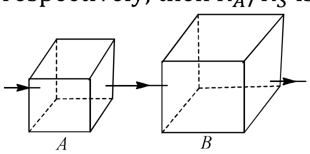
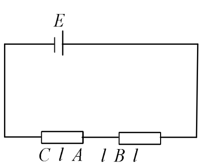
Single Correct Answer Type

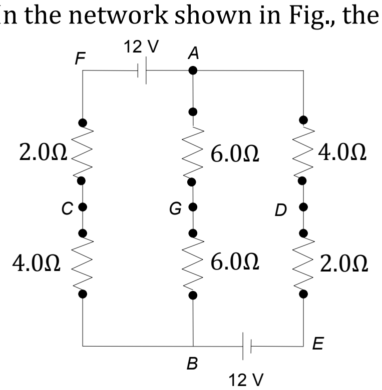
1. Two electric bulbs have tungsten filament of same length. If one of them gives 60 W and the other 100 W, then
   a) 100 W bulb ha thicker filament
   b) 60 W bulb has thicker filament
   c) Both filaments are of same thickness
   d) It is not possible to get different wattages unless the lengths are different
2. Faraday's laws of electrolysis are related to
   a) The atomic number of positive ion   b) The equivalent weight of electrolyte
   c) The atomic number of negative ion   d) The velocity of positive ion
3. Two square metal plates A and B are of the same thickness and material. The side of B is twice of that of A. These are connected as shown in Fig. (series connection). If R_A and R_B are the resistances of A and B, respectively, then R_A/R_S is



   a) 1 : 2   b) 2 : 1   c) 1 : 1   d) 4 : 1
4. A cell of e.m.f E volt with no internal resistance is connected to a wire whose cross section changes. The wire has three sections of equal length. The middle section has a radius a, whereas the radius of the outer two sections is $2a$. The ratio of the potential difference across section AB to the potential difference across section CA is

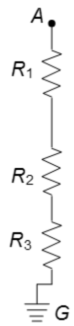


   a) 5   b) 4   c) 1/2   d) 1/4
5. A resistance of 2 Ω is connected across one gap of a meter-bridge(the length of the wire is 100cm) and an unknown resistance, greater than 2 Ω is connected across the other gap. When these resistances are interchanged, the unknown resistance is
   a) 3 Ω   b) 2 Ω   c) 4 Ω   d) 6 Ω
6. In the network shown in Fig., the potential difference across A and B is



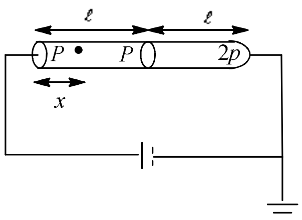
   a) 6 V   b) Zero   c) 2 V   d) 4 V
7. A heater coil is cut into two equal parts and only one part is now used in the heater. The heat generated will now be
   a) Halved   b) One-fourth   c) Four times   d) Doubled

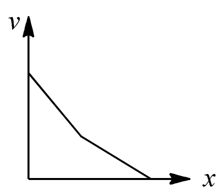
8. A potential of 400 V is applied at the point A. The resistances $R_1 = 1000\ \Omega$, $R_2 = 2000\ \Omega$ and $R_3 = 1000\ \Omega$ are connected between points A and G as shown in Figure. Point G is earthed. The measured potential difference by an ideal voltmeter connected across R_2 is

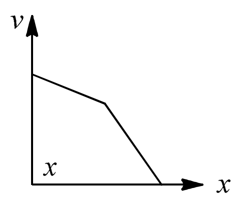


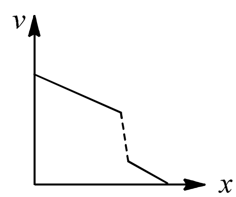
a) 100 V b) 200 V c) 300 V d) 400 V

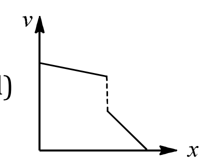
9. Two cylindrical rods of same cross-sectional area and same length are connected in series to an ideal cell as shown. The resistivity of left rod is ρ and that of right rod is 2ρ. Then the variation of potential at any point P distant x from the left end of combined rod system is given by



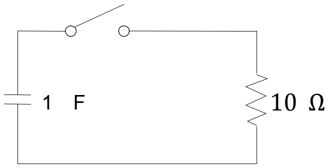
a) 

b) 

c) 

d) 

10. A 1 μ F capacitor holding a charge of 1×10^{-5} C is connected to a 10 Ω resistor via a switch.



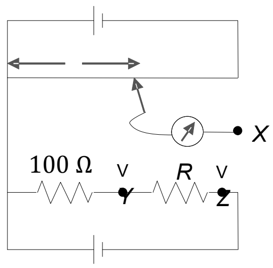
What current will flow after the switch is closed?

a) 0 b) 10^{-5} A c) 1 A d) 10 A

11. A piece of conducting wire of resistance R is cut into $2n$ equal parts. Half the parts are connected in series to form a bundle and remaining half in parallel to form another bundle. These bundles are then connected to give the maximum resistance. The maximum resistance of the combination is

a) $\frac{R}{2}\left(1+\frac{1}{n^2}\right)$ b) $\frac{R}{2}(1+n^2)$ c) $\frac{R}{2(1+n^2)}$ d) $R\left(n+\frac{1}{n}\right)$

12. Figure shows a circuit which may be used to compare the resistance R of an unknown resistor with a 100 Ω standard. The distances l from one end of the potentiometer slider wire to the balance point are 400 mm and 588 mm when X is connected to Y and Z, respectively. The length of the slide wire is 1.00 m. What is the value of resistance R?

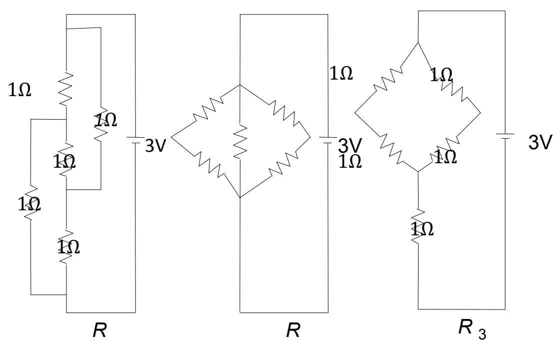


a) 32 Ω b) 47 Ω c) 68 Ω d) 147 Ω

13. A parallel combination of 0.1 MΩ resistor and a 10 μF capacitor is connected across a 1.5 V source of negligible resistance. The time required for the capacitor to get charged up to 0.75 V is approximately (in seconds)

a) ∞ b) $\log_e 2$ c) $\log_{10} 2$ d) Zero

14. Figure shows three resistor configurations R_1, R_2 and R_3 connected to 3 V batteries. If the power dissipated by the configuration R_1, R_2 and R_3 IS P_1, P_2 and P_3, respectively, then



a) $P_1 > P_2 > P_3$ b) $P_1 > P_3 > P_2$ c) $P_2 > P_1 > P_3$ d) $P_3 > P_2 > P_1$

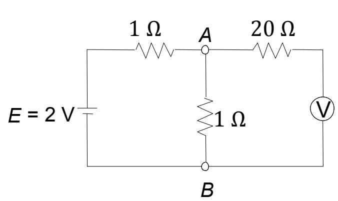
15. A potential difference V is applied to a copper wire of length l and radius r. If V is doubled, the drift velocity

a) Is doubled b) Is halved c) Remains same d) Becomes zero

16. A total charge Q flows across a resistor R during a time interval $= T$ in such a way that the current vs. Time graph for 0 to T is like the loop of a sine curve in the range 0 toπ.
The total heat generated in the resistor is

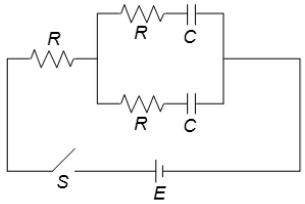
a) $Q^2\pi^2R/8T$ b) $2Q^2\pi^2R/T$ c) $Q^2\pi^2R/T$ d) $Q^2\pi^2R/2T$

17. In the given circuit, the voltmeter and the electric cell are ideal. Find the reading of the voltmeter



a) 1 V b) 2 V c) 3 V d) None of these

18. The switch S in the circuit diagram (Figure) is closed at $t = 0$. The charge on capacitors at any time t is

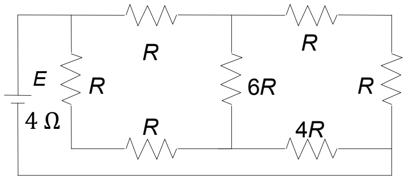


a) $q_{(t)} = EC(1 - e^{-2t/3RC})$ b) $q_{(f)} = EC(1 - e^{-t/2RC})$

c) $q_{(t)} = EC(1 - e^{-t/3RC})$ d) $q_{(f)} = EC(1 - e^{-3t/2RC})$

19. A battery of internal resistance 4 Ω is connected to the network of resistances as shown in Figure. In order

that the maximum power can be delivered to the network, the value of R in Ω should be



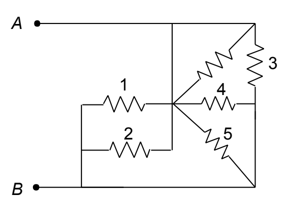
a) $\frac{4}{9}$ b) 2 c) $\frac{8}{3}$ d) 18

20. If a copper wire is stretched to make it 0.1% longer. The percentage change in its resistance is
a) 0.2% increase b) 0.2% decrease c) 0.1% increase d) 0.1% decrease

21. In a metre bridge experiment, null point is obtained at 20 cm from one end of the wire when resistance X is balanced against another resistance Y. If $X < Y$, then where will be the new position of the null point from the same end, if one decides to balance a resistance of $4X$ against Y?
a) 50 cm b) 80 cm c) 40 cm d) 70 cm

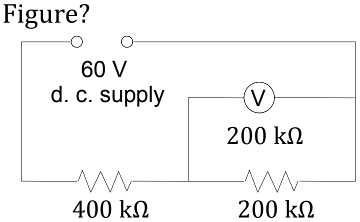
22. The temperature coefficient of resistance of conductor varies as $\alpha(T) = 3T^2 + 2T$. If R_0 is resistance at $T = 0$ and R is resistance at T, then
a) $R = R_0(6T + 2)$ b) $R = 2R_0(3 + 2T)$
c) $R = R_0(1 + T^2 + T^3)$ d) $R = R_0(1 - T + T^2 + T^3)$

23. The circuit shown has resistors of equal resistance R. Find the equivalent resistance between A and B, when the key is closed:



a) $\frac{11R}{12}$ b) $\frac{13R}{12}$ c) $\frac{R}{5}$ d) $\frac{15R}{12}$

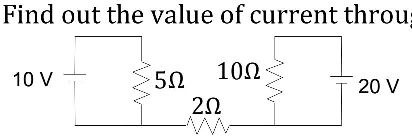
24. A constant 60 V d.c. supply is connected across two resistors of resistance 400 kΩ and 200 kΩ. What is the reading of the voltmeter, also of resistance 200 kΩ, when connected across the second resistor as shown in Figure?



a) 12 V b) 15 V c) 20 V d) 30 V

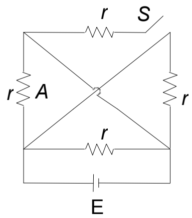
25. A cell of e. m. f. ε and internal resistance r is charged by a current i, then
a) The cell stores chemical energy at the rate of εi
b) The cell stores chemical energy at the rate of $i^2 r$
c) The cell stores chemical energy at the rate of $\varepsilon i - i^2 r$
d) The storage of chemical energy rate cannot be calculated

26. Find out the value of current through 2Ω resistance for the given circuit in Fig.



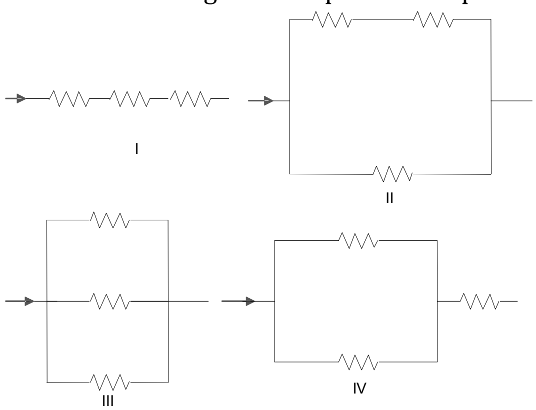
a) Zero b) 2 A c) 5 A d) 4 A

27. In the figure shown, after closing switch S, what is the change in current flowing through A? The battery is ideal



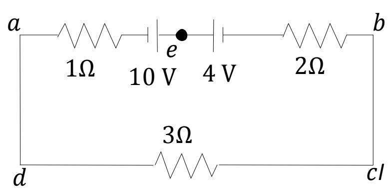
a) No change b) Decreases c) Increases d) Cannot say

28. The three resistances of equal value are arranged in the different combinations shown below. Arrange them in increasing order of power dissipation



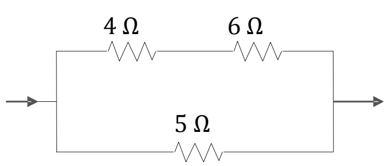
a) III < II < IV <I b) II < III < IV < I c) I < IV < III < II d) I < III < II < IV

29. In the circuit shown in Fig. the magnitudes and the direction of the flow of current, respectively, would be



a) $\frac{7}{3}$ A from a to b via e b) $\frac{7}{3}$ A from b to a via e c) 1 A from b to a via e d) 1 A from a to b via e

30. In the circuit shown in Figure, the heat produced in the 5 Ω resistor due to the current flowing through it is 10 cal s^{-1}. The heat generated in the 4 Ω resistor is



a) 1 cal s^{-1} b) 2 cal s^{-1} c) 3 cal s^{-1} d) 4 cal s^{-1}

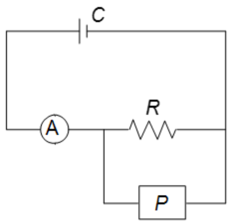
31. Two cylindrical rods of uniform cross-sectional area A and $2A$, having free electrons per unit volume $2n$ and n, respectively, are joined in series. A current I flows through them in steady state. Then the ratio of drift velocity o free electron in left rod to drift velocity of electron in the right rod (V_1/V_R) is

a) 1/2 b) 1 c) 2 d) 4

32. In question 81, after how many time constants will be potential difference across the capacitor fall to 10% of its initial value?

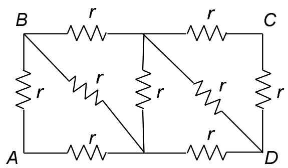
a) 2 b) 2.303 c) $\frac{1}{0.693}$ d) $\frac{1}{0.37}$

33. An ammeter A of finite resistance and a resistor R are joined is series to an ideal cell C. A Potentiometer P is joined in parallel to$R$. The ammeter reading is I_0 and the potentiometer reading isV_0. P is now replaced by a voltmeter of finite resistance. The ammeter reading now is I and the voltmeter reading is$V$. Then



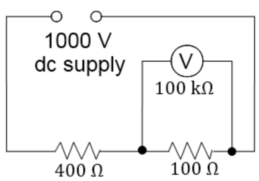
a) $I > I_0, V < V_0$ b) $I > I_0, V > V_0$ c) $I = I_0, V < V_0$ d) $I < I_0, V > V_0$

34. For the circuit shown in Fig., the equivalent resistance between A and C is



a) $\frac{12}{11}r$ b) $\frac{13}{11}r$ c) $\frac{14}{11}r$ d) $\frac{15}{11}r$

35. A constant voltage dc source is connected, as shown in Figure, across two resistors of resistances 400 kΩ and 100 kΩ



What is the reading of the voltmeter, also of resistance 100 k Ω, when connected across the second resistor as shown?

a) 111 V b) 250 V c) 125 V d) 333 V

36. A factory is served by a 220 V supply line. In a circuit protected by a fuse marked 10 A, the maximum number of 100 W lamps in parallel that can be turned on is

a) 11 b) 22 c) 33 d) 66

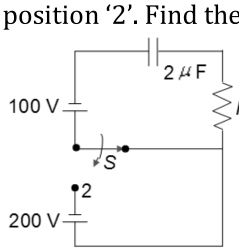
37. A capacitor discharges through a resistance. The stored energy U_0 in one capacitive time constant falls to

a) U_0/e^2 b) eU_0 c) U_0/e d) None of these

38. In the above question what would have been the change in current in A if battery were having some internal resistance

a) No change b) Decreases c) Increases d) Cannot say

39. In the circuit shown in the figure, the switch S is in position '1' for a long time. Now the switch is thrown to position '2'. Find the total heat developed in the circuit till the steady state is reached again



a) 0.04 J b) 0.4 J c) 0.02 J d) 0.2 J

40. N identical cells are connected to form a battery. When the terminals of the battery are joined directly (short-circuited), current I flows in the circuit. To obtain the maximum value of I,

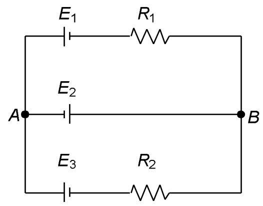
a) all the cells should be joined in series

b) All the cells should be joined in parallel

c) Two rows of $N/2$ cells each should be joined in parallel

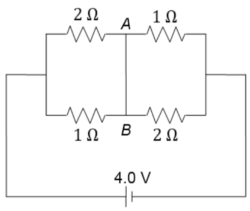
d) $\sqrt{N}$ rows of $N/2$ cells each should be joined in parallel, given that $\sqrt{N}$ is an integer

41. In the circuit shown in Fig. $E_1 = E_2 = E_3 = 2$ V and $R_1 = R_2 = 4$ Ω. The current flowing between points A and B through battery E_2 is



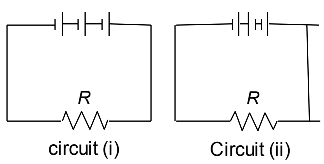
a) Zero b) 2 A from A to B c) 2 A from B to A d) None of the above

42. In Figure, points A and B are connected by a perfectly conducting wire. Calculate the current through AB



a) 2 A b) 1 A c) 1.5 A d) 2.5 A

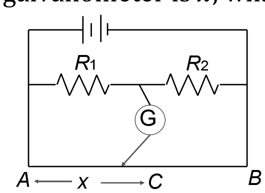
43. Three identical cells, each having an e.m.f. of 1.5 V and a constant internal resistance of 2.0 Ω, are connected in series with a 4.0 Ω resistor R, first as in circuit (i), and secondly as in circuit (ii)



What is the ratio $\frac{\text{Power in } R \text{ in circuit (i)}}{\text{Power in } R \text{ in circuit (ii)}}$?

a) 9.0 b) 7.2 c) 1.8 d) 3.0

44. In the shown arrangement of the experiment of a meter bridge, if AC corresponding to null deflection of galvanometer is x, what would be its value if the radius of the wire AB is doubled?

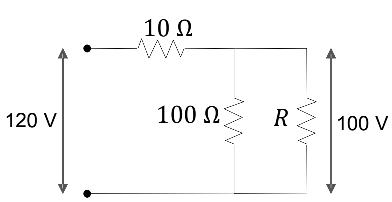


a) x b) $x/4$ c) $4x$ d) $2x$

45. The e.m.f of a cell is ε and its internal resistance is r. Its terminals are connected to a resistance R. The potential difference between the terminals is 1.6 V for $R = 4\Omega$, and 1.8 V for $R = 9\Omega$. Then,

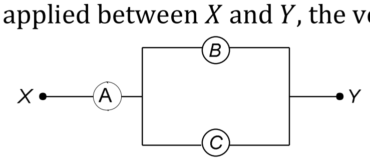
a) $\varepsilon = 1$ V, $r = 1\Omega$ b) $\varepsilon = 2$ V, $r = 1\Omega$ c) $\varepsilon = 2$ V, $r = 2\Omega$ d) $\varepsilon = 2.5$ V, $r = 0.5\Omega$

46. Find out the value of resistance R in Fig.



a) 100 Ω b) 200 Ω c) 50 Ω d) 150 Ω

47. A, B and C are voltmeters of resistance R, $1.5R$ and $3R$, respectively. When some potential difference is applied between X and Y, the voltmeter reading are V_A,V_B and V_C, respectively. Then



a) $V_A = V_B = V_C$ b) $V_A \neq V_B = V_C$ c) $V_A = V_B \neq V_C$ d) $V_B \neq V_A = V_C$

48. A galvanometer has a resistance of 3663Ω. A shunt S is connected across it such that (1/34) of the total

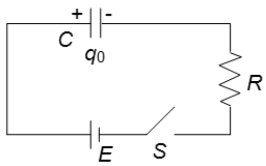
current passes through the galvanometer, the external resistance which must be connected in series with the main circuit so that the total current in the main circuit remains unaltered even when the galvanometer is shunted is

a) 3663 Ω b) 111 Ω c) 107.7 Ω d) 3555.3 Ω

49. Two cells, each of e.m.f. E and internal resistance r are connected in parallel across a resistor R. The power delivered to the resistor is maximum if R is equal to

a) $r/2$ b) r c) $2r$ d) 0

50. A capacitor having initial charge $q_0 = CE/2$ is connected to a cell ofe.m.f. E through a resistor R as shown. Find the total heat generated in the circuit after the switch S is closed.



a) $(1/12)\ CE^2$ b) $(1/8)\ CE^2$ c) $(1/4)\ CE^2$ d) None of these

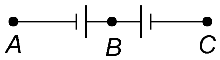
51. A capacitor is charged and then made to discharge through a resistance. The time constant is τ. In what time will the potential difference across the capacitor decreases by 10%?

a) τ In (0.1) b) τ In (0.9) c) τ In (10/9) d) τ In (11/10)

52. In a Wheatstone bridge, resistance P, Q and R are connected in the three arms and the fourth arm is formed by two resistance S_1 and S_2 connected in parallel. The condition for the bridge to be balanced will be

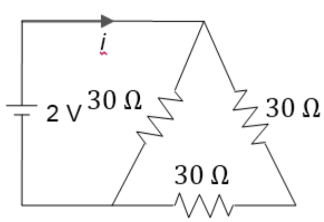
a) $\frac{P}{Q} = \frac{R(S_1 + S_2)}{2S_1S_2}$ b) $\frac{P}{Q} = \frac{R}{S_1 + S_2}$ c) $\frac{P}{Q} = \frac{2R}{S_1 + S_2}$ d) $\frac{P}{Q} = \frac{R(S_1 + S_2)}{S_1S_2}$

53. A potentiometer is connected across A and B and a balance is obtained at 64.0 cm. When potentiometer lead to B is moved to C, a balance is found at 8.0 cm. If the potentiometer is now connected across B and C, a balance will be found at



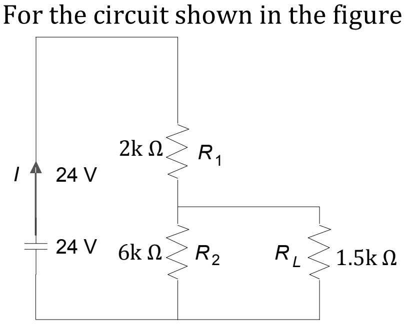
a) 8.0 cm b) 56.0 cm c) 64.0 cm d) 72.0 cm

54. The current i in the circuit is



a) 1/45 A b) 1/15 A c) 1/10 A d) 1/5 A

55. For the circuit shown in the figure



a) The current I through the battery is 7.5mA

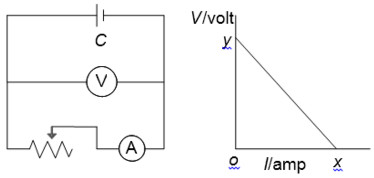
b) The potential difference across R_L is 18 V

c) Ratio of powers dissipated in R_1 and R_2 is 3

d) If R_1 and R_2 are interchanged, magnitude of the power dissipated in R_L will decrease by a factor of 9

56. Figures (a) and (b) show a circuit used in an experiment to determine the e. m. f. and internal resistance of

the battery$C$. A graph was plotted of the potential difference V between the terminals of the battery against the current$I$, which was varied by adjusting the rheostat. The graph is shown in Figure(b); x and y are the intercepts of the graph with the axes as shown. What is the internal resistance of the battery?

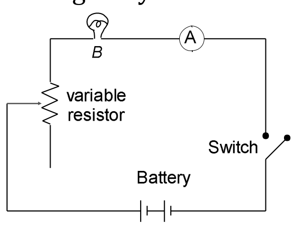


(a) (b)

a) x b) y c) x/y d) y/x

57. The e.m.f. of the driver cell of a potentiometer is 2 V and its internal resistance is negligible. The length of the potentiometer wire is 100 cm and resistance is 5Ω. How much resistance is to be connected in series with the potentiometer wire to have a potential gradient of 0.05mV/cm?
a) 1990 Ω b) 2000 Ω c) 1995 Ω d) None of these

58. In the circuit below (Figure), bulb B does not light although ammetr A indicates that the current is flowing. Why does the bulb not light?



a) The bulb is fused
b) There is break in the circuit between bulb and ammeter
c) The variable resistor has too large resistance
d) There is a break in the circuit between the bulb and the variable resistance

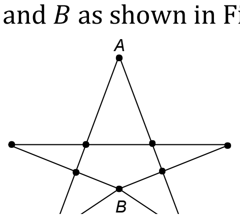
59. When temperature of the conductor is increase, then the collision frequency between current carriers (electrons) and atoms increases. This results in
a) Decrease in the resistance of the conductor
b) Increase in the resistance of the conductor
c) No change in the resistance
d) Decrease or increase in the resistance depending upon the type of the conductor

60. It takes 16 min to boil some water in an electric kettle. Due to some defect it becomes necessary to remove 10% turns of the heating coil of the kettle. After repairs, how much time will it take to boil the same mass of water?
a) 17.7 min b) 14.4 min c) 20.9 min d) 13.7 min

61. n identical cells, each of e.m.f ε and internal resistance r, are joined in series to form a closed circuit. The potential difference across any one cell is
a) Zero b) ε c) $\frac{\varepsilon}{n}$ d) $\frac{n-1}{n}\varepsilon$

62. When two identical batteries of internal resistance 1 Ω each are connected in series across a resistor R, the rate of heat produced in R is J_1. When the same batteries are connected I parallel across R, the rate is J_2. If $J_1 = 2.25\, J_2$ then the value of R in Ω is
a) 4 b) 6 c) 4.8 d) 5.16

63. The resistance of all the wires between any two adjacent dots is R. The equivalent resistance between A and B as shown in Fig. is

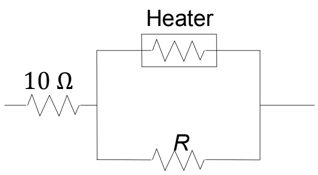


a) $\frac{7}{3}R$ b) $\frac{7}{6}R$ c) $\frac{14}{8}R$ d) None of these

64. Two similar head light lamps are connected in parallel to each other. Together, they consume 48 W from a 6 V battery. What is the resistance of each filament?

a) 6 Ω b) 4 Ω c) 3.0 Ω d) 1.5 Ω

65. A heater is designed to operate with a power of 1000W on a line of 100 V. It is connected in combination with resistance of 10Ω and a resistance R to line of 100 V. the value of R so that entire circuit operates with a power of 625 W is



a) 5 Ω b) 10 Ω c) 15 Ω d) 20 Ω

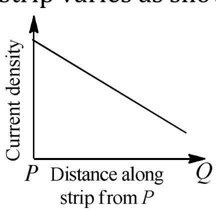
66. A steady current flows in a metallic conductor of non-uniform cross section. The quantity/quantities constant along the length of the conductor is/are

a) Current, electric field and drift speed b) Drift speed only
c) Current and drift speed d) Current only

67. All the edges of a block with parallel faces are unequal. Its longest edge is twice its shortest edge. The ratio of the maximum to minimum resistance between parallel faces is

a) 2
b) 4
c) 8
d) Indeterminate unless the length of the third edge is specified.

68. An electric current flows along an insulated strip PQ of a metallic conductor. The current density in the strip varies as shown in the graph in Fig.



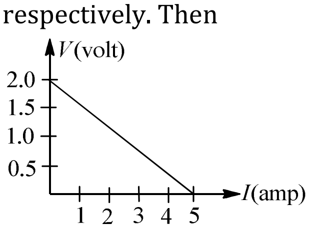
Which of the following statements could explain this variation?

a) The strip is narrower at P that at Q.
b) The strip is narrower at Q than at P.
c) The potential gradient along the strip is uniform.
d) The resistance per unit length of the strip is constant.

69. What amount of heat will be generated in a coil of resistance R due to a charge q passing through it if the current in the coil decreases to zero uniformly during a time interval T?

a) $\frac{4}{3}\frac{q^2R}{T}$ b) $\ln\left(\frac{q^2R}{2T}\right)$ c) $\frac{2q^2R}{3T}$ d) $\ln\left(\frac{2T}{q^2R}\right)$

70. For a cell, a graph is plotted between the potential difference V across the terminals of the cell and the current I drawn from the cell (see Fig.). The e.m.f and the internal resistance of the cell are E and r, respectively. Then



a) $E = 2$ V, $r = 0.5$ Ω b) $E = 2$ V, $r = 0.4$ Ω c) $E > 2$ V, $r = 0.5$ Ω d) $E > 2$ V, $r = 0.4$ Ω

71. A cell of internal resistances r is connected to a load of resistance R. Energy is dissipated in the load, but

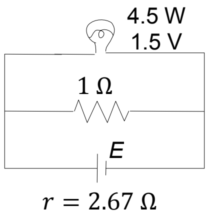
some thermal energy is also wasted in the cell. The efficiency of such an arrangement is found from the expression

$$\frac{\text{Energy dissipated in the load}}{\text{Energy dissipated in the complete circuit}}$$

Which of the following gives the efficiency in this case?

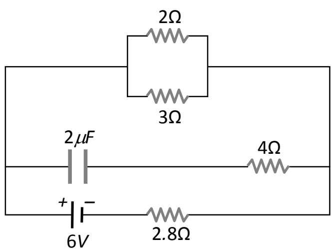
a) $\frac{r}{R}$ b) $\frac{R}{r}$ c) $\frac{r}{R+r}$ d) $\frac{R}{R+r}$

72. A torch bulb rated 4.5 W, 1.5 V is connected as shown in Figure. The e.m.f. of the cell needed to make the bulb glow at full intensity is



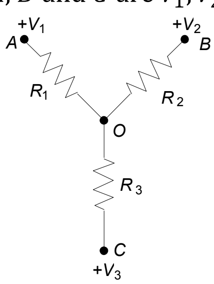
a) 4.5 V b) 1.5 V c) 2.67 V d) 13.5 V

73. In the figure shown, the capacity of the condenser C is 2 μF. The current in 2Ω resistor is



a) 9 A b) 0.9 A c) $\frac{1}{9}A$ d) $\frac{1}{0.9}A$

74. Three resistances are joined together to form a letter Y, as shown in Fig. If the potentials of the terminals A, B and C are V_1, V_2 and V_3, respectively, then determine the potential of the node O



a) $\left[\frac{V_1}{R_1^2}+\frac{V_2}{R_2^2}+\frac{V_3}{R_3^2}\right]\left[\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}\right]^{-2}$

b) $\left[\frac{V_1}{R_1}+\frac{V_2}{R_2}+\frac{V_3}{R_3}\right]\left[\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}\right]^{-1}$

c) $\left[\frac{V_1}{R_1}+\frac{V_2}{R_2}+\frac{V_3}{R_3}\right][R_1+R_2+R_3]$

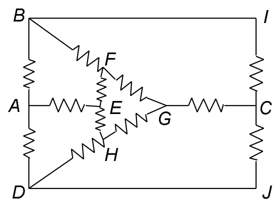
d) $\left[\frac{V_1}{R_1^2}+\frac{V_2}{R_2^2}+\frac{V_3}{R_3^2}\right][R_1^2+R_2^2+R_3^2]$

75. A steady current flows in a metallic conductor of non-uniform cross section. The quantity/quantities constant along the length of the conductor is/are

a) Current, electric field and drift speed b) Drift speed only

c) Current and drift speed d) Current only

76. Find the equivalent resistance between A and E (Resistance of each resistor is R).

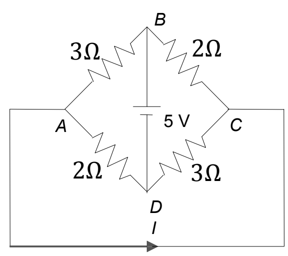


a) $\dfrac{7}{12}R$ b) $\dfrac{7}{13}R$ c) $\dfrac{7}{15}R$ d) $\dfrac{8}{13}R$

77. The resistance of a galvanometer is 10 Ω. It is gives full-scale deflection when 1 mA current is passed. The resistance connected in series for converting it into a voltmeter of 2.5 V will be

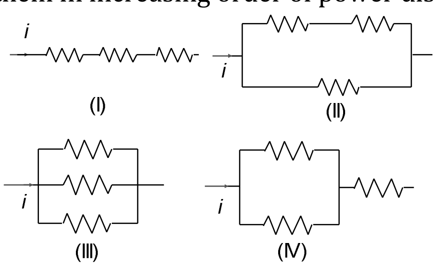
a) 24.9 Ω b) 249 Ω c) 2490 Ω d) 24900 Ω

78. Find the current I shown in the figure



a) −5/12A b) 5/13A c) 12/5A d) 13/5A

79. The three resistances of equal values are arranged in the different combinations shown below. Arrange them in increasing order of power dissipation

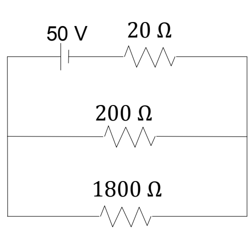


a) III < II < IV < I b) II < III < IV < I c) I < IV < III < II d) I < III < II < IV

80. To get the maximum current through a resistance of 2.5 Ω, one can use m rows of cells, each row having n cells. The internal resistance of each cell is 0.5Ω. What are the valued of n and$m$, if the total number of cells is 45?

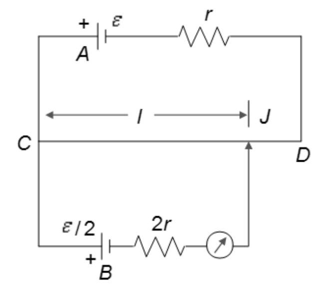
a) 3, 15 b) 5, 9 c) 9, 5 d) 15, 3

81. A voltmeter having a resistance of 1800 Ω is employed to meaure the potential difference across 200 Ω resistance which is connected to be power supply of 50 V and internal resistance 20 Ω. What is the approximate percentage change in the p.d. across 200 Ω resistance as a result of connecting the voltmeter across it?



a) 2.2% b) 5% c) 10% d) 20%

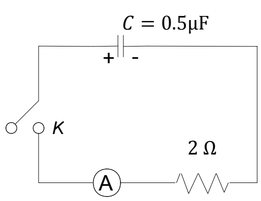
82. In the potentiometer arrangement (Figure), the driving cell A has e. m. f. ε and internal resistance r. The e.m.f. of the cell B is to be rechecked has e.m.f. $\varepsilon/2$ And internal resistance $2r$. The potentiometer wire CD is 100 cm long. If balance is obtained, the length $CJ = I$ is



a) $l = 50$ cm
b) $l > 50$ cm
c) $l < 50$ cm
d) Balance cannot be obtained

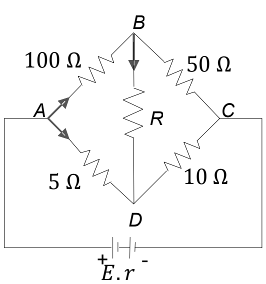
83. A wire of length L and three identical cells of negligible internal resistances are connected in series. Due to the current, the temperature of the wire is raised by ΔT in a time t. A number N of similar cells is now connected in series with a wire of the same material and cross section but of length $2L$. The temperature of the wire is raised by the same amount ΔT in the same time t, the value of N is
a) 4
b) 6
c) 8
d) 9

84. A charged capacitor is allowed to discharge through a resistor by closing the key at the instant $t = 0$ (see Fig.). At the instant $t =$(In 4) μs, the reading of the ammeter falls half the initial value. The resistance of the ammeter is equal to



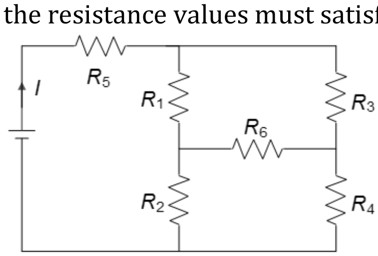
a) 1 MΩ
b) 1 Ω
c) 2 Ω
d) 2 MΩ

85. Figure shows an unbalanced Wheatstone bridge. What is the direction of conventional current between B and D?



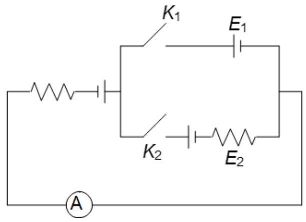
a) B to D
b) D to B
c) Depends on the value of e.m.f E of the cell
d) Depends on the internal resistance of the cell

86. In the given circuit, it is observed that the current I is independent of the value of the resistance R_6. Then the resistance values must satisfy



a) $R_1R_2R_5 = R_3R_4R_6$
b) $\frac{1}{R_5} + \frac{1}{R_6} = \frac{1}{R_1 + R_2} + \frac{1}{R_3 + R_4}$
c) $R_1R_4 = R_2R_3$
d) $R_1R_3 = R_2R_4 = R_5R_6$

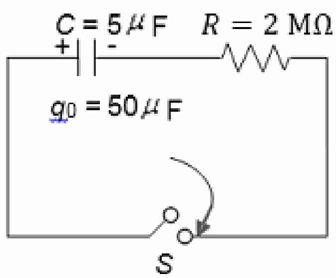
87. In the given arrangement, the reading if ammeter is same in each case when either K_1 or K_2 is closed. The reading of the ammeter is



a) $\frac{E_1 + E_2}{R}$
b) $\frac{E_1 - E_2}{R}$
c) Data given is not sufficient
d) None of these

88. The resistance of hot tungsten filament is about 10 times the cold resistance. What will be the resistance of 100 W and 200 V lamp when not in use?
a) 14000 Ω b) 400 Ω c) 40 Ω d) 4 Ω

89. For the arrangement shown in Fig., the switch is closed at $t = 0$. The time after which the current becomes 2.5 μA is given by (Take in 2=0.69)



a) 10 s b) 5 s c) 7 s d) 0.693 s

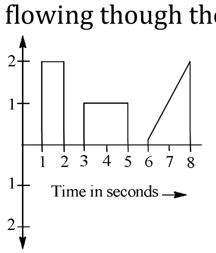
90. An electric kettle (rated accurately at 2.5 kW) is used to heat 3 kg of water from 15°C to boiling point. It takes 9.5 min. Then the amount of heat that has been lost is
a) 3.5×10^5 J b) 7×10^8 J c) 3.5×10^4 J d) 7×10^8 J

91. A wire of length L and three identical cells of negligible internal resistances are connected in series. Due to the current, the temperature of the wire is raised by ΔT in a time t. A number N of similar cells is now connected in series with a wire of the same material and cross section but of length $2L$. The temperature of the wire is raised by the same amount ΔT in the same time t, the value of N is
a) 4 b) 6 c) 8 d) 9

92. An electric current is passed through a circuit containing two wires of the same material, connected in parallel. If the lengths and the radii of the wires are in the ratio of 4/3 and 2/3, then the ratio of the currents passing through the wires will be
a) 3 b) 1/3 c) 8/9 d) 2

93. To deposit one gm equivalent of an element at an electrode, the quantity of electricity needed is
a) One *ampere* b) 96000 *amperes* c) 96500 *farads* d) 96500 *coulombs*

94. The plot represents the flow of current through a wire at three different times. The ratio of charges flowing though the wire at different times is (see Fig.)



a) 2 : 1 : 2 b) 1 : 3 : 3 c) 1 : 1 : 1 d) 2 : 3 : 4

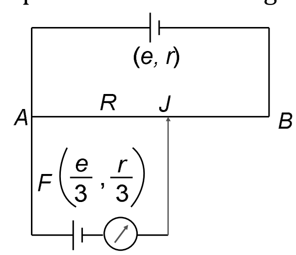
95. The Kirchhoff's first law ($\Sigma\, i = 0$) and second law ($\Sigma iR = \Sigma E$), where the symbols have their usual meanings, are respectively based on

a) Conservation of momentum, conservation of energy
b) Conservation of charge, conservation of energy
c) Conservation of charge, conservation of momentum
d) Conservation of energy, conservation of charge

96. If a wire of resistance 20 Ω is covered with ice and a voltage of 210 V is applied across the wire, then the rate of melting of ice is

a) 8.85 gs^{-1} b) 1.92 gs^{-1} c) 6.56 gs^{-1} d) None of these

97. A potentiometer arrangement is shown in the figure. Deriving cell has e.m.f. e and internal resistance r



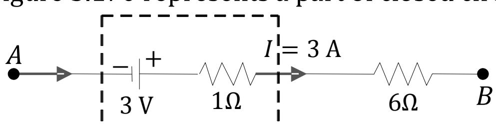
Resistance of potentiometer wire AB is R. F is the cell of e.m.f. $e/3$ and internal resistance $r/3$. Balance points (J) can be obtained for all finite values of

a) $R > r/2$ b) $R < r/2$ c) $R > r/3$ d) $R < r/3$

98. Silver and copper voltameter are connected in parallel with a battery of e.m.f. 12 V. In 30 $minutes$, 1g of silver and 1.8g of copper are liberated. The power supplied by the battery is ($Z_{Cu} = 6.6 \times 10^{-4} g/C$ and $Z_{Ag} = 11.2 \times 10^{-4} g/C$)

a) 24.13 J/sec b) 2.413 J/sec c) 0.2413 J/sec d) 2413 J/sec

99. Figure 5.170 represents a part of closed circuit. The potential difference ($V_A - V_B$) is

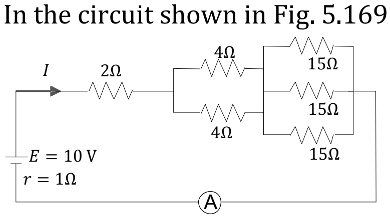


a) 24 V b) 0 V c) 6 V d) 18 V

100. A galvanometer has a resistance of 3663Ω. A shunt S is connected across it such that (1/34) of the total current passes through the galvanometer, the combined resistance of the shunt and the galvanometer is

a) 3665 Ω b) 111 Ω c) 107.7 Ω d) 3555.3 Ω

101. In the circuit shown in Fig. 5.169 the current I has a value equal to



a) 1 A b) 2 A c) 4 A d) 3.5 A

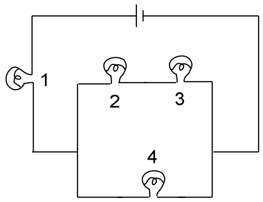
102. A wire has linear resistance ρ (in Ω/m). Find the resistance R between points $A$and B if the side of the big square is$d$.

a) $\frac{\rho d}{\sqrt{2}}$ b) $\sqrt{2\rho d}$ c) $2\rho d$ d) None of these

The temperature coefficient of resistance at temperature t°C is

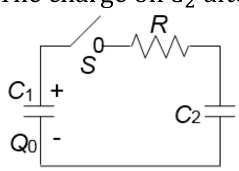
a) $\dfrac{(1+at+\beta t^2)}{a+2\beta t}$ b) $(a+2\beta t)$ c) $\dfrac{a+2\beta t}{(1+at+\beta t^2)}$ d) $\dfrac{a+2\beta t}{2(1+at+\beta t^2)}$

104. All bulbs in Figure are identical. Which bulb lights more brightly?



a) 1 b) 2 c) 3 d) 4

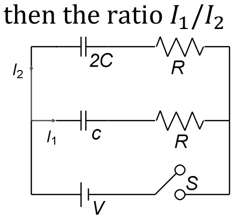
105. In the circuit shown, the capacitor C_1 is initially charged with chargeq_0. The switch S is closed at time$t=0$. The charge on C_2 after time t is



a) $\dfrac{q_0C_1}{C_1+C_2}\left(1-e^{\frac{t(C_1+C_2)}{C_1C_2R}}\right)$ b) $\dfrac{q_0C_2}{C_1+C_2}\left(I-e^{\frac{t(C_1+C_2)}{C_1C_2R}}\right)$

c) $\dfrac{q_0C_1}{C_1+C_2}\left(1-e^{\frac{t}{C_2R}}\right)$ d) $\dfrac{q_0C_2}{C_1+C_2}\left(1-e^{\frac{t}{C_2R}}\right)$

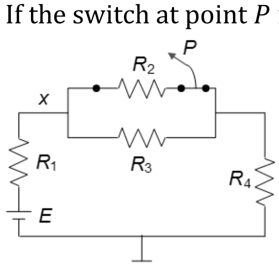
106. In the circuit shown in Fig. switch S is closed at time $t=0$, Let I_1 and I_2 be the currents at any finite time t, then the ratio I_1/I_2



a) Is constant b) Increases with time

c) Decreases with time d) First increases, then decreases

107. If the switch at point P is opened (shown in the figure), hoose the correct option.



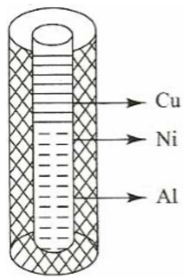
a) The current in R_1 would not change

b) The potential difference between point X and the ground would increase

c) The current provided by the battery would increase

d) The e. m. f. produced by the battery (assumed to have no internal resistance) would change

108. A metal wire of length L and radius r is made of copper and aluminium contributing equal lengths (Figure). This wire is now coated by nickel till the radius of wire becomes R. if specific, resistances of these materials are ρ_{Cu}, ρ_{Al} and ρ_{Ni} the equivalent conductance of the system across the length will be

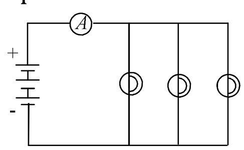


a) $\frac{\pi r^2}{L}\left[\frac{1}{\rho_{Cu}}+\frac{1}{\rho_{A1}}+\frac{R^2}{r^2\rho_{Ni}}\right]$ b) $\frac{\pi}{L}\left[\frac{r^2}{\rho_{Cu}}+\frac{r^2}{\rho_{A1}}+\frac{2(R^2-r^2)}{r\rho_{Ni}}\right]$
c) $\frac{\pi}{L}\left[\frac{2(R^2-r^2)}{\rho_{Cu}+\rho_{A1}}-\frac{r^2}{\rho_{Ni}}\right]$ d) $\frac{\pi}{r}\left[\frac{2r^2}{\rho_{Cu}+\rho_{A1}}+\frac{R^2-r^2}{\rho_{Ni}}\right]$

109. Two electric bulbs, rated for the same voltage, have powers of 200 and 100 W, respectively. If their resistances are r_1 and r_2, respectively, then
a) $r_1 = 2r_2$ b) $r_2 = 2r_1$ c) $r_2 = 4r_1$ d) $r_1 = 4r_2$

110. In the question 79, if the switch is opened after the capacitor has been charged, it will discharge with a time constant
a) RC b) 2 RC c) $\frac{1}{2}RC$ d) RC In2

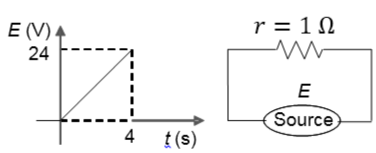
111. Three similar light bulbs are connected to a constant voltage d.c. supply as shown in Figure. Each bulb operates at normal brightness and the ammeter (of negligible resistance) registers a steady current



The filament of one of the bulbs breaks. What happens to the ammeter reading and to the brightness of the remaining bulbs?

	Ammeter reading	*Bulb brightness*
a)	Increases	Increases
b)	Increases	Increases
c)	Unchanged	Unchanged
d)	Decreases	Unchanged

112. A resistance $R = 12\ \Omega$ is connected across a source of e.m.f. as shown In the figure. Its e. m. f. changes with time as shown in the graph. What is the heat developed in the resistance in the first 4 s?

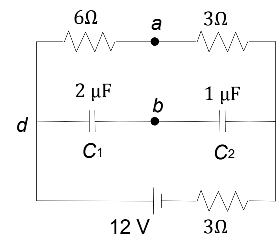


a) 72 J b) 64 J c) 108 J d) 100 J

113. An electric immersion heater of 1.08 kW is immersed in water. After it has reached a temperature of 100°C, how much time will be required to produce 100 g of steam?
a) 50 s b) 420 s c) 105 s d) 210 s

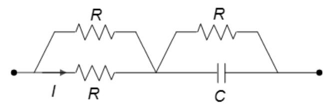
114. In an experiment to measure the internal resistance of a cell by a potentiometer, it is found that the balance point is at a length of 2 m when the cell is shunted by a 5 Ω resistance and is at a length of 3 m when the cell is shunted by a 10 Ω resistance, the internal resistance of the cell is when
a) 1.5 Ω b) 10 Ω c) 15 Ω d) 1 Ω

115. What is the charge stored on each capacitor C_1 and C_2 in the circuit shown below?



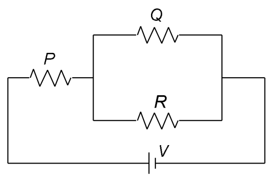
a) 6 μC, 6μC b) 6 μC, 3 μC c) 3 μC, 6 μC d) 3 μC, 3 μC

116. The capacitor shown in Figure is in steady state. The energy stored in the capacitor is



a) CI^2R^2 b) $2CI^2R^2$ c) $4CI^2R^2$ d) None of the above

117. Resistors P, Q and R in the circuit have equal resistances. If the battery is supplying a total power of 12 W, what is the power dissipated as heat in resistor R



a) 2 W b) 6 W c) 3 W d) 8 W

118. A constant voltage is applied between the two ends of a uniform metallic wire. Some heat is developed in it. The heat developed is doubled if

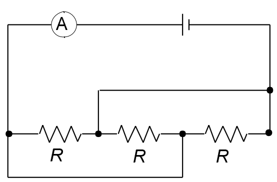
a) Both the length and the radius of the wire are halved

b) Both the length and the radius of the wire are doubled

c) The radius of the wire is doubled

d) The length of the wire is doubled

119. Figure 5.168 represents a load consisting of three identical resistances connected to an electric energy source of e.m.f. 12 V and internal resistance 0.6Ω. The ammeter reads 2 A. The magnitude of each resistance is

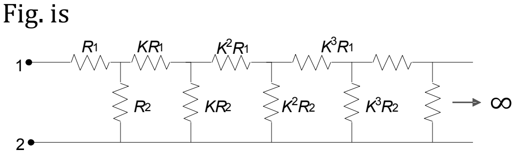


a) 3.6 Ω b) 7.2 Ω c) 16.2 Ω d) 10.8 Ω

120. In the above question, if the balancing length for a cell of e.m.f. E is 60 cm, the value of E will be

a) 3 mV b) 5 mV c) 6 mV d) 2000 Ω

121. The circuit diagram shown in Fig. consists of a large number of elements (each element has two resistors). The resistance of the resistors in each subsequent element differs by a factor of $K = 1/2$ from the resistances of the resistors in the previous elements. The equivalent resistance between A and B shown in Fig. is



a) $\frac{R_1 - R_2}{2}$

b) $\frac{(R_1 - R_2) + \sqrt{6R_1R_2}}{2}$

c) $\frac{(R_1 - R_2) + \sqrt{R_1^2 + R_2^2 + 6R_1R_2}}{2}$

d) None of these

into voltmeter of range nV volt is

a) nG b) $(n-1)G$ c) G/n d) $G/(n-1)$

123. A potential difference V is applied to a copper wire of length l and radius r. If length is doubled, the drift velocity

a) Is doubled b) Is halved c) Remains same d) Becomes zero

124. A capacitor of capacitance C has charge Q. It is connected to an identical capacitor through a resistance. The heat produced in the resistance is

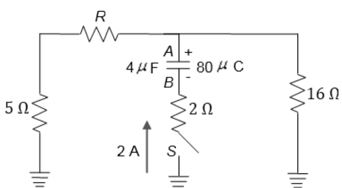
a) $\frac{Q^2}{2C}$

b) $\frac{Q^2}{4C}$

c) $\frac{Q^2}{8C}$

d) Dependent on the value of the resistance

125. An 80 μC charge is given to the 4 μF capacitor in the circuit shown in Figure so that the upper plate A is positively charged. An unknown resistance R is connected in the left limb. As soon as the switch S in the central limb is closed, a current of 2 A flows through the 2 Ω resistor in the central limb. The capacitive time constant for the circuit is

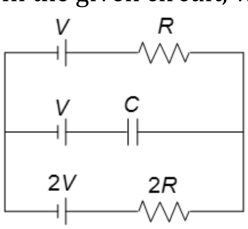


a) 56 μs b) 8 μs c) 200 μs d) 40μs

126. In the previous problem, the power lost in the cable during transmission is

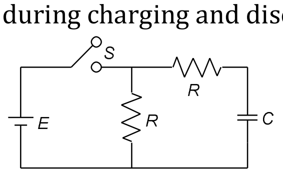
a) 3.15 kW b) 12.5 kW c) 6.25 kW d) 25 kW

127. In the given circuit, with steady current, the potential drop across the capacitor must be



a) V b) $V/2$ c) $V/3$ d) $2V/3$

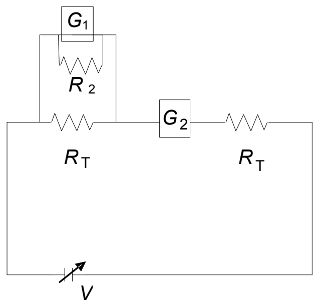
128. A capacitor C is connected to the two equal resistances as shown in Fig. What is the ratio of time constant during charging and discharging of the capacitance?



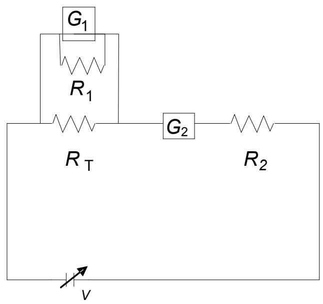
a) 1 : 1 b) 2 : 1 c) 1 : 2 d) 4 : 1

129. To verify Ohm's law, a student is provided with a test resistor R_T, a high resistance R_1, a small resistance R_2, two identical galvanometers $G_1$and $G_2$and a variable voltage source V. the correct circuit to carry out the experiment is

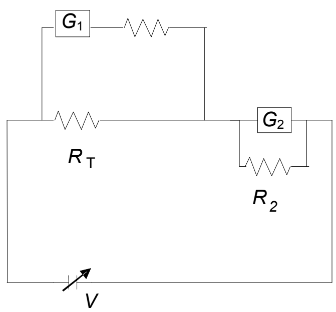
a)



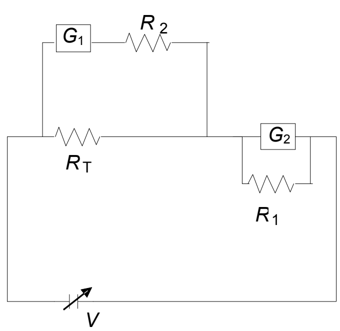
b)



c)



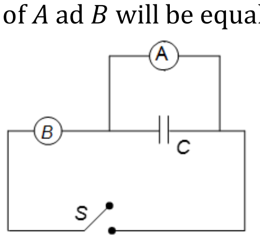
d)



130. If a given volume of water in a 220 V heater is boiled in 5 min, then how much time will it take for the same volume of water in a 110 V heater to be boiled?

a) 20 min b) 30 min c) 25 min d) 40 min

131. A capacitor of capacitance C is connected to two voltmeter A and B (Figure). A Is ideal, having infinite resistance, while B has resistance$R$. The capacitor is charged and then the switch S is closed. The readings of A ad B will be equal

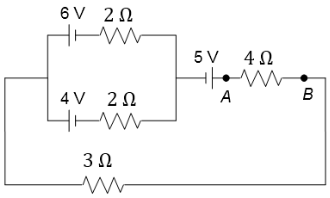


a) At all times b) After time RC

c) After time RC in 2 d) Only after a very long time

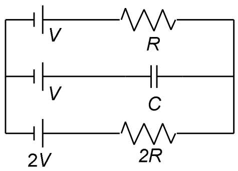
132. In the circuit shown (Figure), what is the change of total electrical energy stored in the capacitors when

the key is pressed?



a) $\frac{CV^2}{12}$ b) $\frac{7CV^2}{8}$ c) $\frac{5CV^2}{4}$ d) $\frac{3CV^2}{8}$

133. In the given circuit of Fig., with steady current, the potential drop across the capacitor must be



a) V b) $V/2$ c) $V/3$ d) $2\,V/3$

134. The operating temperature of the filament of lamp is 2000°C. The temperature coefficient of the material of filament is 0.005°C^{-1}. If the atmospheric temperature is 0°C, then the current in the 100 W-200 V lamp when it is switched on is nearest to

a) 2.5 A b) 3.5 A c) 4.5 A d) 5.5 A

135. A spherical shell, made of material of electrical conductivity $10^9/\pi(\Omega\text{m})^{-1}$, has thickness $t = 2$ mm and radius $R = 10$ cm. In an arrangement, it's inside surface is kept at a lower potential than its outside surface

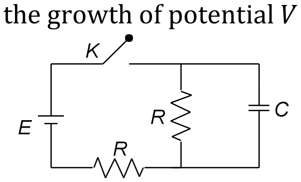
The resistance offered by the shell is equal to

a) $5\pi \times 10^{-12}\Omega$ b) $2.5\times 10^{-11}\Omega$ c) $5\times 10^{-12}\Omega$ d) $5\times 10^{-11}\Omega$

136. A constant voltage is applied between the two ends of a metallic wire. If both the length and the radius of the wire are doubled, the rate of heat developed in the wire will

a) Be halved b) Be doubled c) Remain the same d) Be quadrupled

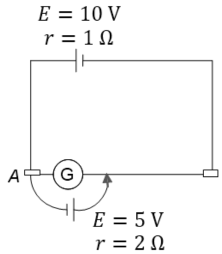
137. In the circuit shown in the diagram, E is the e.m.f of the cell, connected of resistances each f magnitude R and a capacitor of capacitance C as shown in the diagram. If the switch key K is connected at time $t = 0$, the growth of potential V across the capacitor will be correctly given by



a) $V(t) = E\left[1 - \exp\left(-\frac{t}{RC}\right)\right]$ b) $V(t) = \frac{E}{2}\left[1 - \exp\left(-\frac{2t}{RC}\right)\right]$

c) $V(t) = E\left[1 - \exp\left(-\frac{2t}{RC}\right)\right]$ d) $V(t) = \frac{E}{2}\left[1 - \exp\left(-\frac{t}{RC}\right)\right]$

138. For the potentiometer arrangement shown in the figure, length of wire AB is 100 cm and its resistance is 9Ω. Find the length AC for which the galvanometer G will show zero deflection



a) 66.7 cm b) 60 cm c) 50 cm d) 33.3 cm

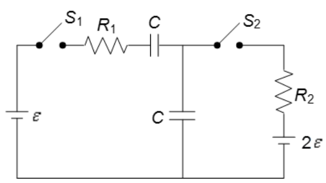
139. A battery is supplying power to a tape recorder by cable of resistance of 0.02 Ω. if the battery is generating 50 W power at 5 V, then the power received by the tape recorder is

a) 50 W b) 45 W c) 30 W d) 48 W

140. Two wires of same dimensions but resistivities ρ_1 and ρ_2 are connected in series. The equivalent resistvity of the combination is

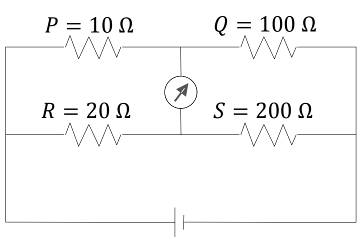
a) $\sqrt{\rho_1\rho_2}$ b) $\rho_1 + \rho_2$ c) $\frac{\rho_1 + \rho_2}{2}$ d) None of the above

141. In the circuit shown (Figure), switch S_2 is closed first and is kept closed for a long time. Now S_1 is closed. Just after that instant, the current through S_1 is



a) $\frac{\varepsilon}{R_1}$ towards right b) $\frac{\varepsilon}{R_1}$ towards left c) Zero d) $\frac{2\varepsilon}{R_1}$

142. Figure shows a balanced Wheatstone net. Now, it is disturbed by changing P to 11Ω. Which of the following steps will not bring the bridge to balance again?

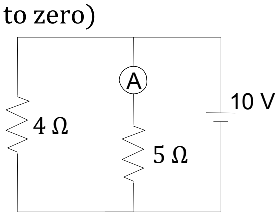


a) Increasing R by 2 Ω b) Increasing S by 20 Ω
c) Increasing $Q$by 10 Ω d) Making product $RQ = 2200(\Omega)^2$

143. When a galvanometer is shunted with a 4 Ω resistance, the deflection is reduced to 1/5. If the galvanometer is further shunted with a 2 Ω wire, the new deflection will be (assuming the main current remains the same)

a) 5/13 of the deflection when shunted with 4 Ω only
b) 8/13 of the deflection when shunted with 4 Ω only
c) 3/4 of the deflection when shunted with 4 Ω only
d) 3/13 of the deflection when shunted with 4 Ω only

144. In the circuit shown in Figure, the reading of the ammeter is (assume internal resistance of the battery be to zero)



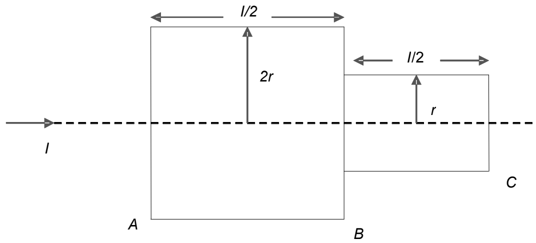
a) $\frac{40}{29}$ A b) $\frac{10}{9}$ A c) $\frac{5}{3}$ A d) 2 A

145. A 1°C rise in temperature is observed in a conductor by passing a certain current. If the current is doubled,

then the rise in temperature is approximately

a) 2.5 °C b) 4°C c) 2°C d) 1°C

146. Two bars of radius r and $2r$ are kept in contact as shown. An electric current I is passed through the bars. Which one of following is correct?



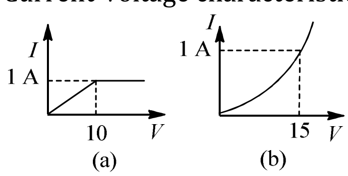
a) Heat produced in bar BC is 4 times the heat produced in bar AB

b) Electric field in both halves is equal

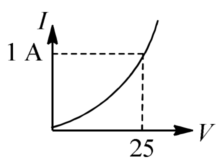
c) Current density across AB is double that of across BC

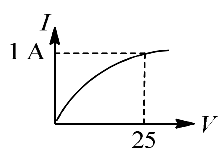
d) Potential difference across AB is 4 times that of across BC

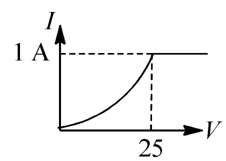
147. Current-voltage characteristics of two elements A and B are as shown in Figure and (a)and (b)

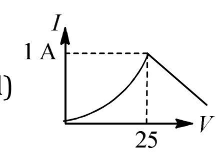


Which of the following graphs represents current-voltage characteristics for their series combination?

a) 

b) 

c) 

d) 

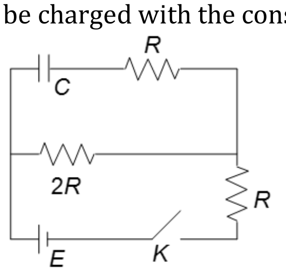
148. A potential difference V is applied to a copper wire of length l and radius r. If radius is doubled, the drift velocity

a) Is doubled b) Is halved c) Remains same d) Becomes zero

149. An ammeter is obtained by shunting a 30 Ω galvanometer with a 30 Ω resistance. What additional shunt should be connected across it to double the range?

a) 15 Ω b) 10 Ω c) 5 Ω d) None of these

150. In the given circuit, the capacitor of capacitance C is charged by closing key K at $t = 0$.
Find the time required to charge the capacitor up to the maximum charge for the given circuit, if it were to be charged with the constant initial charging rate at t= 0 in the given circuit

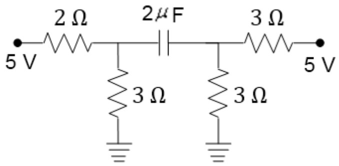


a) $\frac{RC}{3}$ b) $\frac{2RC}{5}$ c) $\frac{2RC}{3}$ d) $\frac{5RC}{3}$

151. A 100 W bulb designed to operate on 100 V is to be connected across a 500 V source. Find the resistance to be put in series so that bulb consumes 100 W only

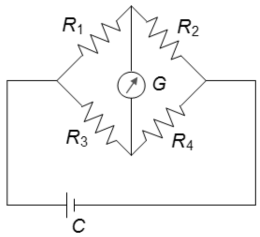
a) 100 Ω b) 500 Ω c) 400 Ω d) 300 Ω

152. The charge on the capacitor in steady state in the circuit shown (Figure) is



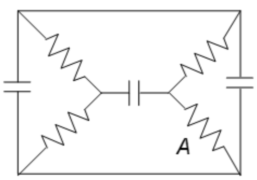
a) 0.5 μC   b) 1 μC   c) 2 μC   d) 4 μC

153. The Wheatstone's bridge shown in the Figure is balanced. If the positions of the cell C and the galvanometer G are now interchanged, G will show zero deflection



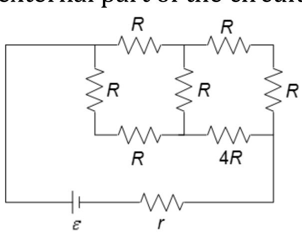
a) In all cases   b) Only if all the resistances are equal
c) Only if $R_1 = R_3$ and $R_2 = R_4$ d) Only if $R_1/R_3 = R_2/R_4$

154. Each resistor in the following circuit (Figure) has a resistance of 2 M Ω and the capacitors have capacitances of 1 μF. The battery voltage is 3 V. the voltage across the resistor A in the following circuit in steady state is



a) 0 V   b) 0.5 V   c) 0.75 V   d) 1.5 V

155. The relation between R and r (internal resistance of the battery) for which the power consumed in the external part of the circuit is maximum.

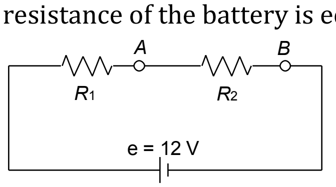


a) $R = r$ b) $R = r/2$ c) $R = 2r$ d) $R = 1.5\,r$

156. A 25 W-220 V bulb and a 100 W-220 V bulb are connected in series across a 220 V line; which electric bulb will glow more brightly?

a) 25 W bulb   b) 100 W bulb
c) Both will have equal incandescence   d) Neither will give light

157. When an ammeter of negligible internal resistance is inserted in series with circuit, it reads 1 A. When the voltmeter of very large resistance is connected across R_1, it reads 3 V. But when the points A and B are short-circuited by a conducting wire, then the voltmeter measures 10.5 V across the battery. The internal resistance of the battery is equal to

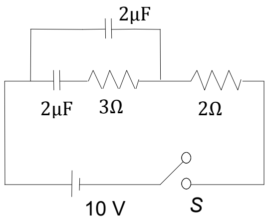


a) $\frac{3}{7}\Omega$ b) 5 Ω   c) 3 Ω   d) None of these

158. The power rating of an electric motor which draws a current of 3.75 A, when operated at 200 V, is nearly

a) 54 W   b) 1 hp   c) 500 W   d) 750 hp

159. Current through the battery at instant when the switch S is closed is (see Fig.)



a) Zero
b) 2 A
c) 4 A
d) 5 A

160. If the length of the filament of a heater is reduced by 10%, the power of the heater will

a) Increase by about 9%
b) Increase by about 11%
c) Increase by about 19 %
d) Decrease by about 10 %

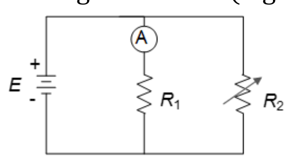
161. When a motor car is started, its light becomes slightly dim because of

a) Induced current in the coil
b) Starter draws low current
c) Starter draws high current
d) Battery e.m.f. falls

162. An electric bulb rated for 500 W at 100 V is used in a circuit having a 200 V supply. The resistance R that must be put in series with the bulb, so that the bulb draws 500 W, is

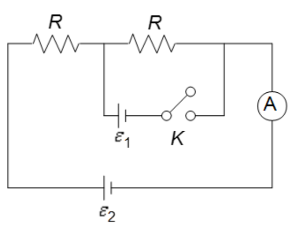
a) 18 Ω
b) 20 Ω
c) 40 Ω
d) 700 Ω

163. In the given circuit (Figure) in which case will the ammeter reading not change when R_2 is varied?



a) $R_1 = r$
b) $R_1 = 2r$
c) $R_1 > R_2$
d) $r = 0$

164. In the given circuit (Figure), when key K is open, reading of ammeter is I. Now key K is closed then the correct statement is

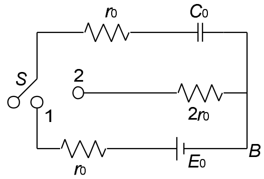


a) If $\varepsilon_1 < IR$, reading of the ammeter is less then I
b) If $IR < \varepsilon_1$, reading of the ammeter is greater than I
c) If $\varepsilon_1 < 2IR$, reading of the ammeter will be zero
d) Reading of ammeter will not change

165. Three bulbs of 40, 60 and 100 W are connected in series with a 240 V source

a) The potential difference will be maximum across the 40 W bulb
b) The current will be maximum in 100 W bulb
c) The resistance of the 40 W bulb is minimum
d) The current through the 60 W bulb will be 0.1 A

166. In the circuit given in Fig. switch S is at position 1 for long time. Find the total heat generated in resistor of resistance $(2r_0)$, when the switch S is shifted from position 1 to position 2



a) $\frac{C_0E_0^2}{}$
b) $C_0E_0^2$
c) $\frac{C_0E_0^2}{}$
d) None

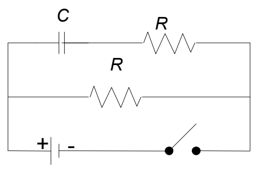
167. A galvanometer has a resistance of 3663Ω. A shunt S is connected across it such that (1/34) of the total current passes through the galvanometer. The value of the shunt is

a) 3663 Ω b) 111 Ω c) 107.7 Ω d) 3555.3 Ω

168. n identical cells, each of e.m.f ε and internal resistance r, are joined in series to form a closed circuit. One cell A is joined with recersed polarity. The potential difference across each cell, except A, is

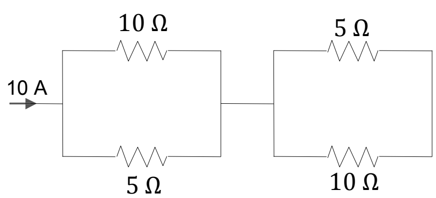
a) $\frac{2\varepsilon}{n}$ b) $\frac{n-1}{n}\varepsilon$ c) $\frac{n-2}{n}\varepsilon$ d) $\frac{2n}{n-2}\varepsilon$

169. In the circuit shown in Fig., when the switch is closed, the capasitor charges with a time constant



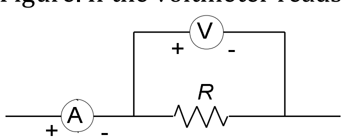
a) RC b) $2\ RC$ c) $\frac{1}{2}RC$ d) $RC\ \log 2$

170. Four resistances carrying a current shown in Figure are immersed in a box containing ice at 0°C. How much ice must be put in the box every 10 min to keep the average quantity of ice in the box constant? Latent heat of ice is 80 cal g^{-1}



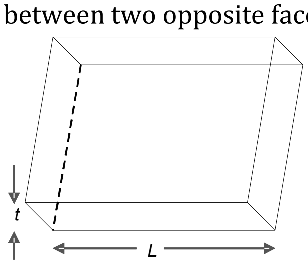
a) 1.190 kg b) 3.20 kg c) 4.2 kg d) 0.25 kg

171. A candidate connects a moving coil voltmeter V, a moving coil ammeter A and a resisot R as shown in Figure. If the voltmeter reads 20 V and the ammeter reads 4 A, R is



a) Equal to 5 Ω
b) Greater than 5 Ω
c) Less than 5 Ω
d) Greater or less than 5 Ω depending upon its material

172. Consider a thin square sheet of side L and thickness t, made of a material of resistivity ρ. The resistance between two opposite faces, shown by the shaded areas in the figure is



a) Directly proportional to L
b) Directly proportional to t
c) Independent of L
d) Independent of t

173. Consider a cell of e. m. f. and internal resistance$r$. Its terminals are directly connected. Some current I is obtained in the circuit. Now take two such cells

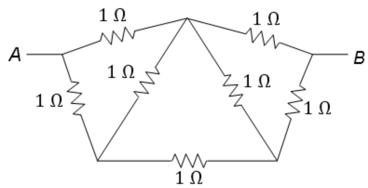
a) Current more than I can be obtained if both cells are connected in series and shorting the two ends

b) Current more than I can be obtained if both cells are connected in parallel and then shorting the two ends of cells

c) Both of the above

d) None of the above

174. Find the effective resistance between A and $A2$

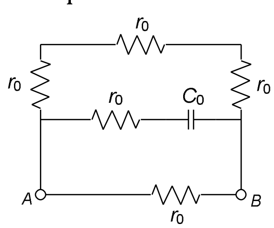


a) 2 Ω b) 1 Ω c) 8/7 Ω d) 7 Ω

175. The two ends of a uniform conductor with some resistance are joined to a cell of e.m.f E and some internal resistance r. Starting from the midpoint P of the conductor, we move in the direction of current and return to P while moving through the complete circuit. The potential V at every point on the path is plotted against the distance covered (x). Which of the following graphs best represents the resulting curve?

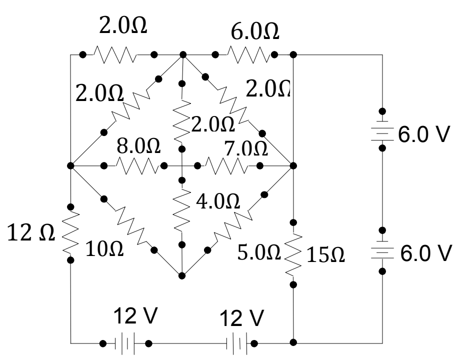
a) b) c) d)

176. Find equivalent resistance between points A and B in Fig. when the circuit is in the steady state



a) $\frac{3}{4}r_0$ b) $\frac{4}{3}r_0$ c) $\frac{5}{3}r_0$ d) None of these

177. The current through the 8 Ω resistor (shown in Fig.) is



a) 4 A b) 2 A c) Zero d) 2.5 A

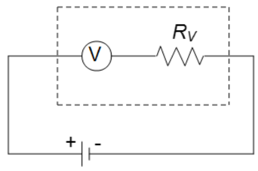
178. The belt of an electrostatic generator is 50 cm wide and travels 30 cm/s. The belt caries charge into the sphere at a rate corresponding to 10^{-4} A. What is the surface density of charge on the belt.

a) 6.7×10^{-5} Cm^{-2} b) 6.7×10^{-4} Cm^{-2} c) 6.7×10^{-7} Cm^{-2} d) 6.7×10^{-8} Cm^{-2}

179. A cable of resistance 10 Ω carries electric power from a generator producing 250 kW at 10,000 V. The current in the cable is

a) 1,000 A b) 250 A c) 100 A d) 25 A

180. A voltmeter with resistance $R_V = 2500\Omega$ indicates a voltage of 125 V in the circuit shown in Figure. What is the series resistance (R) to be connected with voltmeter in this circuit so that it indicates 100 V?

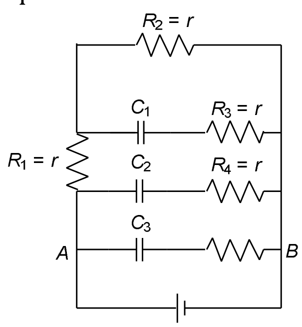


a) 625 Ω b) 120 Ω c) 550 Ω d) Data are insufficient

181. Two circular rings of identical radii and resistance of 36 Ω each are placed in such a way that they cross each other''s center C_1 and C_2 as shown in Figure. conducting joints are made at intersection points A and B of the rings. An ideal cell of e.m.f. 20 V is connected acrossAB. The power delivered by cell is

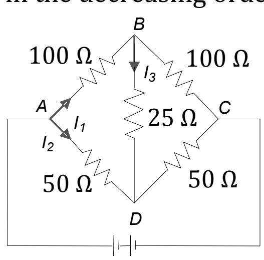
a) 80 W b) 100 W c) 120 W d) 200 W

182. The equivalent resistance between points A and B in Fig. at steady state will be



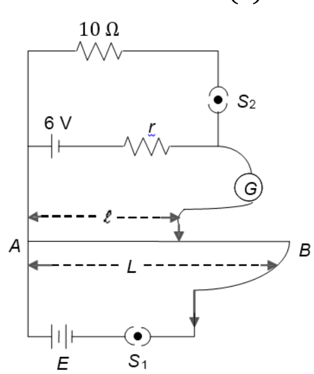
a) $2r$ b) $\frac{3}{5}r$ c) $\frac{5}{3}r$ d) None of these

183. Figure shows a Wheatstone bridge circuit. Which of the following correctly shows the currents I_1, I_2 and I_3 in the decreasing order of magnitude?



a) I_1, I_2, I_3 b) I_2, I_3, I_1 c) I_2, I_1, I_3 d) I_3, I_2, I_1

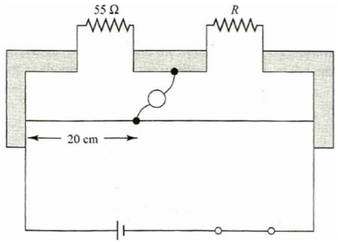
184. In the arrangement shown in Figure, when the switch S_2 is open, the galvanometer shows no deflection for$\ell = L/2$. When the switch S_2 is closed, the galvanometer shows no deflection for$\ell = 5/21L$. The internal resistance (r) of 6 V cell, and the e.m.f. E of the other battery are respectively



a) 3 Ω, 8 V b) 2 Ω, 12 V c) 2 Ω, 24 V d) 3 Ω, 12 V

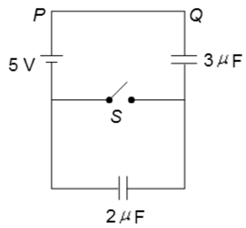
185. Figure shows a meter-bridge set up with null deflection in the galvanometer. The value of the unknown

resistor R is



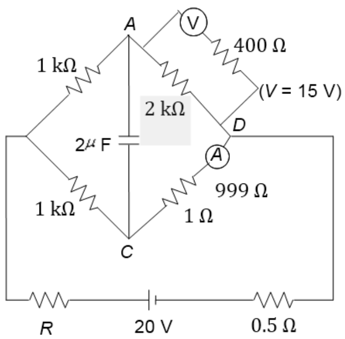
a) 110 Ω b) 55 Ω c) 13.75 Ω d) 220 Ω

186. In figure, the charge that flows from P and Q when the switch S is closed is



a) 3 μC b) 6 μC c) 9 μC d) 15 μC

187. Calculate the energy stored in the capacitor of capacitance 2 μF. The voltmeter gives a reading of 15 V and the ammeter A reads 15 mA



a) 5 μJ b) 10 μJ c) 0.5 μJ d) Zero

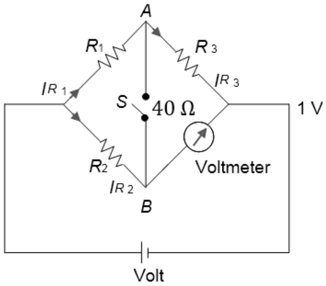
188. The charge flowing through a resistance R varies with time t as $Q = at - bt^2$. The total heat produced in R is

a) $\frac{a^3R}{6b}$ b) $\frac{a^3R}{3b}$ c) $\frac{a^3R}{2b}$ d) $\frac{a^3R}{b}$

189. A moving coil galvanometer of resistance 100Ωis used as an ammeter using a resistance 0.1Ω. The maximum deflection current in the galvanometer is 100μA. Find the minimum current in the circuit so that the ammeter shows maximum deflection

a) 100.1mA b) 1000.1mA c) 10.01mA d) 1.01mA

190. In the given circuit (Figure), $R_1 \neq R_2$ and the reading of the voltmeter is the same, irrespective of whether the switch S is open or closed. Then, which of the following is correct?

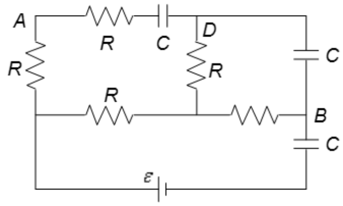


a) $I_{R_2} = I_V$ b) $I_{R_1} = I_{R_2}$ c) $I_{R_3} = I_V$ d) None of the above

191. A battery of internal resistance r having no load resistance has an e.m.f E volt. What is the observed e.m.f across the terminals of the battery when a load resistance $R\ (= r)$ is connected to its terminals?

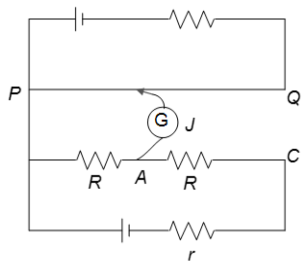
a) $2E$ volt b) E volt c) $E/2$ volt d) $E/4$ volt

192. Consider the circuit shown in the figure. Find the charge on capacitor C between A and D In steady state.



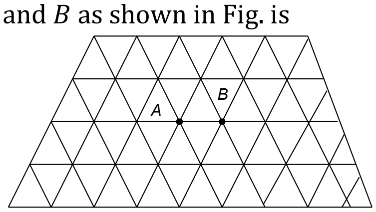
a) Cε b) Cε/2 c) Cε/3 d) Zero

193. Circuit for the measurement of resistance by potentiometer is shown in Figure. The galvanometer is first connected at point A and zero deflection is observed at length $PJ = 10$ cm. In second case, it is connected at point C and zero deflection is observed at a length 30 cm from P, then the unknown resistance X is



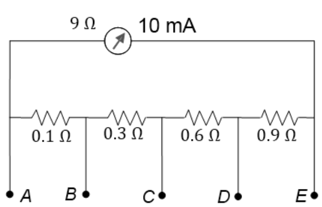
a) 2 R b) $R/2$ c) $R/3$ d) 3 R

194. There is an infinite wire grid with cells in the form of equilateral triangles. The resistance of each wire between neighbouring joint connections is R_0. The net resistance of the whole grid between the points A and B as shown in Fig. is



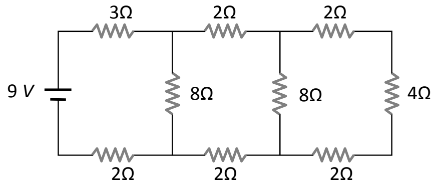
a) R_0 b) $\frac{R_0}{2}$ c) $\frac{R_0}{3}$ d) $\frac{R_0}{4}$

195. A milli-ammeter of range 10 mA and resistance 9 Ω are joined in a circuit as shown in Figure. The meter gives full scale deflection, when current in the main circuit is I and A and D are used at terminals. The value of I is



a) 1.09 A b) 10.9 A c) Zero d) 0.109 A

196. In the circuit shown in the figure, the current through



a) The 3Ω resistor is 0.50 A b) The 3Ω resistor is 0.25 A
c) The 4Ω resistor is 0.50 A d) The 4Ω resistor is 0.25 A

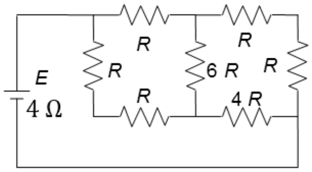
197. An 80 Ω galvanometer deflects full-scale for a potential of 20 mV. A voltmeter deflecting full-scale of 5 V is to be made using this galvanometer. We must connect

a) A resistance of 19.92 kΩ parallel to the galvanometer

b) A resistance of 19.92 kΩ in series with the galvanometer

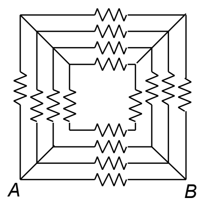
c) A resistance of 20 kΩ parallel to the galvanometer
d) A resistance of 20 kΩ in series with the galvanometer

198. A battery of internal resistance 4 Ω is connected to the network of resistances as shown. In order that the maximum power can be delivered to the network, the value of R in Ω should be



a) 4/9 b) 2 c) 8/3 d) 18

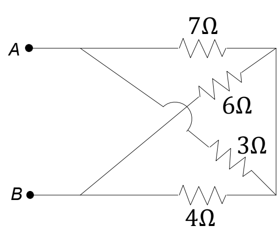
199. Sixteen resistors, each of resistance 16Ω, are connected in the circuit as shown in Fig. The net resistance between AB is



a) 1 Ω b) 2 Ω c) 3 Ω d) Ω

200. The resistance of a metallic conductor increases with temperature due to
a) Change in carrier density
b) Change in the dimensions of the conductor
c) Increase in the number of collisions among the carriers
d) Increase in the rate of collisions between the carriers and the vibrating atoms of the conductor

201. The equivalent resistance between A and B (of the circuit as shown in Fig.) is



a) 4.5 Ω b) 12 Ω c) 5.4 Ω d) 20 Ω

202. When current I is set up in a wire of radius r, then the drift velocity is V_d. If the same current is set up through a wire of radius $2r$, then drift velocity will be
a) $4V_d$ b) $2V_d$ c) $V_d/2$ d) $V_d/4$

203. In the shown wire frame, each side of a square (the smallest square) has a resistance R. the equivalent resistance of the circuit between the points A and B is

a) R b) $2R$ c) $4R$ d) $8R$

204. A source of constant potential difference is connected across a conductor having irregular cross section as shown in Figure

a) Electric field intensity at P is greater than that at Q

b) Rate of electrons crossing per unit area of cross section at P is less than that at Q

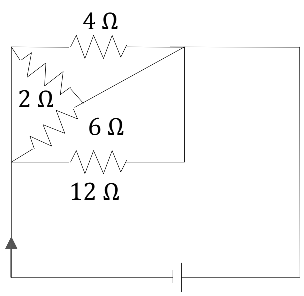
c) The rate of generation of heat per unit length at P is greater than that at Q

d) Mean kinetic energy of free electrons at P is greater than that at Q

205. Two long coaxial and conducting cylinders of radius a and b are separated by a material of conductivity σ and a constant potential difference V is maintained between them by a battery. Then the current per unit length of the cylinder flowing from one cylinder to the other is

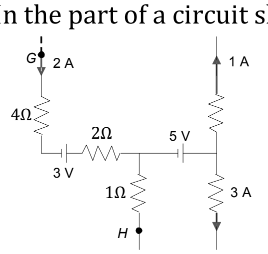
a) $\frac{4\pi\sigma}{ln(b/a)}V$ b) $\frac{4\pi\sigma}{(b/a)}V$ c) $\frac{2\pi\sigma}{\ln(b/a)}V$ d) $\frac{2\pi\sigma}{(b+a)}V$

206. The resistance in which the maximum heat is produced is given by (Figure)



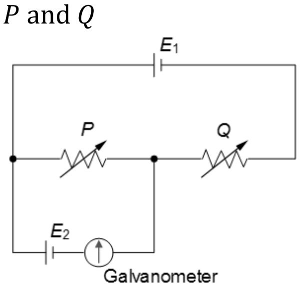
a) 2 Ω b) 6 Ω c) 4 Ω d) 12 Ω

207. In the part of a circuit shown in the Fig. the potential difference $(V_G - V_n)$ between points G and H will be



a) 0 V b) 15 V c) 7 V d) 3 V

208. Two cells of e. m. f. sE_1 and E_2 and of negligible internal resistances are connected with two variable resistors as shown in Figure. When the galvanometer shows no deflection, the values of the resistances are P and Q



What is the value of the ratio E_2/E_1?

a) $\frac{P}{Q}$ b) $\frac{P}{P+Q}$ c) $\frac{Q}{P+Q}$ d) $\frac{P+Q}{P}$

209. The mass of the three wires of copper are in the ratio 1: 3: 5. And their length are in ratio 5: 3: 1. The ratio of their electrical resistance is

a) 1 : 3 : 5 b) 5 : 3 : 1 c) 1 : 15 : 125 d) 125 : 15 : 1

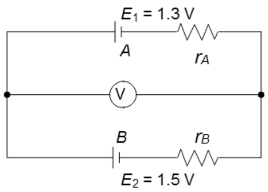
210. The length of a wire of a potentiometer is 100 cm, and the e.m.f. of its standard cell is E volt. It is employed to measure the e.m.f. of a battery whose internal resistance is 0.5Ω. If the balance point is obtained at $I = 30$ cm from the positive end, e.m.f. of the battery is
Where i is the current in the potentiometer wire.

a) $\frac{30E}{100}$ b) $\frac{30E}{100.5}$ c) $\frac{30E}{(100-0.5)}$ d) $\frac{30(E-0.5i)}{100}$

211. If a shunt of 1/10th of the coil resistance is applied to a moving coil galvanometer, its sensitivity becomes

a) 10-fold b) 11-fold c) $\frac{1}{10}$-fold d) $\frac{1}{11}$-fold

212. Two cells A and B of electromotive forces 1.3 V and 1.5 V, respectively, are arranged as shown in Figure, the voltmeter (assumed ideal) reads 1.45 V, the internal resistances of cells A and B are $r_A$and r_B, respectively. Which of the following is correct?



a) $r_A = 2r_B$ b) $r_A = 3r_B$ c) $r_B = 2r_A$ d) $r_B = 3r_A$

213. Two electric bulbs A and B are rated 60 and 100 W, respectively. If they are connected in parallel to the same source, then

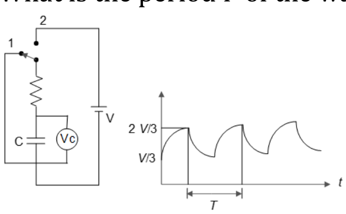
a) Both the bulbs draw the same current

b) Bulb A draws more current than bulb B

c) Bulb B draws more current than bulb A

d) Currents drawn in the bulbs are in the ratio of their resistances

214. V_c is the ideal voltmeter in the figure. Resistance of the resistor shown in R. initially the switch is in position 2 when charging of the capacitor starts. Initially the capacitor was uncharged. The witch in circuit shifts automatically from 2 to 1 when V_C>2V/3
and goes back to 2 from 1 when $V_C < V/3$. The ideal voltmeter reads voltage across capacitor as plotted. What is the period T of the wave form in terms of R and$C$?

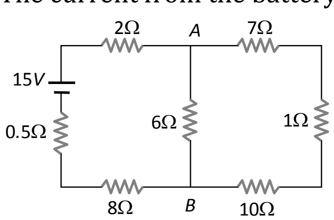


a) $3RC$ In 3 b) $2RC$ In 2 c) $(RC/2)$ In 2 d) None of these

215. A straight conductor of uniform cross section carries a current I. Let s be the specific charge of an electron. The momentum of all the free electrons per unit length of the conductor, due to their drift velocities only, is

a) $I\ s$ b) I/s c) $\sqrt{I/s}$ d) $(I/s)^2$

216. The current from the battery in circuit diagram shown is

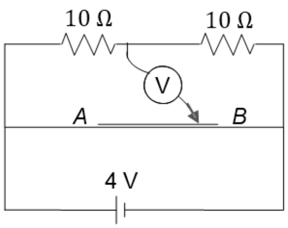


a) 1 A b) 2 A c) 1.5 A d) 3 A

217. How many 60 W lamps may be safely run on a 230 V circuit fitted with a 5 A fuse?

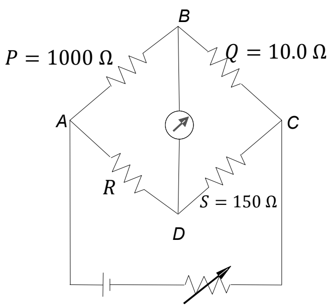
a) 2 b) 19 c) 20 d) 4

218. A potentiometer wire AB as shown is 40 cm long of resistance 50 Ω/m free end of an ideal voltmeter is touching the potentiometer wire. What should be the velocity of the jockey as a function of time so that reading in voltmeter varies with times as
(2 sinπt)?



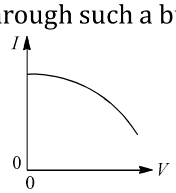
a) $10\ \pi \sin \pi t$ cm/s b) $10\ \pi \cos \pi t$ cm/s c) $20\ \pi \sin \pi t$ cm/s d) $20\ \pi \cos \pi t$ cm/s

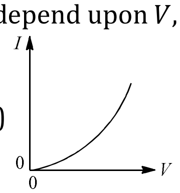
219. Figure shows a Wheatstone net, with $P = 1000\ \Omega$, $Q = 10.0\ \Omega$, R (unknown), S variable and near $150\ \Omega$ for balance. If the connections across A, C and $B,\ D$ are interchanged, the error range in R determination would

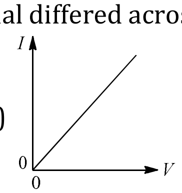


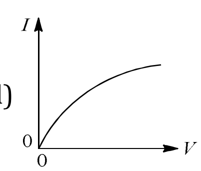
a) Remain unaffected b) Increase substantially
c) Increase marginally d) Decrease substantially

220. Some early electric light bulbs used carbon filaments, the resistances of which decreased as their temperature increase. Which of the following graphs best represents the way in which I, the current through such a bulb, would depend upon V, the potential differed across it?

a) 

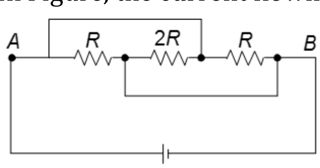
b) 

c) 

d) 

221. The electrostatic field due to a point charge depends on the distance r as $1/r^2$. Indicate which of the following quantities shows same dependence on r
a) Intensity of light from a point source
b) Electrostatic potential due to a point charge
c) Electrostatic potential at a distance r from the centre of a charged metallic sphere. Given $r <$ radius of the sphere
d) None of these

222. In Figure, the current flowing through 2 R is



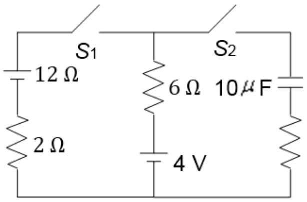
a) From left to right b) From right to left c) No current d) None of these

223. A galvanometer may be converted into ammeter or voltmeter. In which of the following cases the resistance of the device will be largest? (Assume the maximum range of galvanometer = 1 mA)
a) An ammeter of range 10 A b) A voltmeter of range 5 V
c) An ammeter of range 5 A d) A voltmeter of range 10 V

224. The main supply voltage to a room is 120 V. The resistance of the lead wires is 6 Ω. A 60 W bulb is already giving light. What is the decrease in voltage across the bulb when a 240 W heater is switched on?
a) No change b) 10 V c) 20 V d) More than 10 V

225. In the circuit shown (Figure), if switches S_1 and S_2 have been closed for a long time, then the charge on the

capacitor



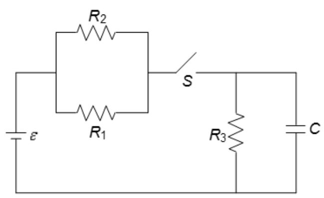
a) Is 100 μC

b) Increases to 120 μC if one-third of the gap of the capacitor's plates is filled with a dielectric ($K = 2$) of same area

c) Both a and b

d) Charge on the capacitor remains unchanged if one-third of the gap of the capacitor's plates is filed with a dielectric ($K = 2$)of same area

226. The circuit shown in Figure consists of a battery of e. m. f. $\varepsilon = 10$ V; a capacitor of capacitance $C = 1.0$ μF and three resistors of values $R_1 = 2\Omega, R_2 = 2\Omega$ and $R_3 = 1\Omega$. initially, the capacitor is completely uncharged and the switch S is open. The switch S is closed at $t = 0$. Then



a) The current through resistor R_3 at the moment the switch closed is zero

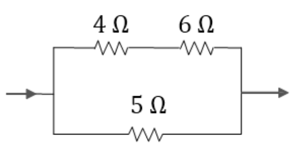
b) The current through resistor R_3 a long time after the switch closed is 5 A

c) The ratio of current through R_1 and R_2 is always constant

d) All of these

227. In the circuit shown in the figure the heat produced in the 5 ohm resistor due to the current flowing through it is 10 calories per second

The heat generated in the 4 ohm resistor is



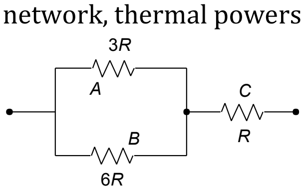
a) 1 caloric/sec b) 2 caloric/sec c) 3 caloric/sec d) 4 caloric/sec

228. A piece of copper and another of germanium are cooled from room temperature to 80 K. The resistance of

a) Each of them increases b) Each of them decreases

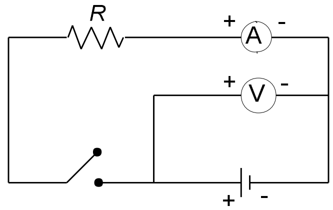
c) Copper increases and germanium decreases d) Copper decreases and germanium increases

229. Figure shows a network of three resistances. When some potential difference is applied across the network, thermal powers dissipated by A, B and C are in the ratio



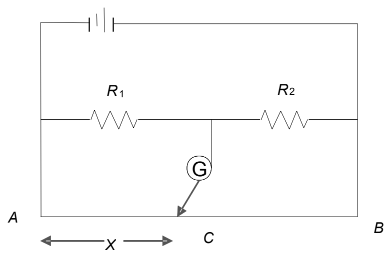
a) 2 : 3 : 4 b) 2 : 4 : 3 c) 4 : 2 : 3 d) 3 : 2 :4

230. In the circuit shown in Figure, an ideal ammeter and an ideal voltammeter are used. When key is open, the voltmeter reads 1.53 V. When the key is closed, the ammeter reads 1.0 A and the voltmeter reads 1.03 V. The resistance R is



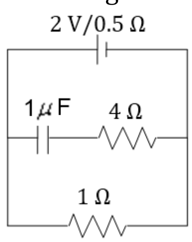
a) 0.5 Ω b) 1.03 Ω c) 1.53 Ω d) 0.53 Ω

231. In the shown arrangement of the experiment of the meter bridge if AC corresponding to null deflection of galvanometer is x, what would be its value if the radius of the wire AB is doubled?



a) x b) $x/4$ c) $4x$ d) $2x$

232. The charge on the capacitor as in figure is

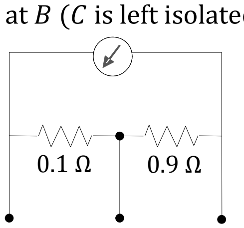


a) 2 μC b) $\frac{2}{3}$ μC c) $\frac{4}{3}$ μC d) Zero

233. In question 54, the potential difference across A is

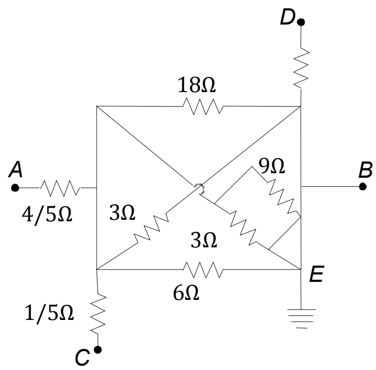
a) $\frac{2\varepsilon}{n}$ b) $\varepsilon\left(1-\frac{1}{n}\right)$ c) $2\varepsilon\left(1-\frac{1}{n}\right)$ d) $\varepsilon\left(\frac{n-2}{n}\right)$

234. A milliammeter of range 10mA and resistance 9 Ω is joined in a circuit as shown in figure. The meter gives full-scale deflection for current I when A and B are used as its terminals, if current enters at A and leaves at B (C is left isolated), the value of I is



a) 100 mA b) 900 mA c) 1 A d) 1.1 A

235. In Fig., if a battery is connected between points A and B e.m.f E= 18 V, the current flowing through the battery is

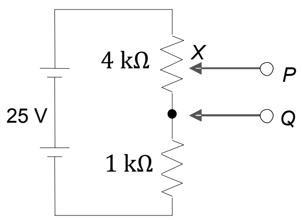


a) 10 A b) 20 A c) 5 A d) 15 A

236. Two identical heaters rated 220 V-1000 W are placed in series with each other across 220 V line; then the combined power is

a) 1000 W b) 2000 W c) 500 W d) 4000 W

237. Figure shows a potential divider circuit which, by adjustment of the position of the contact X, can be used to provide a variable potential difference between the terminals P and Q. What are the limits of this potential difference?



a) 0 and 20 mV b) 5 mV and 25mV c) 0 and 20 V d) 0 and 25 V

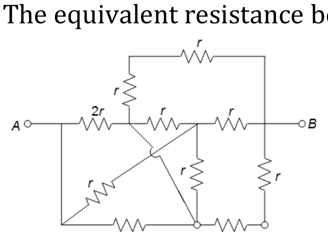
238. In the diagrams, all right bulbs are identical, all cells are ideal and identical. In which circuit (a, b, c, d) will the bulbs be dimmest?

a) b) c) d)

239. Two capacitors C_1 and $C_2 (C_1 > C_2)$ are charged separately to same potential. Now they are allowed to discharge through similar resistors. Initial rate of discharging will be

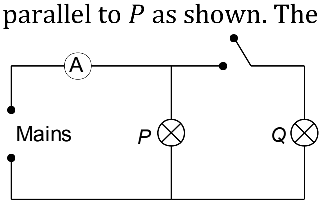
a) More for C_1 b) More for C_2 c) Same for both d) Cannot say

240. The equivalent resistance between A and B in the arrangement of resistances as shown is



a) $4r$ b) $3r$ c) $2.5r$ d) r

241. How will the reading in the ammeter A of Figure be affected if another identical bulb Q is connected in parallel to P as shown. The voltage in the mains is maintained at a constant value



a) The reading will be reduced to one-half

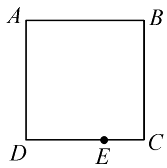
b) The reading will not be affected

d) The reading will be increased four-fold

242. A capacitor charges from a cell through a resistance. The time constant is τ. In what time will the capacitor collect 10% of its final charge?

a) τ In (0.1)　　b) τ In (0.9)　　c) τ In (10/9)　　d) τ In (11/10)

243. $ABCD$ is a square (see Fig.) where each side is a uniform wire of resistance 1 Ω. A point E lies on CD such that if a uniform wire of resistance 1 Ω is connected across AE and constant potential difference is applied across A and C, then B and E are equipotential

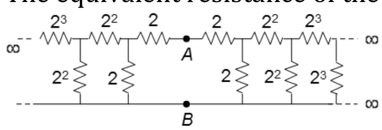


a) $\frac{CE}{ED}=1$　　b) $\frac{CE}{ED}=\frac{1}{\sqrt{2}}$　　c) $\frac{CE}{ED}=-\frac{1}{\sqrt{2}}$　　d) $\frac{CE}{ED}=\sqrt{2}$

244. A capacitor of capacitance 10μF is charged up to a potential difference of 2 V and then the cell is removed. Now it is connected to a cell of e.m.f 4 V and is charged fully. In both cases the polarities of the two cells are In the same directions. Total heat produced In the complete charging process is

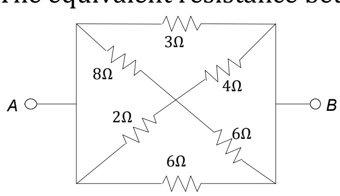
a) 10 mJ　　b) 20 μJ　　c) 40 μJ　　d) 80 mJ

245. The equivalent resistance of the combination across AB (Figure) is



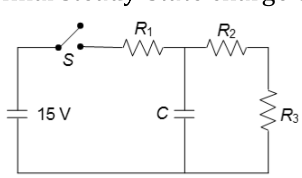
a) $\left(\frac{3+\sqrt{17}}{4}\right)$　　b) $3+\sqrt{17}$　　c) $\frac{3+\sqrt{17}}{2}$　　d) $2(3+\sqrt{17})$

246. The equivalent resistance between A and B in the network in Fig. is



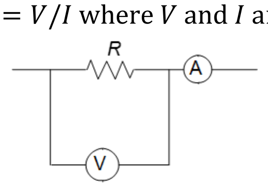
a) $\frac{4}{3}\Omega$　　b) $\frac{3}{2}\Omega$　　c) 3Ω　　d) 2Ω

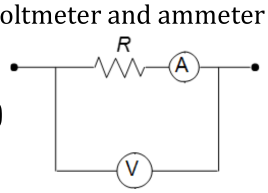
247. Figure shows a battery with e. m. f. 15 V in a circuit with$R_1=30\Omega$, $R_2=10\Omega$, $R_3=20\Omega$ and capacitance $C=10\mu$F. The switch S is initially in the open position and is then closed at time$t=0$. When will be the final steady-state charge on capacitor?

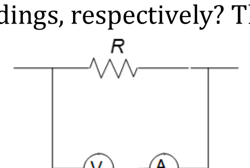


a) 75μC　　b) 50 μC　　c) 10 μC　　d) None of these

248. Which of the following circuits (Figure) gives the correct value of resistance, when computed by using $R=V/I$ where V and I are voltmeter and ammeter readings, respectively? The meters are not ideal

a) 

b) 

c) 

d) None of these

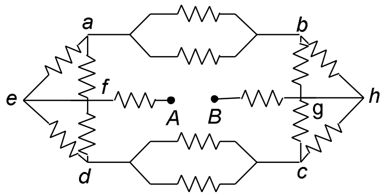
249. A straight conductor of uniform cross section carries a time varying current which varies at the rate $dI/dt=\dot{I}$. If s is the specific charge that is carried by each charge carrier of the conductor and l is the length of the conductor, then the total force experienced by all the charge carries per unit length of the conductor due to their drift velocities only is

a) $F = \dot{I}s$ b) $F = \frac{\dot{I}}{2\sqrt{Is}}$ c) $F = \frac{\dot{I}}{s}$ d) $F = \frac{2I\dot{I}}{s}$

250. Incandescent bulbs are designed by keeping in mind that the resistance of their filament increases with the increase in temperature. If at room temperature, 100 W, 60 W and 40 W bulbs have filament resistances R_{100}, R_{60} and R_{40}, respectively, the relation between these resistances is

a) $\frac{1}{R_{100}} = \frac{1}{R_{40}} + \frac{1}{R_{60}}$ b) $R_{100} = R_{40} + R_{60}$ c) $R_{100} > R_{60} > R_{40}$ d) $\frac{1}{R_{100}} > \frac{1}{R_{60}} > \frac{1}{R_{40}}$

251. Each of the resistors shown in the figure has resistance R. Find the equivalent resistance between A and B.



a) $\frac{7R}{4}$ b) $\frac{5R}{4}$ c) $\frac{9R}{4}$ d) $\frac{11R}{4}$

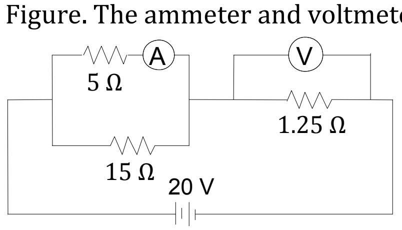
252. The resistance of the filament of a lamp increases with the increase in temperature. A lamp rated 100 W and 220 V is connected across 220 V power supply. If the voltage drops by 10 %, then the power of the lamp will be

a) 90 W b) 81 W
c) Between 90 and 100 W d) Between 81 and 90 W

253. The heat generated through 4 and 9 Ω resistances separately, when a capacitor of 100 μF capacity charged to 200 V is discharged one by one, will be

a) 2 and 8 J, respectively
b) 8 and 2 J, respectively
c) 2 and 4 J, respectively
d) 2 and 2 J, respectively

254. An ideal ammeter (zero resistance) and an ideal voltmeter (infinite resistance) are connected as shown in Figure. The ammeter and voltmeter readings are



a) 6.25 A, 3.75 V b) 3.00 A, 5 V c) 3.00 A, 3.75 V d) 6.00 A, 6.25 V

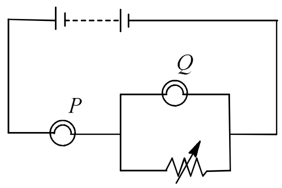
255. In question 83, after how many time constants will the charge on the capacitor be 10% less than its final charge?

a) 2 b) 2.303 c) $\frac{1}{0.693}$ d) $\frac{1}{0.37}$

256. Consider a cylindrical element as shown in the figure. Current flowing through element is I and resistivity of material of the cylinder is ρ. Choose the correct option out the following

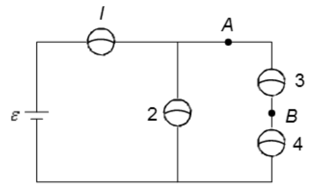
a) Power loss is second half is four times the power loss in first half
b) Voltage drop in first is twice of voltage drop in second half
c) Current density in both halves are equal
d) Electric field in both halves is equal

257. The circuit shown in Figure contains a battery, a rheostat and two identical lamps. What will happen to the brightness of the lamps if the resistance of the rheostat is increased?



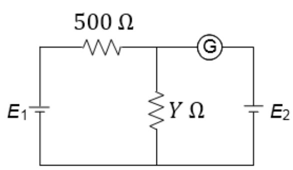
Option	Lamp P	Lamp Q
a)	Less bright	Brighter
b)	Less brighter	Less brighter
c)	Brighter	Less brighter
d)	No change	Brighter

258. For the circuit shown, a shorting wire of negligible resistance is added to the circuit between points A and$B$. When this shorting wire is added, bulb 3 goes out. Which bulbs (all; identical) in the circuit brighten?



a) Only bulb 2 b) Only bulb 4 c) Only bulbs 1 and 4 d) Only bulbs 2 and 4

259. In the circuit shown in Figure, the battery E_1 has an e.m.f. of 12 V and zero internal resistance, while the battery E_2 has an e.m.f. of 2 V. if the galvanometer G reads zero, then the value of the resistance Y is

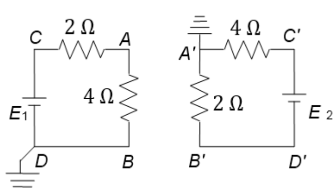


a) 10 Ω b) 100 Ω c) 500 Ω d) 200 Ω

260. Sensitivity of the potentiometer can be increased by
a) Increasing the e.m.f of the cell
b) Increasing the length of the potentiometer
c) Decreasing the length of the potentiometer wire
d) None of the above

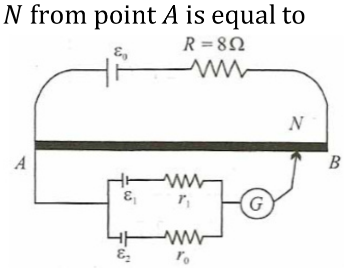
261. If the current in electric bulb decreases by 0.5 % the power in the bulb decreases by approximately
a) 1% b) 2% c) 0.5% d) 0.25%

262. Given that current through CA= 1 A. current through $C'A' = 2$ A. now if A is connected to A' and B is connectedB'. Find currents through CA and $C'A'$, respectively,



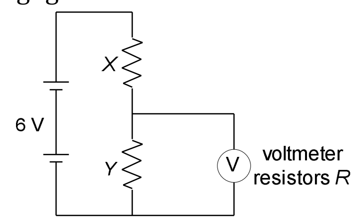
a) 1 A, 3 A b) 3 A, 1 A c) 1 A, 1 A d) 3 A, 3 A

263. A battery of e. m. f. $\varepsilon_0 = 12$ V Is connected across a 4 m long uniform wire having resistance 4 Ω/m. The cells of small e. m. f. $\varepsilon_1 = 2$ V and $\varepsilon_2 = 4$ V having internal resistances $r_1 = 2\Omega$ and$r_2 = 6\Omega$, respectively, are connected as shown in the figure. If galvanometer shows no deflection at point N, the distance of point N from point A is equal to



a) 1/6 m b) 1/3 m c) 25 cm d) 50 cm

264. In the circuit shown in Figure, resistors X and Y, each with resistance R, are connected to a 6V battery of negligible internal resistance. A voltmeter, also of resistance R, is connected across Y



What is the reading of the voltmeter?

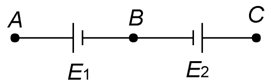
a) Zero

b) Between zero and 3 V

c) 3 V

d) Between 3 V and 6 V

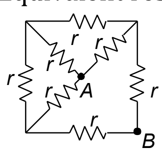
265. Two cells of e.m.f.s E_1 and E_2 $(E_1 > E_2)$ are connected as shown in Figure



When a potentiometer is connected between A and B, the balancing length of the potentiometer wire is 300 cm. On connecting the same potentiometer between A and C, the balancing length is 100 cm. The ratio E_1/E_2 is

a) 3 : 1 b) 1 : 3 c) 2 : 3 d) 3 : 2

266. Equivalent resistance between A and B in the figure is

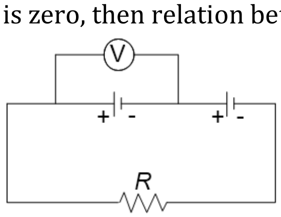


a) $8r/7$ b) $7r/8$ c) $3r/4$ d) r

267. A given resistor cannot carry currents exceeding 20 A, without exceeding its maximum power dissipation ratings. By forced air cooling suppose that we increase the rate at which heat can be carried by a factor of 2. Now the maximum current that the resistor can carry is

a) 10 A b) $20\sqrt{2}$ A c) $30\sqrt{2}$ A d) 40 A

268. In figure two cells have equal e. m. f. E but internal resistances are r_1 andr_2. If the reading of the voltmeter is zero, then relation between R, r_1 and r_2 is

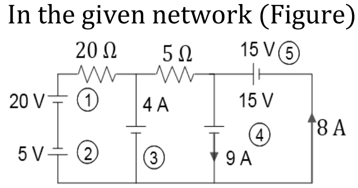


a) $R = r_1 - r_2$ b) $R = r_1 + r_2$ c) $2r_1 = r_2$ d) r_1r_2

269. Two moving coil galvanometers 1 and 2 are with identical field magnets and suspension torque constants, but with coil of different number of turns, N_1 and N_2, area per turn A_1 and A_2 and resistance $R_1$and R_2 . When they are connected in series in the same circuit, they show deflections θ_1 and θ_2
Then $(\theta_1\theta_2)$ is

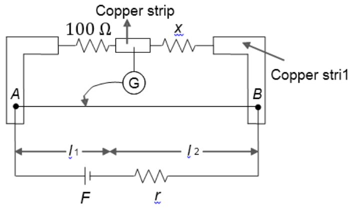
a) (A_1N_1/A_2N_2) b) (A_1N_2/A_2N_1) c) $(A_1R_2N_1/A^2R^2N^2)$ d) $(A_1R_1N_1/A_2R_2N^2)$

270. In the given network (Figure) the batteries getting charged are



a) 1 and 3 b) 1 , 3 and 5 c) 1 and 4 d) 1, 2 and 5

271. In a practical Wheatstone bridge circuit (Figure), when one more resistance of 100 Ω is Connected in parallel with unknown resistance x, then the ratio l_1/l_2 become 2. l_1 Is The balance length. AB is a uniform wire. Then the value of x must be



a) 50 Ω b) 100 Ω c) 200 Ω d) 400 Ω

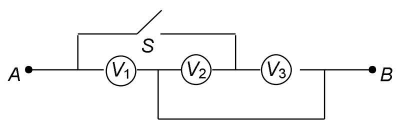
272. A milliammeter of range 10 mA has a coil of resistance 1 Ω. To use it as an ammeter of range 1 A, the required shunt must have a resistance of

a) $\frac{1}{101}\Omega$ b) $\frac{1}{100}\Omega$ c) $\frac{1}{99}\Omega$ d) $\frac{1}{9}\Omega$

273. An ammeter and a voltmeter are joined in series to a cell. Their readings are A and V, respectively. If a resistance is now joined in parallel with the voltmeter, then

a) Both A and V will increase
b) Both A and V will decrease
c) A will decrease, V will increase
d) A will increase, V will decrease

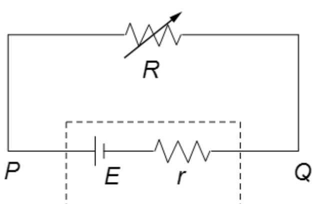
274. Three voltmeters are connected as shown



A potential difference has been applied between A and B. On closing the switch S, what will be the effect on the readings of voltmeters?

a) V_1 increases
b) V_1 decreases
c) V_2 and V_3 both increase
d) One of V_2 and V_3 increases and other decreases

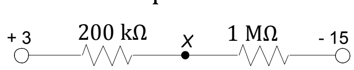
275. In the circuit shown in the figure, take the potential of point Q to be zero, and potential of P to be V



The variation of V w.r.t R is correctly shown by

a) b) c) d)

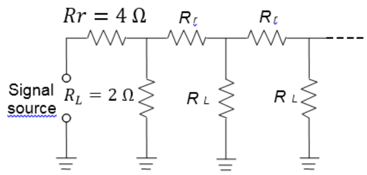
276. Two resistors of resistances 200 kΩ and 1 MΩ, respectively, form a potential divider with outer junctions maintained at potentials of +3 V and −15 V



What is the potential at the junction X between the resistors?

a) +1 V b) 0 V c) −0.6 V d) −12 V

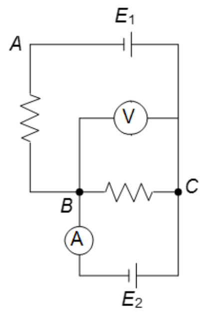
277. Figure shows a circuit model for the transmission of an electrical signal, such as cable TV, to a large number of subscribers. Each subscriber connects a load resistance R_L between the transmission line and the ground. Assume the ground to be at zero potential and to have negligible resistance. The resistance of the transmission line between the connection points of different subscribers is modelled as the constant resistance R_T. The equivalent resistance across the signal source is



a) $10\ \Omega$ b) $5\ \Omega$ c) $\sqrt{55}\Omega$ d) $\sqrt{65}\Omega$

278. Resistance of a wire at $20^\circ C$ is 20Ω and at $500^\circ C$ is 60Ω. At what temperature its resistance is 25Ω?
a) $160^\circ C$ b) $250^\circ C$ c) $100^\circ C$ d) $80^\circ C$

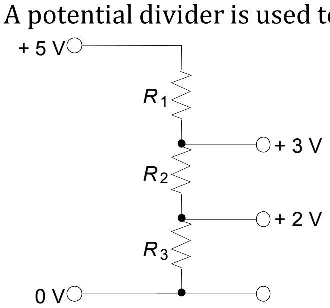
279. Two ideal batteries having e. m. f. E_1 and E_2 are connected as shown in Figure. The values of resistances are chosen in such a way that ammeter reading is zero. The reading of voltmeter will be (consider the meters to be ideal)



a) E_1
b) E_2
c) In between E_1 and E_2
d) Nothing can be predicted about voltmeter reading from the given information

280. Two identical batteries each of e.m.f. $E = 2$ V and internal resistance $r = 1\ \Omega$ are available to produce heat in an external circuit. What is the maximum rate of production of heat that can be obtained in the external circuit?
a) 1 W b) 2 W c) 4 W d) 8 W

281. A potential divider is used to give outputs of 2 V and 3 V from a 5 V source, as shown in Fig.



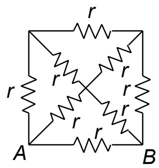
Which combination of resistances, R_1, R_2 and R_3 gives the correct voltages?

	$R_1 k\Omega$	$R_2 k\Omega$	$R_3 k\Omega$
a)	1	1	2
b)	2	1	2
c)	3	2	2
d)	3	2	3

282. A capacitor is charged to a certain potential and then allowed to discharge through a resistance R. The ratio of charge on the capacitor to current in the circuit
a) Changes with time
b) Does not change with time and it is equal to time constant of circuit
c) Does not change with time, but not equal to time constant of circuit
d) May or may not change depending upon the charge given to the capacitor

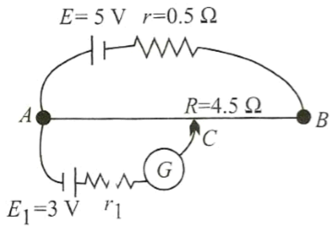
283. A non-conducting ring of radius R has charge Q distributed unevenly over it. If it rotates with an angular velocity ω, the equivalent current will be
a) 0 b) $Q\omega$ c) $Q\dfrac{\omega}{2\pi}$ d) $Q\dfrac{\omega}{2\pi R}$

284. Equivalent resistance between A and B in the figure is



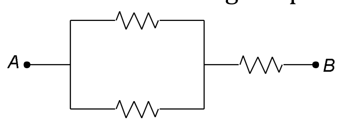
a) $8r/15$ b) $7r/15$ c) $15r/8$ d) $15r/7$

285. In the given potentiometer circuit length of the wire AB is 3 m and resistance is $R = 4.5\Omega$. the length AC for no deflection in galvanometer is



a) 2 m b) 1.8 m c) Dependent on r_1 d) None of these

286. Three 10Ω, 2W resistors are connected as in Figure. The maximum possible voltage between points A and B without exceeding the power dissipation limits of any of the resistors is

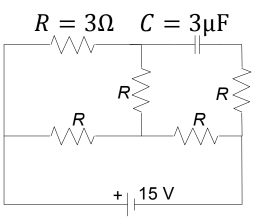


a) $5\sqrt{3}$ V b) $3\sqrt{5}$ V c) 15 V d) $\frac{5}{3}$ V

287. A wire of length L and three identical cells of negligible internal resistance are connected in series. Due to the current, the temperature of the wire is raised by ΔT in time t. A number N of similar cells is now connected in series with a wire of same material and cross section but of length $2L$. The temperature of the wire is raised by the same amount ΔT in the same time. The value of N is

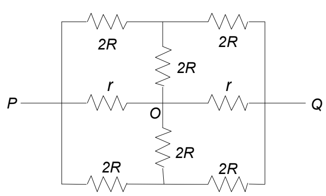
a) 4 b) 6 c) 8 d) 9

288. In the circuit shown in Fig. the cell is ideal with e.m.f = 15 V. Each resistance is of 3Ω. The potential difference across the capacitor in steady state is



a) 0 b) 9 V c) 12 V d) 15 V

289. The effective resistance between point P and Q of the electrical circuit shown in Figure is

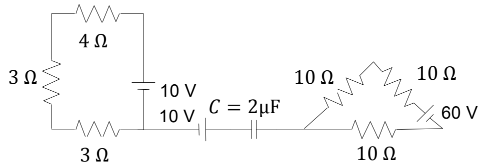


a) $\frac{2Rr}{R+r}$ b) $\frac{8R(R+r)}{3R+r}$ c) $2r+4R$ d) $\frac{5R}{2}+2r$

290. A conductor of resistivity ρ and resistance R, as shown in the figure, is connected across a battery of e.m.f. V. Its radius varies from a at left end to b at right end. The electric field at a point P at distance x from left end of it is

a) $\dfrac{VI^2\rho}{\pi R(Ia+(b-a)x)^2}$ b) $\dfrac{2VI^2\rho}{\pi R(Ia+(b+a)x)^2}$ c) $\dfrac{VI^2\rho}{2\pi R(Ia+(b-a)x)^2}$ d) None of these

291. In the circuit shown in Fig, find the maximum energy stored on the capacitor. Initially, the capacitor was uncharged

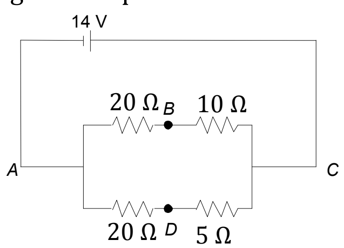


a) 150 μC b) 100 μC c) 50 μC d) Zero

292. The length of a given cylindrical wire is increases by 100%. Due to the consequent decrease in the diameter, the change in the resistance of the wire will be

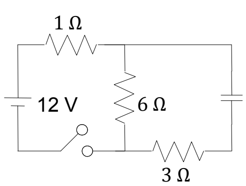
a) 300% b) 200% c) 100% d) 50%

293. What resistor should be connected in parallel with the 20 Ω resistor in branch ADC in the circuit shown in Fig. so that potential difference between B and D may be zero?



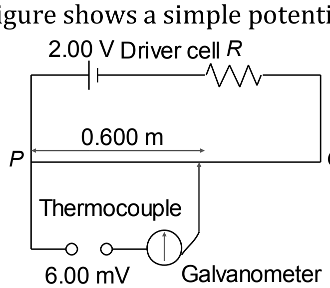
a) 20 Ω b) 10 Ω c) 5 Ω d) 15 Ω

294. When the switch is closed, then the initial current through 1 Ω resistor is (see Fig.)



a) 12 A b) 4 A c) $\frac{10}{7}A$ d) 3 A

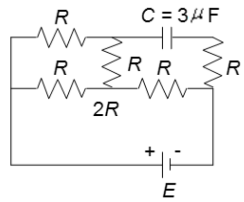
295. Figure shows a simple potentiometer circuit for measuring a small e.m.f. produced by a thermocouple.



The metre wire PQ has a resistance of 5 Ω and the driver cell has an e.m.f. of 2.00 V. If a balance point is obtained 0.600 m along PQ when measuring an e.m.f. of 6.00 mV,
what is the value of resistance R?

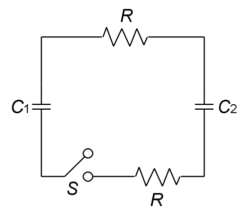
a) 95 Ω b) 995 Ω c) 195 Ω d) 1995 Ω

296. In the given circuit (figure), the potential difference across the capacitor is 12 V, Each resistance is of 3 Ω. the cell is ideal. the e. m. f. of the cell is



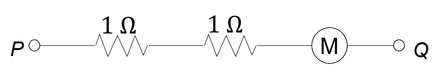
a) 15 V b) 9 V c) 12 V d) 24 V

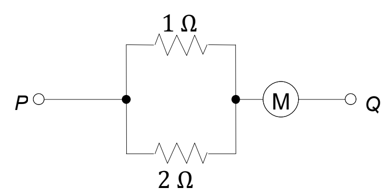
297. In the circuit shown in Fig., $C_1 = 2C_2$. Initially, capacitor C_1 is charged to a potential of V. The current in the circuit just after the switch S is closed is

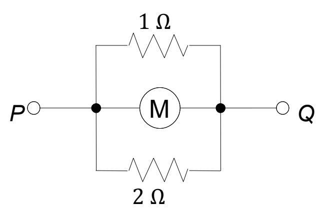


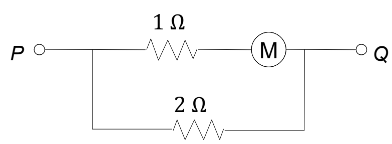
a) 0 b) $2V/R$ c) ∞ d) $V/2R$

298. In which one of the following arrangement of resistors does the meter M, which has a resistance of 2 Ω, give the largest reading when the same potential difference is applied between points P and Q?

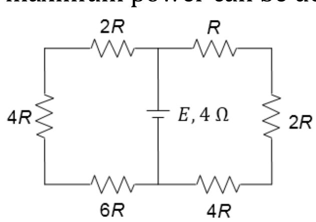
a) 

b) 

c) 

d) 

299. A battery of internal resistance 4 Ω is connected to the network of the resistance as shown in Figure. If the maximum power can be delivered to the network, the magnitude of resistance in Ω should be



a) $\frac{19}{21}\Omega$ b) $\frac{84}{19}\ \Omega$ c) 12 Ω d) 7 Ω

300. A 2kW heater used for 1 h every day consumes the following electrical energy in 30 days

a) 60 units b) 120 units c) 15 units d) None of the above

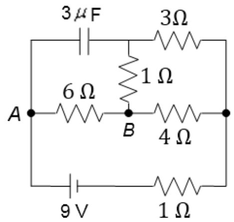
301. A constant voltage is applied between the two ends of a uniform metallic wire. Some heat is developed in it. The heat developed is doubled if

a) Both the length and radius of the wire are halved
b) Both the length and radius of the wire are doubled
c) The radius of the wire is doubled
d) The length of the wire is doubled

302. A 220 V, 1,000 W bulb is connected across a 110 V main supply. The power consumed will be

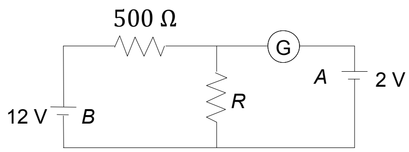
a) 1000 W b) 750 W c) 500 W d) 250 W

303. Find the potential drop across the capacitor in the given circuit



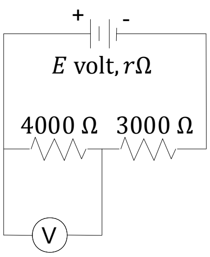
a) 6 V b) 6.5 V c) 7 V d) None of these

304. In the circuit shown in Figure the galvanometer G shows zero deflection. If the batteries A and B have negligible internal resistance, the value of the resistor R will be



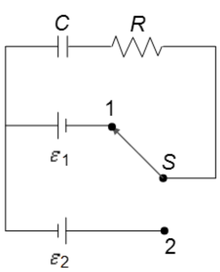
a) 1000 Ω b) 500 Ω c) 100 Ω d) 200 Ω

305. In Figure, when an ideal voltmeter is connected across 4000 Ω resistance, it reads 30 V. If the voltmeter is connected across 3000 Ω resistance, it will read



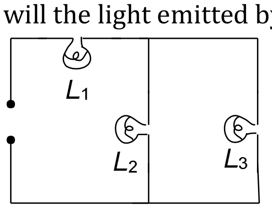
a) 20 V b) 22.5 V c) 35 V d) 40 V

306. Initially, switch S is connected to position 1 for a long time (Figure) the net amount of heat generated in the circuit after it is shifted to position 2 is



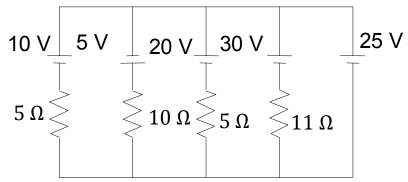
a) $\frac{C}{2}(\varepsilon_1 + \varepsilon_2)\varepsilon_2$ b) $C(\varepsilon_1 + \varepsilon_2)\varepsilon_2$ c) $\frac{C}{2}(\varepsilon_1 + \varepsilon_2)^2$ d) $C(\varepsilon_1 + \varepsilon_2)^2$

307. Figure shows three similar lamps L_1,L_2 and L_3 connected across a power supply. If the lamp L_3 fuses, how will the light emitted by L_1 and L_2 change?



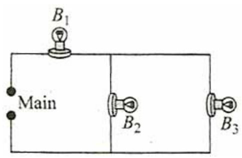
a) No change
b) Brilliance of L_1decreases and that of L_2 increases
c) Brilliance of both L_1 and L_2 increases
d) Brilliance of both L_1 and L_2 decreases

308. In the circuit shown, current through 25 V cell is



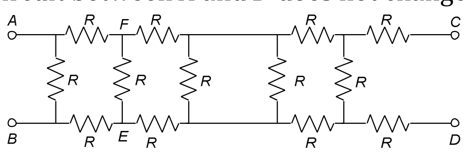
a) 7.2 A b) 10 A c) 12 A d) 14.2 A

309. Three bulbs B_1, B_2 and B_3 are connected to the mains as shown in Figure. How will the brightness of bulb B_1 be affected if B_2 or B_3 are disconnected from the circuit?



a) Bulb B_1 becomes brighter
b) Bulb B_1 becomes dimmer
c) No change occurs in the brightness
d) Bulb B_1 becomes brighter if bulb B_2 is disconnected and dimmer if bulb B_3 is disconnected

310. In Fig. find the value of resistor to be connected between C and D, so that the resistance of the entire circuit between A and B does not change with the number of elementary sets.



a) R b) $R(\sqrt{3}-1)$ c) $3R$ d) $R(\sqrt{3}+1)$

311. The variation of current (I) and voltage (V) is as shown in the figure

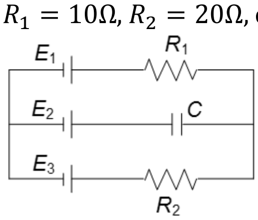
The variation of power P with current I is best shown by which of the following graphs?

a) b) c) d)

312. A constant p.d. is applied across a resistance. Consider variation of resistance with temperature. Which graph represents best the variation of power produced in resistance versus resistance?

a) b) c) d)

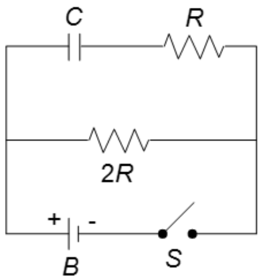
313. In the circuit shown (Figure), the batteries have e. m. f. $E_1 = E_2 = 1$ V, $E_3 = 2.5$ V and the reistance $R_1 = 10\Omega$, $R_2 = 20\Omega$, capacitance $C = 10\mu$F. the charge on the left plate of the capacitor C at steady state is



a) +2 μ C b) −4 μC c) −5 μC d) +12 μC

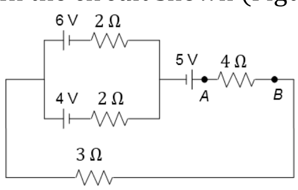
314. The resistance of the series combination of two resistance is S. When they are joined in parallel, the total resistance is P. If $S = nP$, then the minimum possible value of n is

a) 4 b) 3 c) 2 d) 1



a) RC b) $3\ RC$ c) $\frac{2}{3}RC$ d) $RC\ \ln\left(\frac{2}{3}\right)$

316. In the circuit shown (Figure), calculate the current through 6 V battery



a) (1/4) A b) (1/8) A c) (1/2) A d) None of these

317. n identical light bulbs, each designed to draw p power from a certain voltage supply, are joined in series across that supply. The total power which they will draw is

a) nP b) P c) P/n d) P/n^2

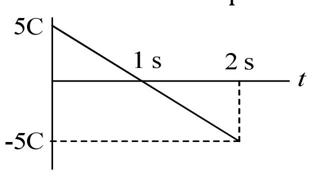
318. The temperature coefficient of resistance of a wire is 0.00125 per °C. At 300 K, its resistance is 1 ohm. This resistance of the wire will be 2 ohm at

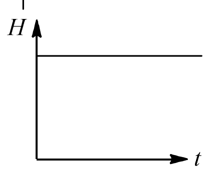
a) 1154 K b) 1100 K c) 1400 K d) 1127 K

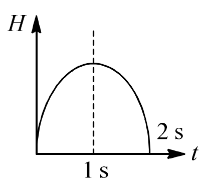
319. How many calories of heat will be approximately developed in a 210 W electric bulb in 5 min?

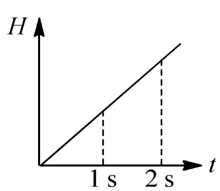
a) 15,000 b) 1,050 c) 63,000 d) 80,000

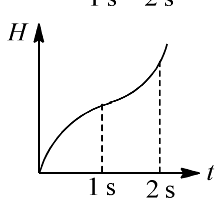
320. A charge passing through a resistor varies with time as shown in the figure. The amount of heat generated in time $'t'$ is best represented (as a function of time) by



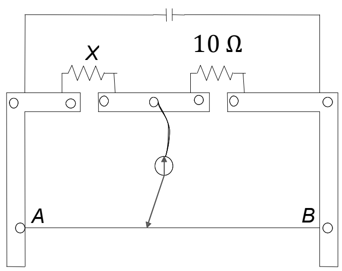
a) 

b) 

c) 

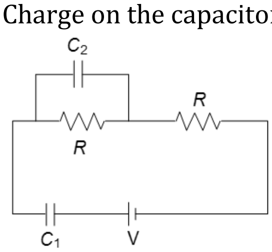
d) 

321. A meter bridge is set-up as shown in figure, to determine an unknown resistance X using a standard 10 Ω resistor. The galvanometer shows null point when tapping key is at 52cm mark. The end-corrections are 1cm and 2cm respectively for the ends A and B. the determined value of x is



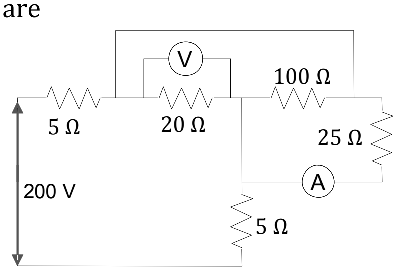
a) 10.2 Ω   b) 10.6 Ω   c) 10.8 Ω   d) 11.1 Ω

322. Charge on the capacitor having capacitance C_2 in steady state (Figure) is



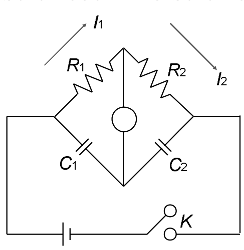
a) Zero   b) $(C_1 + C_2)$V   c) C_2V   d) C_1 V

323. In the figure, voltmeter and ammeter shown are ideal. Then voltmeter and ammeter readings, respectively, are



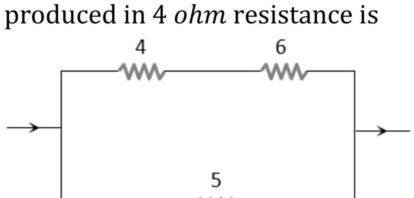
a) 125 V, 3 A   b) 100 V, 4 A   c) 120 V, 4 A   d) 120 V, 3 A

324. In the circuit in Fig., if no current flows through the galvanometer when the key k is closed, the bridge is balanced. The balancing condition for bridge is



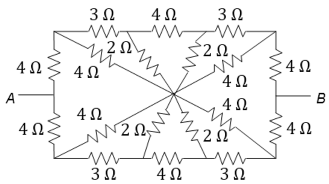
a) $\frac{C_1}{C_2} = \frac{R_1}{R_2}$ b) $\frac{C_1}{C_2} = \frac{R_2}{R_1}$ c) $\frac{C_1^2}{C_2^2} = \frac{R_1^2}{R_2^2}$ d) $\frac{C_2^1}{C_2^2} = \frac{R_2}{R_1}$

325. In the circuit shown in figure, the heat produced in 5 *ohm* resistance is 10 *calories* per *second*. The heat produced in 4 *ohm* resistance is



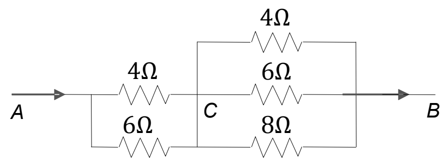
a) 1 *cal*/*sec*   b) 2 *cal*/*sec*   c) 3 *cal*/*sec*   d) 4 *cal*/*sec*

326. A number of resistors are connected as shown in the figure. The equivalent resistance Between A and B is



a) 6 Ω b) 12 Ω c) 9 Ω d) 15 Ω

327. Five resistors are connected between points A and B as shown in Fig. A currect of 10 A flows from A to B. Which of the following is correct?

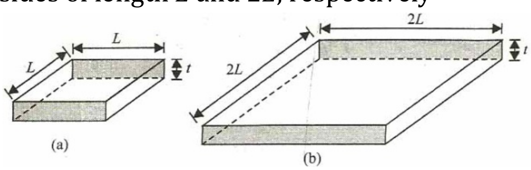


a) $V_{AC} = V_{CB}$ b) $V_{AC} > V_{CB}$ c) $V_{AC} < V_{CB}$ d) None of these

328. A wire when connected to 220 V mains supply has power dissipation P_1. Now, the wire is cut into two equal pieces which are connected in parallel to the same supply. Power dissipation in this case is P_2. Then $P_2 : P_1$ is

a) 1 b) 4 c) 2 d) 3

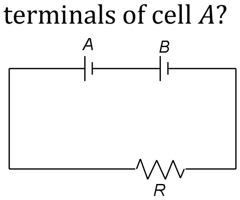
329. Figure 5.171 shows two squares, X and Y, cut from a sheet of metal, of uniform thickness t. X and Y have sides of length L and $2L$, respectively



The resistances R_x and R_y of the square are measured between the opposite faces shaded in Fig

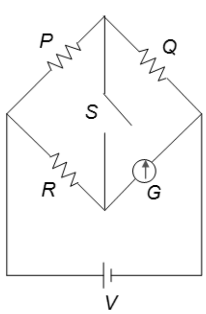
a) 1/4 b) 1/2 c) 1 d) 2

330. Two cells A and B, each of e.m.f 2 V, are connected in series to an external resistance $R = 1\ \Omega$. If the internal resistance of cell A is 1.9 Ω and that of B is 0.9 Ω, what is the potential difference between the terminals of cell A?



a) 2 V b) 3.8 V c) 0 d) None of the above

331. In the circuit $P \neq R$, the reading of the galvanometer is same with switch S open or closed. Then



a) $I_R = I_G$ b) $I_P = I_G$ c) $I_Q = I_G$ d) $I_Q = I_R$

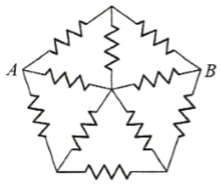
332. When a current I is set up in a wire of radius r, the drift velocity is v_d. If the same current is set up through a wire of radius $2r$ of same material, the drift velocity will be

a) $4v_d$ b) $2v_d$ c) $v_d/2$ d) $v_d/4$

333. If the experiment of Wheatstone bridge, the positions of cells and galvanometer are interchanged, then the balance points will

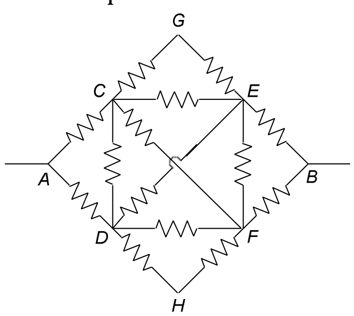
a) Change
b) Remain unchanged
c) Depend on the internal resistance of the cell and resistance of the galvanometer
d) None of these

334. The effective resistance between A and B of the shown network, where resistance of each resistor is R, is



a) $\frac{8R}{11}$ b) $\frac{6R}{11}$ c) $\frac{6R}{5}$ d) None of these

335. Fourteen identical resistors, each of resistance r, are connected as shown. The equivalent resistance between points A and B is

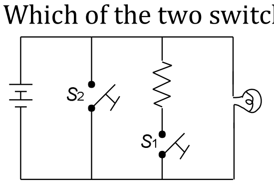


a) r b) $14r$ c) $\frac{r}{14}$ d) $1.2r$

336. 50 V battery is supplying current of 10 A when connected to a resistor. If the efficiency of the battery at this current is 25 %, then the internal resistance of the battery is

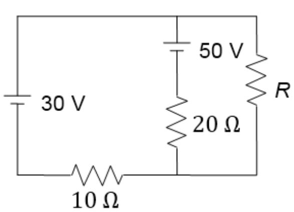
a) 2.5 Ω b) 3.75 Ω c) 1.25 Ω d) 5 Ω

337. Which of the two switches, S_1 and S_2 shown in Figure will produce short-circuiting?



a) S_1 b) S_2 c) Bothe S_1 and S_2 d) Neither S_1 and S_2

338. In the circuit shown (Figure), the value of R in ohm that will result in no current through the 30 V battery is



a) 10 Ω b) 25 Ω c) 30 Ω d) 40 Ω

339. In a potentiometer experiment, the balancing with a cell is at length 240 cm. On shunting the cell with a resistance of 2 Ω, the balancing length becomes 120 cm. The internal resistance of the cell is

a) 2 Ω b) 4 Ω c) 0.5 d) 1 Ω

340. An ideal gas is filed in a closed rigid and thermally insulated container. A coil of 100 Ω resistor carrying current 1 A for 5 min supplies heat to the gas. The change in internal energy of the gas is

a) 10 kJ b) 30 kJ c) 20 kJ d) 0 kJ

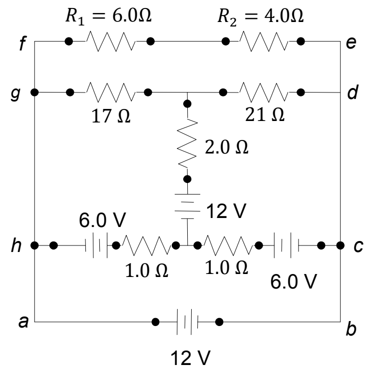
341. A wire of length L and three identical cells of negligible internal resistances are connected in series. Due to the current, the temperature of the wire is raised by ΔT in time t. Nnumber of similar cells are now

the wire is raised by the same amount ΔTin the same time$t$. Assume no loss of heat from the wire to the surrounding. The value of N is

a) 4 b) 5 c) 8 d) 6

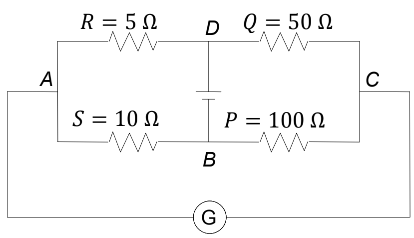
Multiple Correct Answers Type

342. In the circuit shown in Fig. mark the correct options



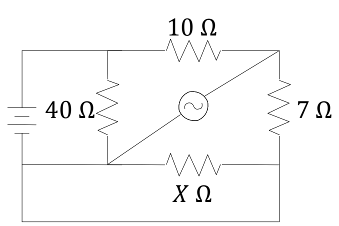
a) Potential drop across R_1 is 3.2 V
b) Potential drop across R_2 is 5.4 V
c) Potential drop across R_1 is 7.2 V
d) Potential drop across R_2 is 4.8 V

343. Figure shows a balanced Wheatstone bridge



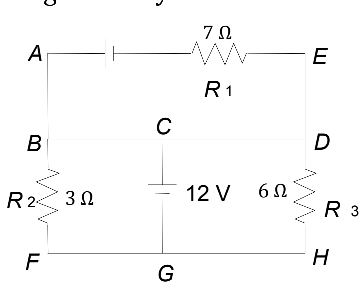
a) If P is slightly increased, the current in the galvanometer flows from C to A
b) If P is slightly increased, the current in the galvanometer flows from A to C
c) If Q is slightly increased, the current in the galvanometer flows from C to A
d) If Q is slightly increased, the current in the galvanometer flows from A to C

344. In the figure, galvanometer reads zero. The resistance x is



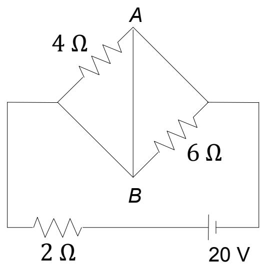
a) 7 Ω b) 21 Ω c) 14 Ω d) 28 Ω

345. A single battery is connected to three resistances as shown in Fig.



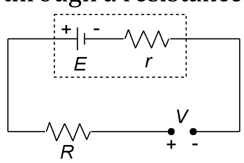
a) The current through 7 Ω resistance is 4 A
b) The current through 3 Ω resistance is 4 A
c) The current through 6 Ω resistance is 2 A
d) The current through 7 Ω resistance is 0

346. In the circuit shown in Figure,



a) Power supplied by the battery is 200 W
b) Current flowing in the circuit is 5 A
c) Potential difference across the 4 Ω resistance is equal to the potential difference across the 6 Ω resistance
d) Current in wire AB is zero

347. A battery of emf E and internal resistance r is connected with an external voltage source (generator) through a resistance R as shown in figure. Choose the correct statements.



a) In order to charge the battery, the output voltage V of the generator must greater then E
b) In order to charge the battery, the output voltage V of the generator must be at least twice of E
c) The charging current i through the circuit is given by $i = \frac{V-E}{(R+r)}$
d) The charging current i through the circuit is given by $i = \frac{V}{(R+r)}$

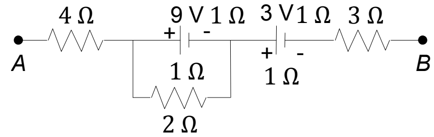
348. A battery of e.m.f E and internal resistance r is connected across a resistance R. Resistance R can be adjusted to any value greater than or equal to zero. A graph is plotted between the current passing through the resistance (I) and potential difference (V) across it. Select the correct alternatives.

a) Internal resistance of the battery is 5Ω
b) E.m.f. of the battery is 10 V
c) Maximum current which can be taken from the battery is 2 A
d) $V - I$ graph can never be a straight lines as shown in Fig.

349. Two electric bulbs rated 25 W, 220 V and 100 W, 220 V are connected in series across a 220 V voltage source. The 25 and 100 W bulbs now draw P_1 and P_2 powers, respectively
a) $P_1 = 16$ W
b) $P_1 = 4$ W
c) $P_2 = 16$ W
d) $P_2 = 4$ W

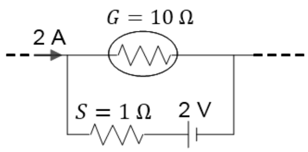
350. Two resistors having equal resistances are joined in series and a current is passed through the combination. Neglect any variation in resistance as the temperature changes. In a given time interval
a) Equal amounts of thermal energy must be produced in the resistances
b) Unequal amounts of thermal energy may be produced
c) The temperature must rise equally in the resistors
d) The temperature may rise equally in the resistors

351. The potential difference between the points A and B in the circuit shown in figure is 16V. Which is/are the correct statements out of the following?



a) The current through the 2Ω resistor is 3.5 A
b) The current through the 4Ω resistor is 2.5 A
c) The current through the 3Ω resistor is 1.5 A
d) The potential difference between the terminals of the 9 V battery is 7 V

352. The galvanometer shown in the figure has resistance 10 Ω. it is shunted by a series Combination of a resistance $S = 1\Omega$ and an ideal cell of e.m.f. 2 V. A current 2 A pases as shown

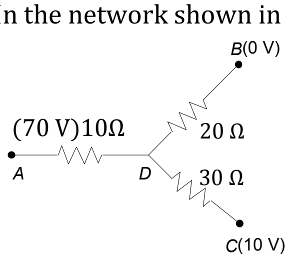


a) The reading of the galvanometer is 1 A
b) The reading of the galvanometer is zero
c) The potential difference across the resistance S is 1.5 V
d) The potential difference across the resistance S is 2 V

353. Two bulbs consume same energy when operated at 200 V and 300 V, respectively. When these bulbs are connected in series across a d.c. source of 500 V, then
a) Ratio of potential difference across them is 3/2
b) Ratio of potential difference across them is 4/9
c) Ratio of power produced in them is 4/9
d) Ratio of power produced in them 2/3

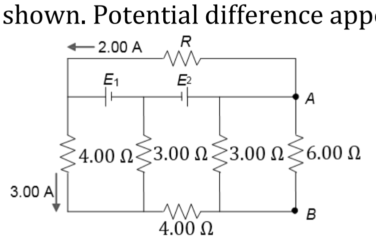
354. The electron in a hydrogen atom moves in a circular orbit of radius 5×10^{-11}m with A speed of $0.6\,\pi \times 10^6$m/s, then
a) The frequency of the electron is 6×10^{15} rev/s
b) The electron carries -1.6×10^{-19} C around the loop
c) The current in the orbit is 0.96 mA
d) The current flow is in the opposite direction to the direction of the motion of electron

355. In the network shown in Fig., points A, B and C are at potentials of 70 V, 0 and 10 V, respectively. Then



a) Point D is at a potential of 40V.
b) The currents in the sections AD, DB, DC are in the ratio 3: 2:1
c) The currents in the sections AD, DB, DC are in the ratio 1: 2:3
d) The network draws a total power of 200 W

356. In the circuit shown in figure, E_1 and E_2 are two ideal sources of unknown e.m.f.s. some currents are shown. Potential difference appearing across 6 Ω resistance is $V_A - V_B = 10$ V



a) The current in the 4.00 Ω resistor is 5 A
b) The unknown e. m. f. E_1 is 36 V

c) The unknown e. m. f. E_2 is 54 V

d) The resistance R is equal to 9 Ω

357. Which of the following statements are correct?

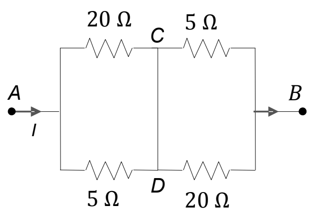
a) If bulbs of difference wattages are joined in parallel, then the lowest wattage bulb glows with the maximum brightness

b) If bulbs of difference wattages are joined in parallel, then the highest wattage bulb glows with the maximum brightness

c) If bulbs of difference wattages are joined in series, then the lowest wattage bulb glows with maximum brightness

d) If bulbs of difference wattages are joined in series, then the highest wattage bulb glows with the maximum brightness

358. When some potential difference is maintained between A and B. Current I enters the network at A and leaves at B (see Fig.)



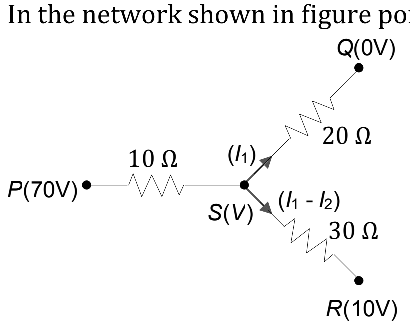
a) The equivalent resistance between A and B is 8 Ω

b) C and D are at the same potential

c) No current flows between C and D

d) Current $3I/5$ flows from D to C

359. In the network shown in figure points P, Q and R are at potentials 70 V, zero and 10 V respectively. Then



a) Points S is at a potential of 40 V

b) The currents in the sections PQ, SQ, SR are in the ratio 3 : 2 : 1

c) The current in the sections PS, SQ, SR are in the ratio 1 : 2 : 3

d) The network draws a total power of 200 W

360. Two electric bulbs rated at 25 W-220 V and 100 W-220 V are connected in series across a 220 V voltage source. The 25 W and 100 W bulbs now draw P_1 and P_2 powers, respectively, therefore

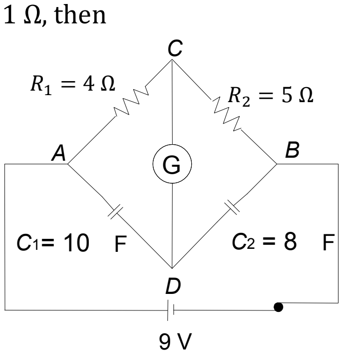
a) $P_1 = 16$ W

b) $P_1 = 4$W

c) $P_2 = 16$ W

d) P_2=4 W

361. In the circuit shown in Figure, the cell is ideal with e.m.f. 9 V. If the resistance of the coil of galvanometer is 1 Ω, then

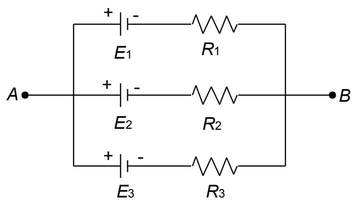


a) No current flows in the galvanometer
b) Charge flowing through 8 μF is 40 μC
c) Potential difference across 10 μF is 5 V
d) Potential difference across 10 μF is 4 V

362. When a potential difference is applied across, the current passing through
a) An insulator at 0 K is zero
b) A semi-conductor at 0 K is zero
c) A metal at 0 K is finite
d) A $p-n$ diode at 300 K is finite, if it is reverse biased

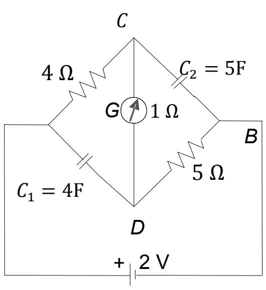
363. The charge flowing in a conductor varies with time as $Q = at - bt^2$. Then, the current
a) Decreases linearly with time
b) Reaches a maximum and then decreases
c) Falls to zero at time $t = a/ab$
d) Changes at a rate $-2b$

364. For the batteries shown in Fig, R_1, R_2 and R_3 are the internal resistances of E_1, E_2 and E_3, respectively. Then, which of the following is/are correct?



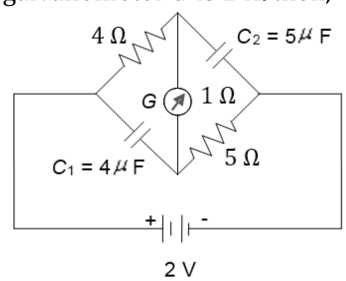
a) The equivalent internal resistance R of the system is given by: $\frac{R_1R_2R_3}{R_1R_2+R_2R_3+R_3R_1}$
b) If $E_3 = \frac{(E_1R_2+E_2R_1)}{(R_1+R_2)}$, the equivalent e.m.f of the batteries will be equal to E_3
c) The equivalent e.m.f of the battery is equal to $E = (E_1 + E_2 + E_3)/3$
d) The equivalent e.m.f of the battery not only depends upon values of E_1, E_2 and E_3 but also depends upon values of R_1, R_2 and R_3

365. In the circuit shown in Fig. the cell is ideal, with c.m.f = 2 V. The resistance of the coil of the galvanometer G is 1 Ω. Then in steady state



a) No current flows in G
b) 0.2 A current flows in G
c) Potential difference across C_1 is 1V
d) Potential difference across C_2 is 1.2 V

366. In the circuit show (Figure), the cell is ideal with e. m. f. = 2 V. the resistance of the coil of the galvanometer G is 1 Ω. then,



a) No current flows in G
b) 0.2 A current flows in G
c) Potential difference across C_1 is 1 V
d) Potential difference across C_2 is 1.2 V

367. Read the following statements carefully:
Y: The resistivity of a semiconductor decreases with the increase in temperature
Z: In a conducting solid, the rate of collisions between free electrons and ions increases with the increase

Select the correct statement(s) from the following

a) Y is true but Z is false

b) Y is false but Z is true

c) Both Y and Z are true

d) Y is true and Z is the correct reason for Y

368. A parallel-plate capacitor of capacitance 10 μF is connected to a cell of e.m.f. 10 V and is fully charged. Now a dielectric slab ($k = 3$) of thickness equal to the gap between the plates is completely filled in the gap, keeping the cell connected. During the filling process,

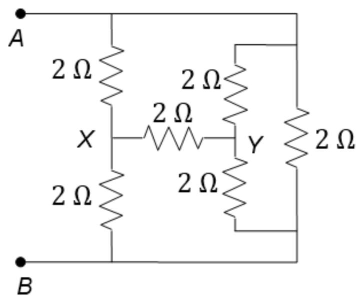
a) The increase in charge on the capacitor is 200μC

b) The heat produced is zero

c) Energy supplied by the cell = increase in stored potential energy + work done on the person who is filling the dielectric slab

d) Energy supplied by the cell = increase in stored potential energy + work done on the person who is filling the dielectric slab +heat produced

369. For the circuit shown in Figure, select the correct statements from the following options



a) x and y are equipotential points

b) Effective resistance between A and B is 2 Ω

c) Effective resistance between A and B is 1 Ω

d) None of the above

370. Capacitor C_1 of capacitance 1 micro-farad and capacitor C_2 of capacitance 2 micro-farad are separately charged fully by a common battery. The two capacitors are then separately allowed to discharge through equal resistors at time $t = 0$

a) The current in each of the two discharging circuits is zero at $t = 0$

b) The current in the two discharging circuits at $t = 0$ are equal but not zero

c) The currents in the two discharging circuits at $t = 0$ are unequal

d) Capacitor C_1 loses 50% of its initial charge sooner than C_2 loses 50% of its initial charge

371. When a potential difference is applied across the current passing through

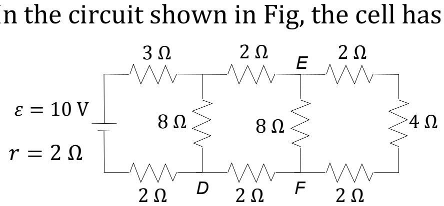
a) An insulator at 0 K is zero

b) A semiconductor at 0 K is zero

c) A metal at 0 K is finite

d) A $p - n$ dipole at 300 K is finite, if it is reverse biased

372. In the circuit shown in Fig, the cell has e.m.f. = 10 V and internal resistance = 1 Ω



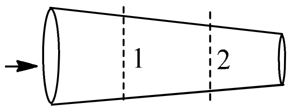
a) The current through the 3 Ω resistor is 1 A

b) The current through the 3 Ω resistor is 0.5 A

c) The current through the 4 Ω resistor is 0.5 A

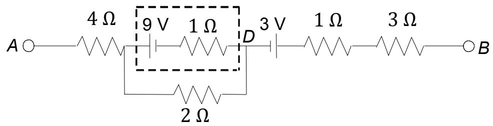
d) The current through the 4 Ω resistor is 0.25 A

373. Consider a conductor of variable cross section in which current is flowing from cross section '1' to '2'. Then



a) Current passing through both the cross sections is the same
b) Current through '1' is less than that through '2'
c) Drift velocity of electrons at '1' is less than that at '2'
d) Drift velocity is same at both the cross sections

374. The potential difference between points A and B in the circuit shown in Fig. is 16 V. Then

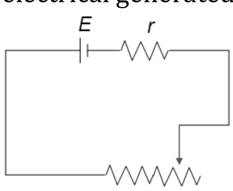


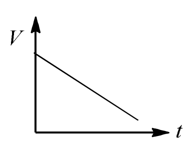
a) The current through the 2 Ω resistance is 3.5 A
b) The current through the 4 Ω resistance is 2.5 A
c) The current through the 3 Ω resistance is 1.5 A
d) The potential difference between the terminals of the 9 V battery is 7 V

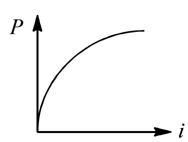
375. A voltmeter and an ammeter are connected in series to an ideal cell of e.m.f. E. The voltmeter reading is V and the ammeter reading is I. Then
i. $V < E$
ii. the voltmeter resistance is V/I
iii. the potential difference across the ammeter is $E - V$
iv. voltmeter resistance plus ammeter resistance $= E/I$
Correct statements are

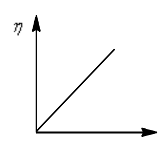
a) i and ii b) ii and iii c) iii and iv d) all

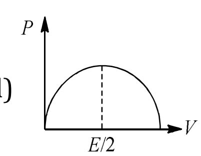
376. In Figure, battery of e. m. f. E has internal resistance r and a variable resistor. At an instant, current flowing through the circuit is i, potential difference between the terminals of cells is V, thermal power developed in external circuit is P and thermal power developed in the cell is equal to fraction η of total electrical generated in it. Which of the following graphs is/are correct?



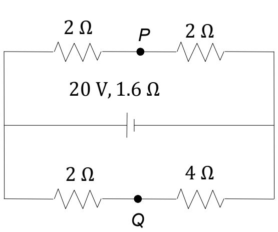
a) 

b) 

c) 

d) 

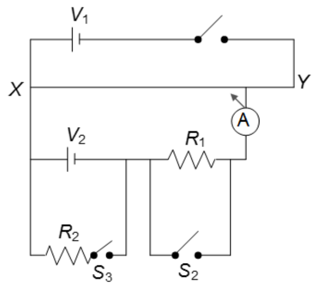
377. In the given circuit (Fig),



a) The current through the battery is 5 A b) P and Q are at the same potential
c) P is 2 V higher than Q d) Q is 2 V higher than P

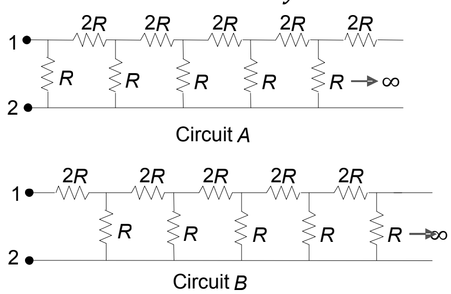
378. In the circuit shown in Figure, XY is a potentiometer wire 100 cm long. The circuit is connected up as shown. With switches S_2 and S_3 open, a balance point is found at$Z$. After switch S_1 has remained closed for some time, it is found that contact at Z must be moved towards Y to maintain a balance. Which of the

following is the most likely reason for this?



a) The cell V_1 is running down
b) The cell V_2 is running down
c) The wire XZ, is getting warm and its resistance is increasing
d) The resistor R_1 is getting warm and increasing in value

379. Two circuits (as shown in Fig.) are called Circuits A and Circuit B. The equivalent resistance of Circuit A is x and that of Circuit B is y between 1 and 2

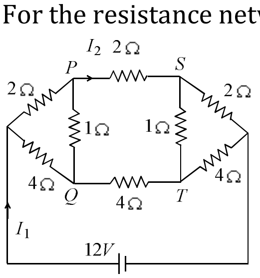


a) $y > x$ b) $y = (\sqrt{3} + 1)R$ c) $xy = 2R^2$ d) $y - x = 2\,R$

380. A steel wire has a resistance twice that of an aluminium wire. Both of them are connected with a constant voltage supply. More heat will be dissipated in
a) Steel wire when both are connected in series
b) Steel wire when both are connected in parallel
c) Aluminium wire when both are connected in series
d) Aluminium wire when both are connected in parallel

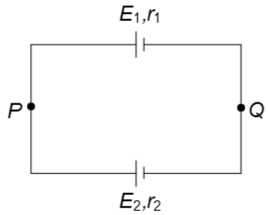
381. A cell of emf E and internal resistance r drives a current I through an external resistance R.
a) The cell supplies a power $= EI$
b) The heat is produced in R in at the rate
c) The heat is produced in R at the rate $= EI \times \frac{R}{(R+r)}$
d) The heat is produced in the cell at the rate $= EI \times \frac{R}{(R+r)}$

382. For the resistance network shown in the figure, choose the correct option(s)



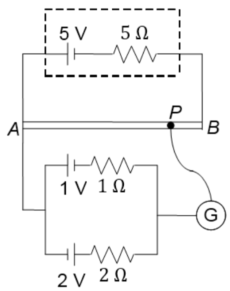
a) The current through PQ is zero
b) $I_1 = 3A$
c) The potential at S is less than that at Q
d) $I_2 = 2A$

383. Two cells of unequal e. m. f. s E_1 and E_2 and internal resistance r_1 and r_2 are joined as shown in Figure. V_P and V_Q are identical at P and Q, respectively, then



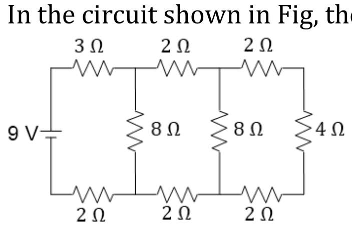
a) The potential difference across both the cells will be equal
b) One of the cells will supply energy to the other cell
c) The potential difference across one of the cells will be greater than its e. m. f.
d) $V_P - V_Q = \frac{E_1 r_2 + E_2 r_1}{r_1 + r_2}$

384. A battery of e. m. f. $\varepsilon_0 = 5$ V and internal resistance 5 Ω is connected across a long uniform wire AB of length 1 m and resistance per unit length 5 Ωm^{-1}. Two cells of $\varepsilon_1 = 1$ V and $\varepsilon_2 = 2$ V are connected as shown in the figure



a) The null point is at A
b) If the jockey is touched to point$B$. The current in the galvanometer will be going towards B
c) When jockey is connected to point A, no current flows through 1 V battery
d) The null point is at distance of 8/15 m from A_2

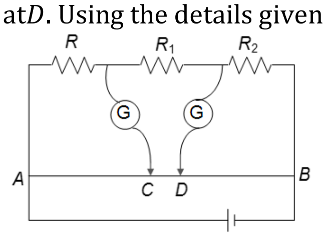
385. In the circuit shown in Fig, the current through the



a) 3 W resistor is 0.50 A b) 3 W resistor is 0.25 A c) 4 W resistor is 0.50 A d) 4 W resistor is 0.25 A

386. A voltmeter reads the potential difference across the terminals of an old battery as 1.40 V while a potentiometer reads its voltage to be 1.55 V. The voltmeter resistance is 280Ω. Then
a) The e.m.f. of the battery is 1.4 V
b) The e.m.f. of the battery is 1.55 V
c) The internal resistance r of the battery is 30 Ω
d) The internal resistance r of the battery is 5 Ω

387. The diagram shows a modified meter bridge, which is used for measuring two unknown resistances at the same time. When only the first galvanometer is used, for obtaining the balance point, it is found at point$C$. Now the first galvanometer is removed and the second galvanometer is used, which gives balance point at$D$. Using the details given in the diagram, find out the value of R_1 andR_2



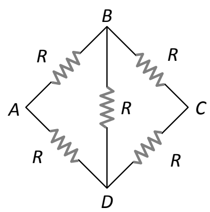
a) $R_1 = 5R/3$ b) $R_2 = 4R/3$ c) $R_1 = 4R/3$ d) $R_2 = 5R/3$

388. An element with e.m.f. ε and internal resistance r is connected across an external resistance R. The

maximum power in external circuit is 9 W. the current flowing through the circuit in these conditions is 3 A. Then which of the following is/are correct?

a) $\varepsilon = 6$ V b) $r = R$ c) $r = 1\ \Omega$ d) $r = 3\ \Omega$

389. Five equal resistances each of value R are connected in a form shown alongside. The equivalent resistance of the network



a) Between the points B and D is R

b) Between the points B and D is $\frac{R}{2}$

c) Between the points A and C is R

d) Between the points A and C is $\frac{R}{2}$

390. Two heaters designed for the same voltage V have different power ratings. When connected individually across a source of voltage V, they produce H amount of heat each in times $t_1$and t_2 respectively. When used together across the same source, they produce H amount of heat in time t.

a) If they are in series, then $t = t_1 + t_2$

b) If they are in series, then $t = 2(t_1 + t_2)$

c) If they are in parallel, then $t = \frac{t_1 \times t_2}{(t_1+t_2)}$

d) If they are in parallel, then $t = \frac{t_1 t_2}{2(t_1+t_2)}$

391. In the above question, if polarity of E_2 is reversed. Then

a) Current in both ammeters will flow in same direction

b) Current in both ammeters will flow in opposite directions

c) Current in both ammeters can be same if $R_1 > R_2$

d) Current in both can be same if $R_1 < R_2$

392. A microammeter has a resistance of 100Ω and a full scale range of 50 μA. It can be used as a voltmeter or as a higher range ammeter provided a resistance is added to it. Pick the correct range and resistance combination(s)

a) 50 V range with 10 $k\Omega$ resistance in series

b) 10 V range with 200 $k\Omega$ resistance in series

c) 5 mA range with 1 Ω resistance in parallel

d) 10 mA range with 1 Ω resistance in parallel

393. In an house hold electric circuit

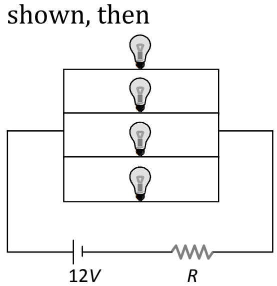
a) All electric appliances drawing power are joined in parallel

b) A switch may be either in series or in parallel with the appliance which controls it

c) If a switch is in parallel with an appliance, it will draw power when the switch is in the off position (open)

d) If a switch is in parallel with an appliance, the fuse will blow (burn out) when the switch is put on (closed)

394. Four identical electrical lamps are labelled $1.5V$, $0.5A$ which describes the condition necessary for them to operate at normal brightness. A $12V$ battery of negligible internal resistance is connected to lamps as shown, then



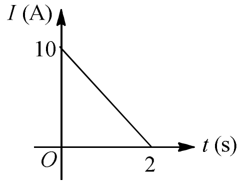
a) The value of R for normal brightness of each lamp is $(3/4)\Omega$

b) The value of R for normal brightness of each lamp is $(21/4)\Omega$

c) Total power dissipated in circuit when all lamps are normally bright is $24W$

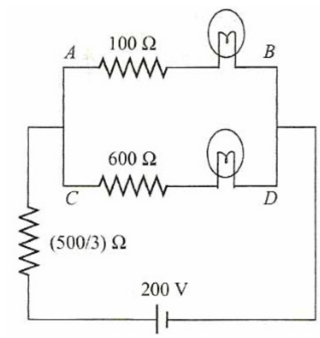
d) Power dissipated in R is $21W$ when all lamps are normally bright

395. A variable current flows through a 1 Ω resistor for 2s. time dependence of the Current is shown in the graph



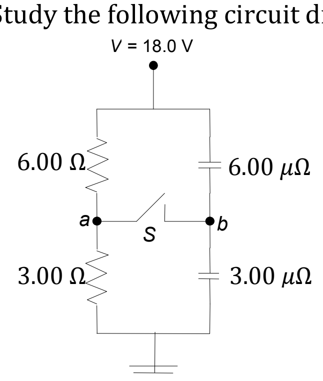
a) Total charge flown through the resistor is 10 C
b) Average current through the resistor is 5 A
c) Total heat produced in the resistor is 50 J
d) Maximum power during the flow of current is 100 W

396. Two bulbs 25 W, 100 V (upper bulb in figure) and 100 W, 200 V (lower bulb in figure) Are connected in the circuit as shown in Figure. Choose the correct answer(s)



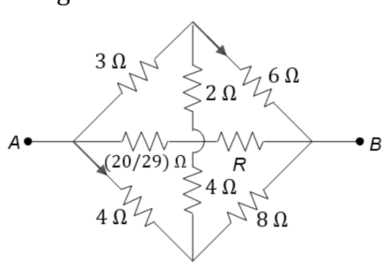
a) Heat lost per second in the circuit will be 80 J
b) Ratio of heat produced per second n bulb will be 1:1
c) Ratio of heat produced in branch AB to that produced in branch CD will be 1:2
d) Current drawn from the cell is 0.4 A

397. Study the following circuit diagram in Fig. and mark the correct options



a) The potential of point a with respect to point b in the figure when switch S is open is −6 V
b) The points a and b are at the same potential, when is opened
c) The charge flows through switch S when it is closed is 54 μC
d) The find potential of b with respect to ground when switch S is closed is 8 V

398. A battery of e. m. f. 2 V and initial resistance 1 Ω is conneced across erminals A and B of the circuit shown in Figure



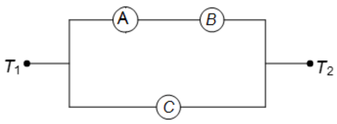
a) Thermal power generated in the external circuit will be maximum possible when $R = \frac{16}{25}\Omega$

b) Maximum possible thermal power generated in the external circuit is equal to 4 W

c) Ratio of current through 3 Ω to that through 8 Ω is independent of R

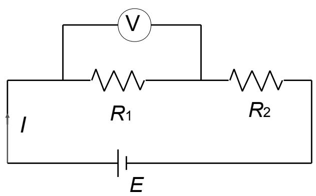
d) None of above

399. Three ammeters A ,B and C of resistance R_A, R_B and R_C, respectively, are joined as shown in Figure. when some potential difference is applied across the terminals T_1 and T_2 their readings are I_A, I_B ad I_C respectively, then



a) $I_A = I_B$ b) $I_A R_A + I_B R_B = I_C R_C$ c) $\frac{I_A}{I_C} = \frac{R_C}{R_A}$ d) $\frac{I_B}{I_C} = \frac{R_C}{R_A + R_B}$

400. In the figure shown, voltmeter is not ideal. If voltmeter is removed from R_1 and then put across R_2, what will be the effect on current I? Given $R_1 > R_2$



a) Decreases b) Remains same

c) Increases d) I would have been same if voltmeter were ideal

401. Consider a resistor of uniform cross-sectional area connected to a battery of internal resistance zero, if the length of the resistor is doubled by stretching it, then

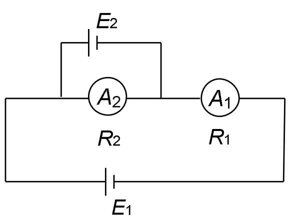
a) The current will become four times

b) The electric field in the wire will become half

c) The thermal power produced by the resistor will become one fourth

d) The product of the current density and conductance will become half

402. Two ideal batteries and two ammeters are arranged as shown in the figure



a) Readings of both ammeters can be same if $E_1 > E_2$

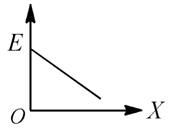
b) Readings of both ammeters can be same if $E_2 > E_1$ provided $R_2 > R_1$

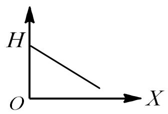
c) Readings of the ammeters can be same if $E_2 > E_1$ provided $R_2 < R_1$

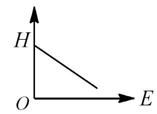
d) If $E_2 > E_1$, then current in ammeters will flow in opposite directions

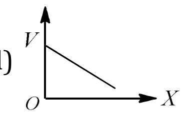
403. A conductor made of an isotropic material has shape of a truncated cone. A battery of constant e. m. f. is connected across it and its left end is earthed a shown in the figure.

If at a section distant x from left end, electric field intensity, potential and time rate of generation of heat per unit length are E, V and H, respectively, which of the following graphs is/are correct?

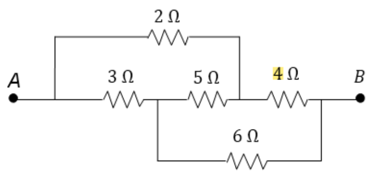
a) 

b) 

c) 

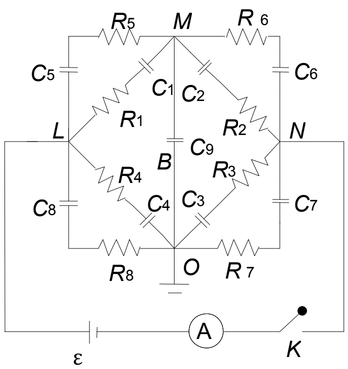
d) 

404. In the circuit shown in Fig. some potential difference is applied between A and B. The equivalent resistance between A and B is R



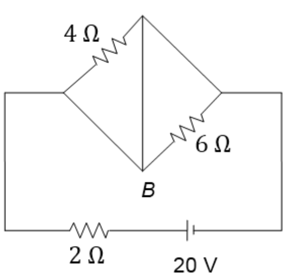
a) No current flows through the 5 Ω resistor
b) $R = 15\ \Omega$
c) $R = 12.5\ \Omega$
d) $R = \frac{18}{5}\ \Omega$

405. In the circuit given in Fig. the resistances $R_1 = R_2 = R_3 = R_4 = 4\Omega$ and $R_5 = R_6 = R_7 = R_8 = 12\Omega$ and the capacitors $C_1 = C_2 = C_3 = C_4 = 1\mu$F and $C_5 = C_6 = C_7 = C_8 = 3\ \mu$F, $C_9 = 5\ \mu$F, are arranged with a battery of e.m.f ε. Point O is earthed



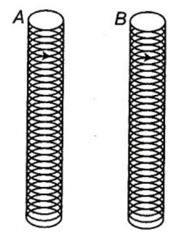
a) The reading of the ammeter long time after closing the switch is 2 A
b) If just after closing the key the ammeter reads 2 A then the value of ε is 6 V
c) The charge on C_1 capacitor at steady state is 3 μC
d) The heat developed in the circuit long time after closing the key is 72μJ

406. In the circuit shown in Figure,



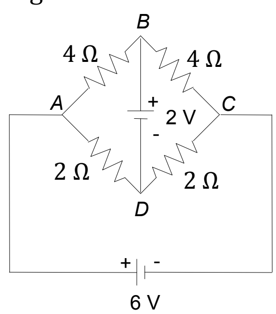
a) Power supplied by the circuit is 200 W
b) Current flowing in the circuit is 5 A
c) Potential difference across 4 Ω resistance is equal to the potential difference across 6Ω resistance
d) Current in wire AB is zero

407. Two metallic rings A and B, identical in shape and size but having different resistivities ρ_A and ρ_B, are kept on top of two identical solenoids as shown in the figure. When current I is switched on in both the solenoids in identical manner, the rings A and B jump to heights h_A and h_B, respectively , with $h_A > h_B$. The possible relation (s) between their resistivities and their masses m_A and m_B is (are)



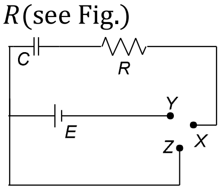
a) $\rho_A > \rho_B$ and $m_A = m_B$
b) $\rho_A < \rho_B$ and $m_A = m_B$
c) $\rho_A > \rho_B$ and $m_A > m_B$
d) $\rho_A < \rho_B$ and $m_A < m_B$

408. Figure shows a network of resistances and batteries. Select the correct statements out of the following



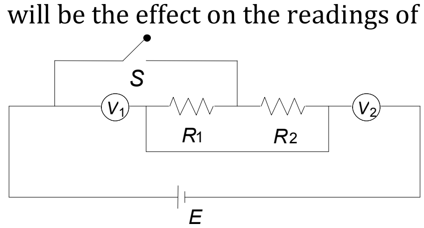
a) The circuit satisfy the condition of a balanced Wheatstone bridge
b) $V_B - V_D = 0$
c) $V_B - V_D = 2V$
d) No current flows in the branch BD

409. The capacitor C is initially without charge. X is now joined to Y for a long time, during which H_1heat is produced in the resistance R. X is now joined to Z for a long time, during which H_2 heat is produced in R(see Fig.)



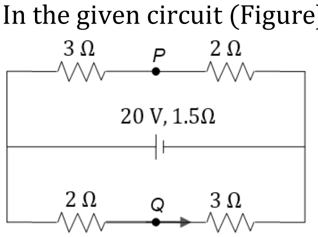
a) $H_1 = H_2$
b) $H_1 = \frac{1}{2}H_2$
c) $H_1 = 2H_2$
d) The maximum energy stored in C at any time is H_1

410. Two voltmeters and two resistances are connected as shown in the figure. On closing the switch S, what will be the effect on the readings of the voltmeters?



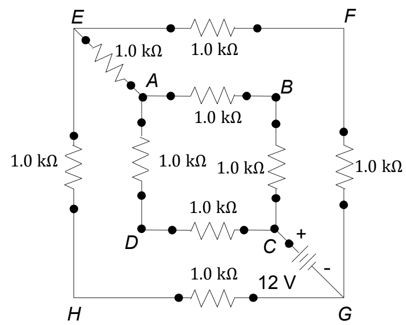
a) V_1 increases
b) V_1 decreases
c) V_2 increases
d) V_2 decreases

411. In the given circuit (Figure)



a) The current through the battery is 5.0 A
b) P and Q are at the same potential
c) P is 2.5 V higher than Q
d) Q is 2.5 V higher than P

412. In the given circuit (as shown in Fig.),



a) The equivalent resistance between C and G is 3 kΩ
b) The current provided by the source is 4 mA
c) The current provided by the source is 8 mA
d) Voltage across points G and E is 4 V

Assertion - Reasoning Type

This section contain(s) 0 questions numbered 413 to 412. Each question contains STATEMENT 1(Assertion) and STATEMENT 2(Reason). Each question has the 4 choices (a), (b), (c) and (d) out of which **ONLY ONE** is correct.

a) Statement 1 is True, Statement 2 is True; Statement 2 **is** correct explanation for Statement 1

b) Statement 1 is True, Statement 2 is True; Statement 2 **is not** correct explanation for Statement 1

c) Statement 1 is True, Statement 2 is False

d) Statement 1 is False, Statement 2 is True

413

Statement 1: a

Statement 2: The given resistor are in parallel to one another

414

Statement 1: When a 40 W, 220 V lamp and 100 W, 220 V lamp are connected in series across 440 V supply then 40 W lamp will fuse.

Statement 2: 40 W and 100 W lamps can tolerate 440 V.

415

Statement 1: Neutral temperature of a thermocouple does not depend upon temperature of cold junction

Statement 2: Its value is constant for the given metals of the couple

416

Statement 1: Duddell's thermo galvanometer is suitable to measure direct current only.

Statement 2: Thermopile can measure temperature differences of the order of 10^{-3} .

417

Statement 1: When an external resistor of resistance R (connected across a cell to internal resistance r) is varied, power consumed by resistance R is maximum when $R = r$

Statement 2: Power consumed by a resistor of constant resistance R is maximum when current through it is maximum

418

Statement 1: A certain charge is liberated by 0.8 g of oxygen, 10.8 g of can liberate same amount of charge.

Statement 2: From Faraday's first law of electrolysis, the amount of charge liberated is proportional to the mass of substance taken.

419

Statement 1: If a wire is stretched to increase its length n times, then its resistance also become n times

Statement 2: Resistance of the wire is directly proportional to its length

420

Statement 1: Thermocouple acts as a heat engine

Statement 2: When two junctions of thermocouple are at different temperature, thermo e.m.f. is produced

421

Statement 1: Leclanche cell is used when constant supply of electric current is not required

Statement 2: The e.m.f. of a Leclanche cell falls if it is used continuously

422

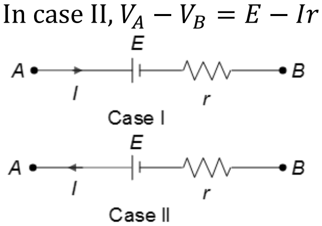
Statement 1: An electric bulb is first connected to a dc source and then to an ac source having then same brightness in both the cases

Statement 2: The peak value of voltage for an A.C. source is $\sqrt{2}$ times the root mean square voltage

423

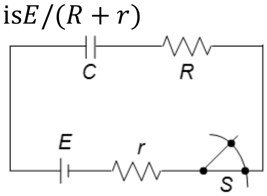
Statement 1: Consider the two situations shown in Figure. potential difference between point A and B in case I is more as compared to Case II

Statement 2: In case I, $V_A - V_B = E + Ir$
In case II, $V_A - V_B = E - Ir$



424

Statement 1: The switch S shown in Figure is closed at $t = 0$. Initial current flowing through battery is$E/(R + r)$



Statement 2: Initially, capacitor was uncharged, so the resistance offered by capacitor at $t = 0$ is zero

425 a

Statement 1: a

Statement 2: r

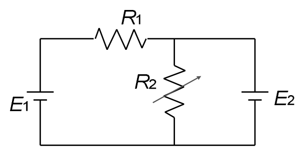
426

Statement 1: If the current of a lamp increases by 20%, the percentage increase in the illumination of the lamp is 40%

Statement 2: Illumination of the lamp is directly proportional to the square of the current through the lamp

427

Statement 1: In the circuit in Figure, both cells are ideal and of fixed e.m.f. the resistor R_1 has fixed resistance and the resistance of resistor R_2 can be varied (but R_2 is always non-zero). Then the electric power delivered to resistor of the resistance R_1 is independent of the value of resistance R_2



Statement 2: If potential difference across a fixed resistance is unchanged, the power delivered to the resistor remains constant

428

Statement 1: The drift velocity of electrons in a metallic wire will decrease, if the temperature of the wire is increased

Statement 2: On increasing temperature, conductivity of metallic wire decreases

429

Statement 1: A domestic electrical appliance, working on a three pin will continue working even if the top pin is removed

Statement 2: The third pin is used only as a safety device

430

Statement 1: A person touching a high power line gets stuck with the line

Statement 2: The current carrying wires attract the man towards it

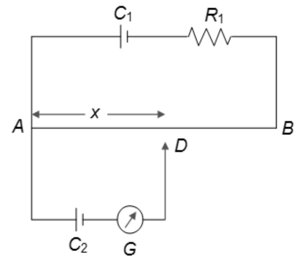
431

Statement 1: The possibility of an electric bulb fusing fusing is higher at the time of switching ON and OFF

Statement 2: Inductive effects produce a surge at the time of switch-OFF switch-ON

432

Statement 1: In the potentiometer circuit shown in figure, E_1 and $E_2$are the e.m.f. of cells C_1 and C_2 respectively, with $E_1 > E_2$.Cell C_1 has negligible internal resistance. For a given resistor$R$, the balance length I x. If the diameter of the potentiometer wire AB is increased, the balance length x will decrease



Statement 2: At the balance point, the potential difference between AD due to cell C_1 is E_2 then e. m. f. of cell C_2

433

Statement 1: Voltmeter always gives e.m.f. of a cell if it is connected across the terminals of a cell

Statement 2: Terminal potential of a cell is given by $V = E - ir$

434

Statement 1: A potentiometer is preferred over that of a voltmeter for measurement of emf of a cell.

Statement 2: Potentiometer is preferred as it does not draw any current from the cell.

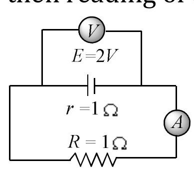
435

Statement 1: The higher the range, the greater is the resistance of an ammeter

Statement 2: To increase the range of an ammeter, addition shunt is needed to be used across it

436

Statement 1: In the following circuit emf is $2V$ and internal resistance of the cell is $1\ \Omega$ and $R = 1\Omega$, then reading of the voltmeter is $1V$



Statement 2: $V = E - ir$ where $E = 2V, i = \frac{2}{2} = 1A$ and $R = 1\ \Omega$

437

Statement 1: The drift velocity of electrons in a metallic wire will decrease, if the temperature of the wire is decreases

Statement 2: On increasing temperature, the conductivity of the metallic wire decreases

438

Statement 1: A car battery is of 12 V. eight dry cells of 1.5 V connected in series can give 12V. still such cells are not used in starting a car.

Statement 2: It is easier to start a car engine on a warm day than on a rainy day.

439 Consider the following statements A and B are identify the correct answers given below :

Statement 1: Peltier coefficient is numerically equal to the potential difference across the junctions of the thermocouple through which current is flowing.

Statement 2: According to Thomson, energy is neither absorbed nor evolved at the junction of a thermocouple but is observed or evolved only along the lengths of both the conductors.

440

Statement 1: The current density $\vec{J}$ at any point in ohmic resistor is in the direction of electric field $\vec{E}$ at that point

Statement 2: A point charge when released from rest in a region having only electrostatic field always moves along electric lines of force

441

Statement 1: A

Statement 2: All the resistances are in parallel to each other

442

Statement 1: When a cell is charged by connecting its positive electrode with positive terminal of the charger battery, then the potential difference across the electrodes of cell will be smaller to the e. m. f. of cell

Statement 2: Potential difference across electrodes in a cell providing electric current is $E - ir$, where E is e.m.f. and r internal resistnace

443

Statement 1: A piece of copper and of germanium are cooled from room temperature to 100 K. Conductivity of copper increases and that of germanium decreases

Statement 2: Copper has positive temperature coefficient where as germanium has negative temperature coefficient

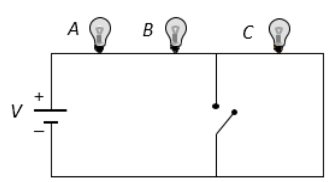
444

Statement 1: If the radius of copper wire carrying a fixed current is doubled, then the drift velocity of the electrons will become one-fourth

Statement 2: Drift velocity will change according to the relation $I = neAv_d$

445

Statement 1: If three identical bulbs are connected in series as shown in figure, then on closing the switch bulb C is short circuited and hence illumination of bulbs A and B is decreases



Statement 2: Voltage on A and B decreases

446

Statement 1: A potentiometer is preferred over a voltmeter for the measurement of e.m.f. of a cell

Statement 2: A potentiometer is preferred, as it does not draw any current from the cell

447

Statement 1: In a simple battery circuit the point of lowest potential is positive terminal of the battery

Statement 2: The current flows towards the point of the higher potential as it flows in such a circuit from the negative to the positive terminal

448

Statement 1: Two bulbs of same wattage, one having a carbon filament and other having a metallic filament are connected in series. The metallic filament bulb will glow more brightly than carbon filament bulb

Statement 2: Carbon is a semiconductor

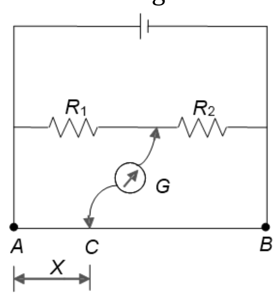
449

Statement 1: a

Statement 2: b

450

Statement 1: In the meter bridge experiment shown in Figure, the balance length AC corresponding to null deflection of the galvanometer is x. If the radius of the wire AB is doubled, the balanced length becomes $4x$



Statement 2: The resistance of a wire is inversely proportional to the square of its radius

451

Statement 1: In a given thermo-couple, the temperature of cold junction is 15°C, while the neutral temperature is 270°C. The value of the temperature of inversion is 720°C.

Statement 2: Neutral temperature is the arithmetic mean to temperature of cold junction and temperature of inversion.

452

Statement 1: Two electric bulbs of 50 and 100 W are given. When connected in series 50 W bulb glows more but when connected parallel 100 W bulb glows more

Statement 2: In series combination, power is directly proportional to the resistance of circuit. But in parallel combination, power is inversely proportional to the resistance of the circuit

453

Statement 1: A silver voltmeter and a zinc voltmeter are connected in series and current i is passed for a time t liberated w kg of zinc, the weight of the silver deposited is 3.5 w.

Statement 2: $\frac{m_1}{m_2} = \frac{z_1}{z_2} = \frac{w_1}{w_2}$.

454

Statement 1: The wire of a potentiometer should be of uniform area of cross section

Statement 2: It satisfies the requirement of the principle of a potentiometer

455

Statement 1: The temperature coefficient of resistance is positive for metals and negative for p-type semiconductor

Statement 2: The effective charge carries in metals are negatively charged whereas in p-type semiconductor they are positively charged

456

Statement 1: A heater coil is cut into two equal parts and only one part is used in the heater. Heat generated will be doubled.

Statement 2: Heat generated is given by the expression $Q = \frac{V^2 t}{R}$.

457

Statement 1: A laser beam of 0.2 W power can drill holes through a metal sheet, whereas 1000 W torch-light cannot

Statement 2: The frequency of laser light is much higher than that of torch light

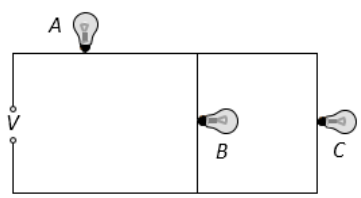
458

Statement 1: The wires supplying current to an electric heater are not heated appreciably

Statement 2: Resistance of connecting wires is very small and $H \propto R$

459

Statement 1: In the given circuit if lamp B or C fuses then light emitted by lamp A decreases



Statement 2: Voltage on A decreases

460

Statement 1: The electric bulbs glows immediately when switch is on

Statement 2: The drift velocity of electrons in a metallic wire is very high

461

Statement 1: The 200 W bulbs glow with more brightness than 100 W bulbs

Statement 2: A 100 W bulbs has more resistance than a 200 W bulbs

462

Statement 1: The e.m.f. of the driver cell in the potentiometer experiment should be greater than the e.m.f. of the cell to be determined

Statement 2: The fall of potential across the potentiometer wire should not be less than the e.m.f. of the cell to be determined

463

Statement 1: The resistance of an ideal voltmeter should be infinite

Statement 2: Lower resistance of voltmeters gives a reading lower than the actual potential difference across the terminals

464

Statement 1: The equivalent resistance in series combination is larger than the largest resistance.

Statement 2: The equivalent resistance of the parallel combination is smaller than the smallest resistance.

465

Statement 1: Two unequal resistances are connected in series across a cell, then the potential drop across the larger resistance is more

Statement 2: The current will be the same in both unequal resistances

466

Statement 1: Two unequal resistance are connected in series with a cell, then potential drop across a larger resistance is more

Statement 2: The current will be same in both unequal resistance

467

Statement 1: A toaster produces more heat than a bulb, when connected in parallel.

Statement 2: Toaster has less resistance than a bulb

468

Statement 1: A wire of uniform cross section and uniform resistivity is connected across an ideal cell. Now the length of the wire is doubled keeping volume of the wire constant. The drift velocity of electrons after stretching the wire becomes one-fourth of what it was before stretching the wire

Statement 2: If a wire (of uniform resistivity and uniform cross section) of length $l_0$is stretched to length nl_0, then it resistance becomes n^2times of what it was before stretching the wire (the volume of wire is kept constant in stretching process.) Further at constant potential difference, current is inversely proportional to resistance. Finally, drift velocity of free electron is directly proportional to current and inversely proportional to cross-sectional area of current carrying wire

469

Statement 1: There is no current in the metals in the absence of electric field

Statement 2: Motion of free electrons is random

470

Statement 1: In a metre bridge experiment, a high resistance is always connected in series with a galvanometer

Statement 2: A resistance increases, current through the circuit increases

471

Statement 1: The e.m.f. of the driver cell in the potentiometer experiment should be greater than the e.m.f. of the cell to be determined

Statement 2: The fall of potential across the potentiometer wire should not be less than the e.m.f. of the cell to be determined

472

Statement 1: In a simple battery circuit, the point at the lowest potential is the positive terminal of the battery

Statement 2: The current flows towards the point of lowest potential for battery, as it does in a circuit from the positive to negative terminal

473

Statement 1: If an electric field is applied to a metallic conductor, the free electrons experience a force but do not accelerate; they only drift at a constant speed

Statement 2: The force exerted by the electric field is completely balanced by the coulomb force between electrons and protons

474

Statement 1: The equivalent resistance in series combination is larger than even the largest individual resistance

Statement 2: The equivalent resistance of the parallel combination is smaller than even the smallest resistance

475

Statement 1: A conductor carrying electric current becomes electrically charged.

Statement 2: A conductor carrying electric current contains same number of positive and negative charges and thus conductor is electrically neutral.

476

Statement 1: Since all the current coming to our house returns to powerhouse (as current travels in a closed loop), there is no need to pay the electricity bill

Statement 2: The electricity bill is paid for the power used, not for the current used

477

Statement 1: The value of temperature coefficient of resistance is positive for metals

Statement 2: The temperature coefficient of resistance for insulator is also positive

478

Statement 1: Two unequal resistances are connected in parallel across a cell, then the potential drop across the larger resistance is more

Statement 2: More current will flow through a larger resister

479

Statement 1: Electric field outside the conducting wire which carries a constant current is zero

Statement 2: Net charge on conducting wire is zero

480

Statement 1: Bending a wire does not effect electrical resistance

Statement 2: Resistance of wire is proportional to resistivity of material

481

Statement 1: Internal resistance of a battery is drawn parallel to a battery in electrical circuit

Statement 2: Heat generated in a battery is due to internal resistance

482

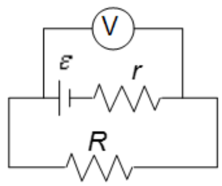
Statement 1: Though the same current flows through the line wires and the filament of the bulb but heat produced in the filament is much higher than that in line wires

Statement 2: The filament of bulbs is made of a material of high resistance and high melting point

483

Statement 1: In the following circuit, e. m. f. is 2 V, internal resistance of the cell is 1 Ω and $R = 1\Omega$, the reading of the voltmeter is 1 V

Statement 2: $V = E - ir$, where $E = 2$ V, $i = 1$ A and $R = 1\Omega$



484

Statement 1: In meter bridge experiment, a high resistance is always connected in series with a galvanometer

Statement 2: As resistance increases current through the circuit increases

485

Statement 1: Voltmeter measures current more accurately than ammeter

Statement 2: Relative error will be small if measured from voltameter

486

Statement 1: An electric bulb becomes dim, when an electric heater in parallel circuit is switched on

Statement 2: Dimness decreases after sometime

487

Statement 1: In a Meter Bridge experiment, null point for an unknown resistance is measured. Now, the unknown resistance is put inside an enclosure maintained at a higher temperature. The null point can be obtained at the same point as before by decreasing the value of the standard resistance

Statement 2: Resistance of a metal increases with increase in temperature

488

Statement 1: A wire of resistance R is bent in the form of a circle. The resistance between two points on circumference of the wire or at the end of diameter is $R/4$

Statement 2: The resistance between the two points on the circumference of the circle will be the parallel combination of two resistances of upper and lower parts of the circle

489

Statement 1: Heat is generated continuously is an electric heater but its temperature becomes constant after some time

Statement 2: At the stage when heat produced in heater is equal to the heat dissipated to its surrounding the temperature of heater becomes constant

490

Statement 1: If the length of a conductor is doubled, the drift velocity will become half of the original value (keeping potential difference unchanged)

Statement 2: At constant potential difference, drift velocity is inversely proportional to the length of the conductor

491

Statement 1: Current flows in a conductor only when there is an electric field within the conductor

Statement 2: The drift velocity of electrons in the presence of electric field decreases

492

Statement 1: In all conductors, for studying the thermoelectric behaviour of the metals, lead is taken as a reference metal

Statement 2: In lead, the Thomson effect is negative

493

Statement 1: The temperature dependence of resistance is usually given as $R = R_0(1 + \alpha\Delta t)$. The resistance of a wire changes from 100 Ω to 150 Ω when its temperature is increased from 27°C to 227°C. This implies that $\alpha = 2.5 \times 10^{-3}$/°C

Statement 2: $R = R_0(1 + \alpha\Delta t)$ is valid only when the change in the temperature ΔT is small and $\Delta R = (R - R_0) \ll R_0$

494

Statement 1: When temperature of cold junction of a thermocouple is lowered, the value of neutral temperature of this thermocouple is raised

Statement 2: When the difference of temperature of two junctions is raised, more thermo e.m.f. is produced

495

Statement 1: The power dissipated in a conductor of resistivity ρ is proportional to ρ^{-1}.

Statement 2: The expression for resistance of a conductor is given by $R = \frac{\rho^l}{A}$.

496

Statement 1: If the length of the conductor is doubled, the drift velocity will become half of the original value (keeping potential difference unchanged)

Statement 2: At constant potential difference, drift velocity inversely proportional to the length of the conductor

497

Statement 1: Length is immaterial for fuse wire

Statement 2: Fuse wire consists low melting point

498

Statement 1: a

Statement 2: r

499

Statement 1: Rapidly changing temperatures can be measured by thermocouples.

Statement 2: The thermal capacity of the junction of a thermocouple is very small.

500

Statement 1: A potentiometer of longer length is used for accurate measurement

Statement 2: The potential gradient for a potentiometer of longer length with a given source of e.m.f. becomes small

501

Statement 1: Fuse wire must have high resistance and low melting point

Statement 2: Fuse is used for small current flow only

502

Statement 1: Heater wire must have high resistance than connecting wires and high metallic point

Statement 2: If resistance is high, the electrical conductivity will be less

503

Statement 1: Direction of current cannot be from negative potential

Statement 2: Direction of current is opposite to the flow of electrons

504

Statement 1: The resistance of super-conductor is zero

Statement 2: The super-conductors are used for the transmission of electric power

505

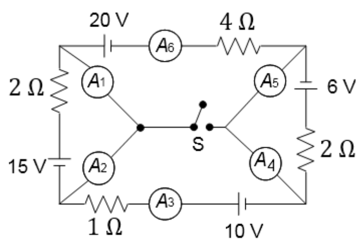
Statement 1: Electric appliances with metallic body have three connections, whereas an electric bulb has a two pin connection

Statement 2: Three pin connections reduce heating of connecting wires

Matrix-Match Type

This section contain(s) 0 question(s). Each question contains Statements given in 2 columns which have to be matched. Statements (A, B, C, D) in **columns I** have to be matched with Statements (p, q, r, s) in **columns II.**

506. In the circuit shown, all the ammeters are ideal. Match the following based on the circuit



Column-I	Column- II
(A) If switch S is open, the ammeter(s) that read (s) less than 10 A	(p) A_1 and A_2

(B)	If switch S is open, the ammeter (s) that read (s) equal current	(q)	A_4 and A_5
(C)	If switch S is closed, the ammeter(s) that read (s) more than 5 A	(r)	A_3 and A_4
(D)	If switch S is closed, the ammeter(s) that show (s) increase in the reading	(s)	A_6 and A_5

CODES :

	A	B	C	D
a)	P,Q,R,S	q,r	p,q	q,r,s
b)	q,r	p,q	p,q	q,r,s
c)	q,r	q,r,s,	p,q,r,s	p,q
d)	p,q,r,s	p,q	q,r	q,r,s

507. Match the statements if column I with the results in column II

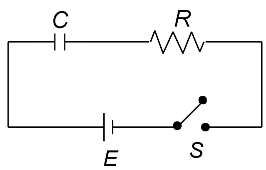
	Column-I		Column- II
(A)	A variable resistor is connected across a non-ideal cell. As the resistance of the variable resistor is continuously increased from zero to a very large value, the electric power consumed by the variable resistor	(p)	First increase for some time and then decreases
(B)	A circular ring lies in space having uniform and constant magnetic field. Initially, the direction of magnetic field is parallel to the plane of the ring. Keeping the centre of ring fixed, the ring is rotated by 180° about one of its diameters with constant angular speed. For the duration the ring rotates, the magnitude of the induced e.m.f. in the ring	(q)	First decrease for some time and then increases
(C)	A thin rod of length 1 cm lies along the principal axis of a convex lens of focal length 5 cm. one end of rod is at a distance 1cm from optical center of the lens. The convex lens is moved (without rotation) perpendicular to the initial principal axis by 5 mm and brought back to its initial position. The length of the image of the rod	(r)	Is always constant
(D)	A bulb (of negligible inductance) and a capacitor in series are connected across an ideal ac source of constant peak voltage and variable frequency. As frequency of ac source is continuously increased, the brightness of bulb	(s)	Increases or may increase over some time interval

CODES :

A	B	C	D

a)	P	q	p,s	s
b)	p,s	q	s	q
c)	q	s	s	p
d)	p,s	s	q	p

508. Figure shows a charging circuit of a capacitor. At $t = 0$, S is closed

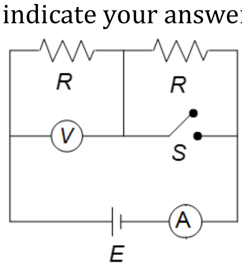


Column-I		Column- II	
(A)	When the charging rate of the capacitor is maximum, the current through R is	(p)	Maximum
(B)	When charge on the capacitor is maximum, then the current through R is	(q)	Minimum but not zero
(C)	When the power supplied by the battery is maximum, then charge on the capacitor is	(r)	Zero
(D)	The difference in the power supplied by battery and power consumed in R at $t = 0$ is	(s)	Not equal to zero

CODES :

	A	**B**	**C**	**D**
a)	a,d	c	c	c
b)	c	a,d	c	c
c)	c	c	a,d	c
d)	c	c	c	a,d

509. In the circuit shown in Figure. Battery, ammeter and voltmeter are ideal and the switch S is initially closed as shown. When switch S is opened, match the parameter in column I with the effects in column II and indicate your answer by darkening appropriate bubbles In the 4×4 matrix given in the OMR



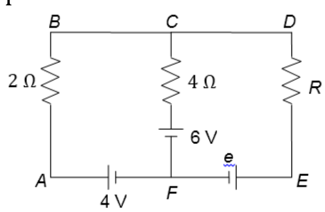
Column-I		Column- II	
(A)	Equivalent resistance across the battery	(p)	Remains same
(B)	Power dissipated by left resistance R	(q)	Increase
(C)	Voltmeter reading	(r)	Decrease

(D) Ammeter reading (s) Becomes zero

CODES :

	A	B	C	D
a)	R	r	r	q
b)	q	r	r	r
c)	r	r	q	r
d)	r	q	r	r

510. A circuit is shown in Figure. R is a non-zero variable but finite resistance. e is some unknown e.m.f. with polarities as shown. Match the columns.

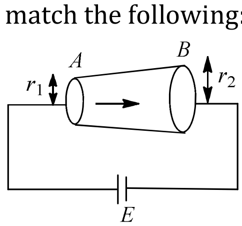


Column-I	Column- II
(A) Current passing through 4 Ω resistance can be zero	(p) Possible if $e = 6$ V
(B) Current passing through 4 Ω resistance can be from F to C direction	(q) Possible if $e > 6$ V
(C) Current passing through 4 Ω resistance can be from C to F direction	(r) Possible if $e = 6$ V
(D) Current passing through 2 Ω resistance will be from B to A direction	(s) Possible for any value of e from zero to infinity

CODES :

	A	B	C	D
a)	b	a,b,c	b	a,b,c,d
b)	a	c,b	d	a,c,d
c)	a	c	b	d
d)	c	a,b,c	d	a,c,d,b

511. A battery of e. m. f. E is connected across a conductor as shown Figure. As one observes from A and B, match the following:



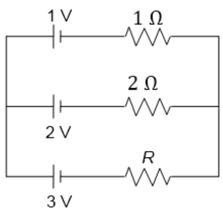
Column-I	Column- II
(A) Current	(p) Increases

(B)	Drift velocity of electron	(q)	Decreases
(C)	Electric field	(r)	Remains same
(D)	Potential drop across the length	(s)	Cannot be determined

CODES :

	A	B	C	D
a)	r	q	r	q
b)	q	r	r	q
c)	r	q	q	q
d)	q	r	q	q

512. For the circuit shown in the figure, all the three batteries are ideal. Match the column.

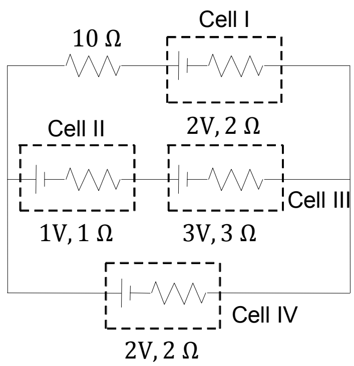


	Column-I		Column- II
(A)	The value of R such that current through 3 V battery is zero.	(p)	1 Ω
(B)	The value of R such that current through 1 V battery is zero.	(q)	2 Ω
(C)	The value of R such that current through 2 V battery is zero.	(r)	3 Ω
(D)	The value of R for which current through 3 V battery is 5/8 A.	(s)	Not possible for any value of R

CODES :

	A	B	C	D
a)	a	a	b	d
b)	b	b	a	d
c)	d	d	d	a
d)	d	d	a	b

513. For the circuit shown in Figure, four cells are arranged. In column I, the cell number is given, while in column II, some statement related to cells are given. Match the entries of Column I with the entries of Column II

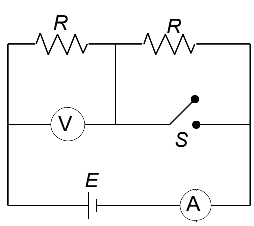


Column-I		Column- II	
(A)	Cell I	(p)	Chemical energy of cell is decreasing
(B)	Cell II	(q)	Chemical energy of cell is increasing
(C)	Cell III	(r)	Work done by cell is + ve
(D)	Cell IV	(s)	Thermal energy developed in cell is + ve

CODES :

	A	B	C	D
a)	a	b,d	a,c,d	b
b)	b,d	b,d	a,c,d	a,c,d
c)	b,d	a,c,d	a,c,d	b,d
d)	a,c,d	b	c	b,d

514. In the circuit shown in Figure, battery, ammeter and voltmeter are ideal and the switch S is initially closed as shown. When switch S is opened, match the parameters of column I with the effects in column II



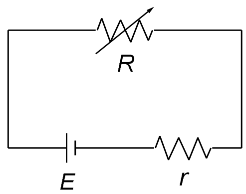
Column-I		Column- II	
(A)	Equivalent resistance across the battery	(p)	Remains same
(B)	Power dissipated by left resistance R	(q)	Increases
(C)	Voltmeter reading	(r)	Decreases
(D)	Ammeter reading	(s)	Becomes zero

CODES :

	A	B	C	D
a)	c	b	b	b

b)	b	c	c	c
c)	b	b	c	c
d)	c	c	c	b

515. In Figure, the resistance R is variable, r is the internal resistance of battery of e.m.f. E.



	Column-I		**Column- II**
(A)	Terminal potential difference across the cell to be maximum	(p)	$R > r$
(B)	Power transferred to R is less than the maximum possible	(q)	$R < r$
(C)	Power dissipated in the cell is maximum	(r)	$R = \infty$
(D)	Fastest drift of ions in the electrolyte in the cell will be for	(s)	$R = 0$

CODES :

	A	**B**	**C**	**D**
a)	a,b,c,d	d	c	d
b)	c	d	d	c
c)	d	a,b,c,d	c	d
d)	c	a,b,c,d	d	d

516. Column I gives physical quantities based on a situation in which in ideal cell of e. m. f. V Is connected across a cylindrical rod of uniform cross-sectional area and conductivity (s) as shown in the figure. E, J, ϕ And i are electric fields at, current density through, electric flux through and current through the shaded cross section, respectively, as shown in Figure. Physical quantities in column II are related to those in column I. match the expressions in column Iwith the statements in columns II.

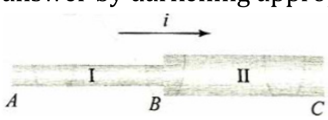
	Column-I		**Column- II**
(A)	$\frac{\varphi}{i}$	(p)	Conductivity of the rod
(B)	$\frac{E}{J}$	(q)	Resistance of the rod
(C)	$\sigma\phi V$	(r)	Resistivity of the rod

(D) $\frac{V}{\sigma\phi}$ (s) Power delivered to the rod

CODES :

	A	B	C	D
a)	R	r	s	q
b)	s	s	r	q
c)	s	r	r	q
d)	s	r	q	r

517. Column I gives physical quantities of a situation in which current i passes through two rods I and II of equal length that are joined I series. The ratio of free electron density (η), resistivity (ρ) and cross-sectional area (A) of both rods are in ratio $n: n_2 = 2 : 1; r_2 = 2 : 1$ and $A_1: A_2 = 1: 2$, respectively. Column II gives corresponding results, match the ratios in column I with the values in column II and indicate your answer by darkening appropriate bubbles in the 4×4 matrix given in the OMR



Column-I		Column- II	
(A)	$\frac{\text{Drift velocity of free electron in rod I}}{\text{Drift velocity of free electron in rod II}}$	(p)	0.5
(B)	$\frac{\text{Electric field in rod I}}{\text{Electric field in rod II}}$	(q)	1
(C)	$\frac{\text{potential difference acros rod I}}{\text{potential difference across rod II}}$	(r)	2
(D)	$\frac{\text{Average time taken by free electron}}{\text{Average time taken by free electron}}$ $\frac{\text{to move from A to B}}{\text{to move from B to C}}$	(s)	4

CODES :

	A	B	C	D
a)	P	r	s	r
b)	r	r	s	p
c)	s	p	r	r
d)	r	p	s	r

518. Math column I with Column II:

Column-I		Column- II	
(A)	Electrical conductivity of conductor depends on	(p)	Dimensions (length, area of cross section etc.)
(B)	Conductance of a conductor depends on	(q)	Temperature
(C)	For a given conductor of given dimensions and at a given temperature, current density	(r)	Nature of conductor

depends on

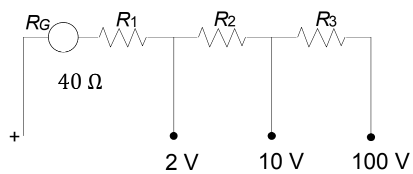
(D) For a given potential difference applied across a conductor of given length, current in it will depend on — (s) Electric field strength

CODES :

	A	B	C	D
a)	b, c	a,b,c	d	a,b,c
b)	d	b,c	a,b,c	a,b,c
c)	b,c	d	a,b,c	a,b,c
d)	a,b,c	a,b,c	b,c	d

519. Figure shows the internal wiring of a three-range voltmeter whose binding posts are marked +, 2 V, 10 V and 100 V

When the meter is connected to the circuit being measured, one connection is made to the post marked + and the other to the post marked with the desired voltage range. The resistance of the moving coil R_G is 40 Ω and a current of 1 mA in the coil causes it to deflect full-scale. Then match the following

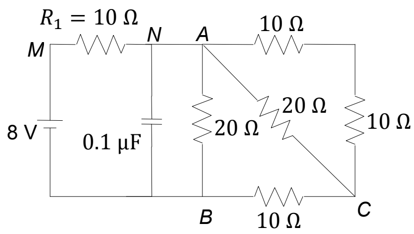


Column-I		Column- II	
(A)	Value of resistance R_1 in kΩ	(p)	100
(B)	Value of resistance R_3 in kΩ	(q)	2
(C)	Overall resistance of the meter in 100 V range in kΩ	(r)	1.96
(D)	Overall resistance of the meter in 2 V range in kΩ	(s)	90

CODES :

	A	B	C	D
a)	c	d	a	b
b)	d	c	a	b
c)	c	d	b	a
d)	a	b	c	d

520. A capacitor of capacitance 0.1 μF is connected to a battery of e.m.f. 8 V (as shown in Figure) under the steady-state condition.



Column-I		Column- II	
(A)	Charge on the capacitor	(p)	0.4 μC
(B)	Current in AC branch	(q)	0.2 A
(C)	Current in AB branch	(r)	0.1 A
(D)	Current in R connected between M and N	(s)	0.4 A

CODES :

	A	B	C	D
a)	b	c	d	a
b)	c	a	b	d
c)	a	c	b	d
d)	d	c	a	b

521. In an experiment for comparing e. m. f. s of two primary cells using potentiometer, some observations are given in column I.

Column-I		Column- II	
(A)	Deflection of galvanometer is in same direction at two ends of the wire	(p)	Accuracy in measurement increase
(B)	A series protective resistance added in series to the galvanometer	(q)	The positive terminals of all batteries/cells are not connected at a point
(C)	A short wire is used in potentiometer	(r)	e. m. f. of battery in primary circuit is less than the e. m. f. of cell to be measured
(D)	More length of wire up to null point	(s)	Uncertainity in the location of balance point increases

CODES :

	A	B	C	D
a)	Q,R	s	s	p
b)	s	s	p	q,r
c)	q,r	s	p	s
d)	s	p	s	q,r

522. In a potentiometer experiment:

Column-I	Column- II

(A)	Deflection of galvanometer is in the same direction at the two ends of the wire	(p)	Accuracy in measurement increases
(B)	A protective resistance added in series to the galvanometer	(q)	Accuracy in measurement decreases
(C)	A short wire is used as a potentiometer	(r)	e.m.f. of the battery in the primary circuit is less than the e.m.f. of the cell to be measured
(D)	More length of potentiometer up to null point	(s)	Uncertainty in the location of balance

CODES :

	A	**B**	**C**	**D**
a)	a	b	d	c
b)	c	d	b	a
c)	a	c	d	b
d)	c	d	a	b

523. Match the List I with the List II from the combination shown. In the left side (List I) there are four different conditions and in the right side (List II), there are ratios of heat produced in each resistance for each condition:

	Column-I		Column- II
(A)	Two wires of same resistance are connected in series and same current is passed through them	(p)	1 :2
(B)	Two wires of resistance R and $2R$ ohm are connected in series and same P.D. is applied across them	(q)	4 :1
(C)	Two wires of same resistance are connected in parallel and same current is flowing through them	(r)	1 :1
(D)	Two wires of resistances in the ratio 1 :2 are connected in parallel and same P.D. is applied across them	(s)	2 :1

CODES :

	A	**B**	**C**	**D**
a)	B	a	c	d
b)	c	d	c	d
c)	b	d	a	c
d)	a	b	d	c

524. Consider two identical cells each of e. m. f. E and internal reistance r connected to a load resistance R

	Column-I		Column- II
(A)	Maximum power transferred to load if cells are connected in series	(p)	$\frac{4E^2}{9r}$

(B) Maximum power transferred to load if cells are connected in parallel — (q) $\frac{E^2}{2r}$

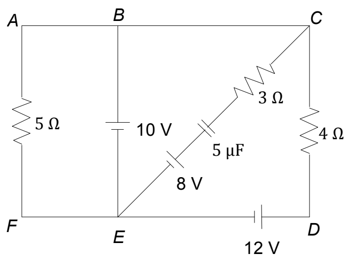
(C) Power transferred to load if cells are connected in series and $R = r$ — (r) $E_{eq} = E, r_{eq} = \frac{r}{2}$

(D) Power transferred to load if cells are connected in parallel and $R = r$ — (s) $E_{eq} = 2E, r_{eq} = 2r$

CODES :

	A	B	C	D
a)	Q,S	p,s	q,r	p,r
b)	q,r	p,s	s,q	p,r
c)	q,s	q,r	p,s	p,r
d)	p,r	q,r	q,s	s,p

525. A network consisting of three resistors, three batteries and a capacitor is shown in Figure. In steady state



Column-I	Column- II
(A) Current in branch EB is	(p) 10 μC
(B) Current in branch CB is	(q) 0.5 A
(C) Current in branch ED is	(r) 1.5 A
(D) Charge on capacitor is	(s) 5 μC

CODES :

	A	B	C	D
a)	a	c	d	b
b)	c	b	b	a
c)	b	d	c	a
d)	b	c	a	d

Linked Comprehension Type

This section contain(s) 55 paragraph(s) and based upon each paragraph, multiple choice questions have to be answered. Each question has atleast 4 choices (a), (b), (c) and (d) out of which ONLY ONE is correct.

Paragraph for Question Nos. 526 to -526

The thermo emf E of a given thermo-couple and temperature θ of the hot junction (with cold junction at 0°C) are found to satisfy approximately the following relation.

$E = a\theta + \frac{1}{2}b\theta^2$

Where E is in μ V, θ in °C of the hot junction and $a = 14\mu V°\ C^{-1}$ and $b = -0.04\mu V°\ C^{-2}$

Answer the following questions

526. At what temperature, the thermo emf in the given thermo-couple is 1.25 mV?

a) 105°C b) 210°C c) 315°C d) 330°C

Paragraph for Question Nos. 527 to - 527

An electric kettle working at 200 V heats up 2 L of water from 20°C to 100°C in 2 min. Density of water is $10^3\ kgm^{-3}$ and specific heat of water is 1 cal $g^{-1}°C^{-1}$.

527. Power of the kettle is

a) 2.8 kW b) 5.6 kW c) 8.4 kW d) 11.2 kW

Paragraph for Question Nos. 528 to - 528

According to modern view, a metal consists of a lattice of fixed positively charged ions in which billions and billions of free electrons are moving randomly at speed, which at room temperature in accordance with kinetic theory of gases is given by $v_{rms} = \frac{\sqrt{3kT}}{m}$, may be of the order of 105 ms^{-1} or even more. The randomly moving free electrons inside the metal lattice collide with the lattice points and follows as $zig - zag$ path. Consequently, the number of electrons crossing in one direction through a cross section of metal is exactly equal to the number of free electrons crossing that cross-section in the reverse direction and net electric current is zero. When an external electric field is applied on metal, electrons drift opposite to the field. Thus, random of electrons get modified and there is a net transfer of electrons across a cross-section resulting in current.

It is mathematically found that drift velocity of electrons is given by

$\vec{v}_d = -\left[\frac{e\tau}{m}\right].\vec{E}$where τ =mean time between

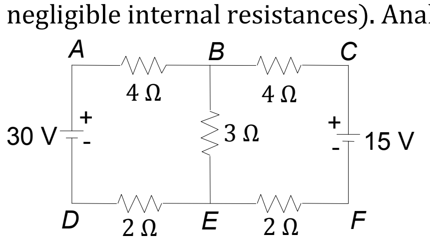
Two successive collisions of an electron with lattice points and the resulting current $I = nAev_d$ where n = free electron density in metal and A the cross-section area

528. A potential difference of 3.0 V has been applied across a metal conductor of length 60 cm. If relaxation period for that metal be taken as 2.5×10^{-14}s, then the magnitude of drift velocity will be

a) $2.2 \times 10^{-2}ms^{-1}$ b) $2.2 \times 10^{-4}ms^{-1}$ c) $1.1 \times 10^{-4}ms^{-1}$ d) $1.1 \times 10^{-6}ms^{-1}$

Paragraph for Question Nos. 529 to - 529

Adjoining figure represents an electrical network of conductors carrying 5 resistors and two batteries (of negligible internal resistances). Analyse the circuit and answer the following questions:



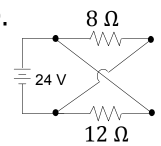
529. The current given by the 30 V battery to the circuit is

a) 4 A
b) 5 A
c) $\frac{10}{3}$ A
d) 1 A

Paragraph for Question Nos. 530 to - 530

Find the current supplied by the battery in the circuit in each case (i), (ii) and (iii) as shown in Fig.

530.

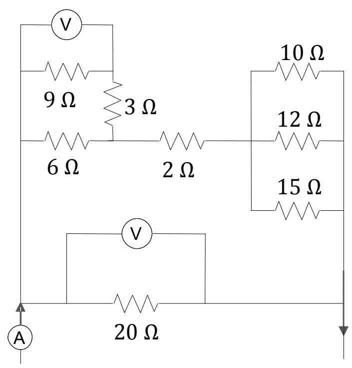


(i)

a) 4 A
b) 3 A
c) 12 A
d) 5 A

Paragraph for Question Nos. 531 to - 531

Figure shows two ideal voltmeter and an ammeter which are connected across the various circuit elements. If the voltmeter connected across 9 Ω resistance reads 4.5 V, then answer the following problems

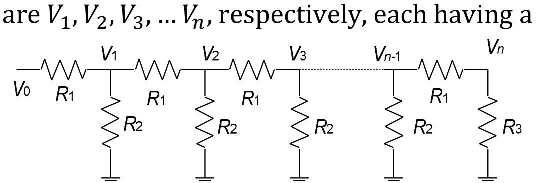


531. The current through 12 Ω resistance is

a) 0.1 A
b) 0.75 A
c) 0.5 A
d) 1.25 A

Paragraph for Question Nos. 532 to - 532

A network of resistances is constructed with R_1 and R_2 as shown in Fig. The potential at the point 1, 2, 3 ... N are $V_1, V_2, V_3, \ldots V_n$, respectively, each having a potential k times smaller than the previous one



532. The ratio R_1/R_2 is

a) $k^2 - \frac{1}{k}$
b) $\frac{k}{k-1}$
c) $k - \frac{1}{k^2}$
d) $\frac{(k-1)^2}{k}$

Paragraph for Question Nos. 533 to - 533

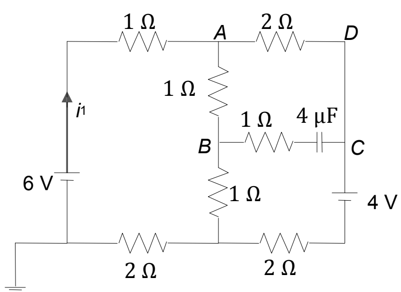
Relation between current in a conductor and time is shown in Fig. then determine

533. Total charge flown through the conductor is

a) $i_0 t_0/2$ b) $i_0 t_0$ c) $i_0 t_0/4$ d) $2i_0 t_0$

Paragraph for Question Nos. 534 to - 534

Consider the circuit shown in Figure. The circuit is in steady state. Find

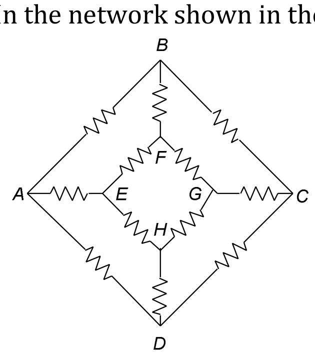


534. The value of i_1 is

a) 7/9 A b) 14/13 A c) 14/3 A d) 17/23 A

Paragraph for Question Nos. 535 to - 535

In the network shown in the figure, each resistance is R, then

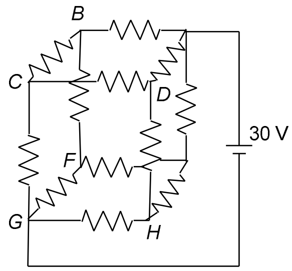


535. The equivalent resistance between A and B is

a) $\frac{3R}{4}$ b) $\frac{5R}{6}$ c) $\frac{7R}{12}$ d) $\frac{4R}{3}$

Paragraph for Question Nos. 536 to - 536

A resistor circuit is constructed such that twelve resistors are arranged to form a cube a shown in the figure. Each resistor has a resistance of 2 Ω. The potential difference of 30 V is applied across two of the opposing point as shown.



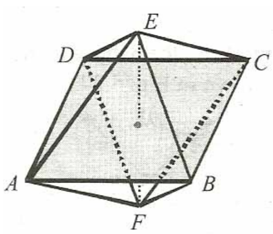
536. The points having the same potential are

(i) B, D, E (ii) C, F, H (iii) C, E

a) Only (i) is correct
b) (i), (ii) and (iii) are correct
c) Only (ii) is correct
d) (i) and (ii) both are correct

Paragraph for Question Nos. 537 to - 537

Consider 12 resistors arranged symmetrically in shape of bipyramid $ABCDEF$. Here $ABCD$ is a square. Point E, point F and centre of square are in the same straight line perpendicular to the plane of square. The resistance of each resistor is R



537. The effective resistance between E and F is

a) $R/2$
b) $R/3$
c) R
d) None of these

Paragraph for Question Nos. 538 to - 538

A battery is connected to a potentiometer and a balance point is obtained at 84 cm along the wire. When its terminals are connected by a 5 Ω resistor, the balance point changes to 70 cm

538. Calculate the internal resistance of the cell

a) 4 Ω
b) 2 Ω
c) 5 Ω
d) 1 Ω

Paragraph for Question Nos. 539 to - 539

A cell of e.m.f. 3.4 V and internal resistance 3 Ω is connected to an ammeter having resistance 2 Ω and an external resistance of 100Ω. When a voltmeter is connected across the 100 Ω resistance, the ammeter reading is 0.04 A

539. Find the resistance of the voltmeter

a) 400 Ω b) 200 Ω c) 300 Ω d) 500 Ω

Paragraph for Question Nos. 540 to - 540

In the connection shown in Figure initially switch K is open and the capacitor is uncharged. Then the switch is closed and the capacitor is charged up to the steady state and the switch is opened again. Determine the values indicated by the ammeter. [Given :$V_0 = 30$ V, $R_1 = 10$ kΩ, $R_2 = 5$ kΩ]

540. Just after closing the switch

a) 2 mA b) 3 mA c) 0 mA d) None of these

Paragraph for Question Nos. 541 to - 541

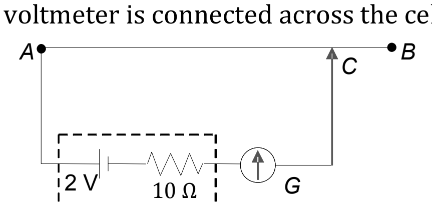
Potentiometer is an ideal voltmeter as voltmeter draws some current through the circuit while potentiometer needs no current to work. Potentiometer works on the principle of e.m.f. comparison. In working condition, a constant current flows throughout the wire of potentiometer using standard cell of e. m. f. e_1. The wire of potentiometer is made of uniform material and cross-sectional area and it has uniform resistance per unit length. The potential gradient depends upon the current in the wire
A potentiometer with a cell of e. m. f. 2 V and internal resistance 0.4 Ω is used across the wire AB. A standard cadmium cell of e. m. f. 1.02 V gives a balance point at 66 cm length of wire. The standard cell is then replaced by a cell of unknown e.m.f. e (internal resistance r) and the balance point found similarly turns out to be 88 cm length of the wire. The length of potentiometer wire AB is 1 m

541. The value of e is

a) 1.36 V b) 2.63 V c) 1.83 V d) None

Paragraph for Question Nos. 542 to - 542

The length of a potentiometer wire AB is 600 cm and it carries a constant current of 40 mA in direction from A to B. For a cell of e.m.f. 2 V and internal resistance 10 Ω the null point is found at 500 cm from A. When a voltmeter is connected across the cell, the balancing length of the wire is decreased by 10 cm



542. Potential gradient along AB is

a) 1/5 V/m b) 2/5 V/m c) 3/5 V/m d) 4/5 V/m

Paragraph for Question Nos. 543 to - 543

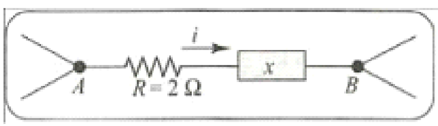
AB is a potentiometer wire of length 100 cm. When a cell E_2 is connected across AC, where $AC = 75$ cm, no current flows from E_2. The internal resistance of the cell E_1 is negligible

543. Find the potential gradient along AB

a) 0.01 V/cm b) 0.03 V/cm c) 0.04 V/m d) 0.02 V/cm

Paragraph for Question Nos. 544 to - 544

In Figure circuit section, AB absorbs energy at a rate of 50 W when a current $i = 1.0$ A passes through it in the indicated direction



544. What is the potential difference between A and B?

a) 10 V b) 50 V c) 20 V d) 30 V

Paragraph for Question Nos. 545 to - 545

A three-way light bulb has three brightness settings (low, medium, high) but only two filaments. The two filaments are arranged in three settings, when connected across a 120 V line and can dissipate 60, 120 and 180 W. answer the following questions:

545. i. Higher resistance filament only working for 60 W

ii. Low resistance filament working for 120 W

iii. Low resistance filament working for 60 W

iv. High resistance filament working for 120 W

v. Low and high resistance filaments in parallel for 180 W

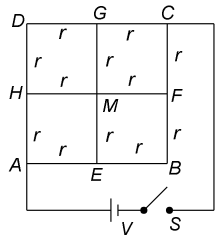
vi. Low and high resistance filament in series for 180 W

a) i, ii and v are correct b) i, ii and vi are correct

c) iii, iv and v are correct d) iii, iv and vi are correct

Paragraph for Question Nos. 546 to - 546

In Figure each of the segments (e.g., AE, GM, etc.) has resistance r. A battery of e.m.f. V is connected between A and C. Internal resistance of the battery is negligible

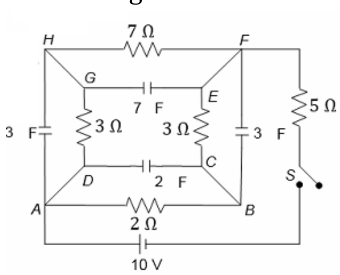


546. What is the equivalent resistance of the system about A and C?

a) r b) $\frac{r}{2}$ c) $\frac{3r}{2}$ d) $2r$

Paragraph for Question Nos. 547 to - 547

Refer to Figure



547. At $t = 0$, the switch is closed. Just after closing the switch, find the current through the 5Ω resistor

a) $\frac{4}{5}$ A b) $\frac{2}{5}$ A c) $\frac{6}{5}$ A d) 2 A

Paragraph for Question Nos. 548 to - 548

All bulbs consume same power. The resistance of bulb is 36 Ω. Answer the following questions:

548. What is the resistance of bulb 3?

a) 4 Ω b) 9 Ω c) 12 Ω d) 18 Ω

Paragraph for Question Nos. 549 to - 549

Ram and Shyam purchased two electric tea kettles A and B of same size, same thickness and same volume of 0.4 litre. They studied the specification of kettles as under

Kettle A:

Specific heat capacity = 1680 J/kgK

Mass= 200 g

Kettle B:
Specific heat capacity = 2450 J/kgK
Mass = 400 g
Cost = Rs. 400
When kettle A is switched on with constant potential source, the tea begins to boil in 6 min. when kettle B is switched on with the same source separately, then tea begins to boil in 8 min. the efficiency of kettle is defined as

$$\frac{\text{Energy used for liquied heating}}{\text{total energy supplied}}$$

They made discussion on specification and efficiency of kettles and subsequently prepared a list of questions to draw the conclusions. Some of them are as under (Assume specific heat of tea liquid as 4200 J/kg K and density 1000 kg/m^3.)

549. Efficiency of kettle A is

a) 63.34% b) 83.34% c) 93.34% d) 73.34%

Paragraph for Question Nos. 550 to - 550

A car battery with a 12 V e. m. f. and an internal resistance of 0.04 Ω is being charged with a current of 50 A

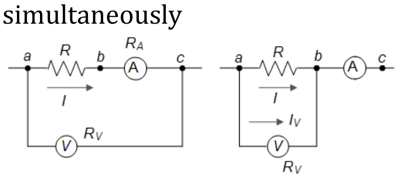
550. The potential difference V across the terminals of the battery is

a) 10 V b) 12 V c) 14 V d) 16 V

Paragraph for Question Nos. 551 to - 551

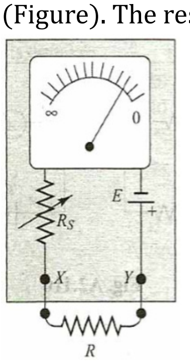
By ammeters and voltmeters in combination

A voltmeter and an ammeter can be used together to measure resistance and power. The resistance R of a resistor equals the potential difference V_{ab}between its terminals divided by the current I; that is, $R = V_{ab}/I$. The power input P to any circuit element is the product of the potential difference across it and the current through it; that is,= $V_{ab}I$. In principle, the most straightward way to measure R or $P$is to meaure V_{ab} and I simultaneously



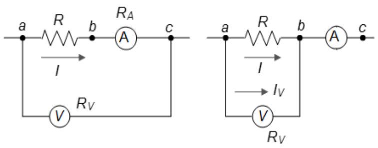
By Ohmmeters

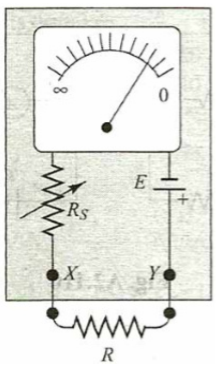
An alternative method for measuring resistance is to use a d' Arsonval meter in an arrangement called an ohmmeter. It consists of a meter, a resistor and a source (often a flashlight battery) connected in series (Figure). The resistance R to be measured is connected between terminals X and$Y$.



The series resistance $R_S$is variable; it is adjusted so that when terminals X and Y are short-circuited (that is,when $R = 0$), the meter shows full-scale deflection. When nothing is connected to terminals X and$Y$, so that the circuit between X and Y is open (that is, when$x \to \infty$), there is no current and no deflection. For any intermediate value of R the meter deflection depends on the value of$R$, and the meter scale can be calibrated to read the resistance R directly. Larger currents correspond to smaller resistance, so this scale reads backward compared to the scale showing the current.

Measurement of Resistance





551. Suppose we want to measure an unknown resistance$R$, using the circuit in Figure. the voltmeter resistance and ammeter resistance are, respectively, $R_v = 10000\ \Omega$ and R_A=2.00 .If the voltmeter reads 12.0 V and the ammeter reads 0.100 A, then resistance R is

a) 120 Ω b) 118 Ω c) 121 Ω d) 108 Ω

Paragraph for Question Nos. 552 to - 552

Important aspect of fuse wire Nd Battery

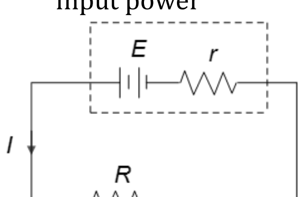
Electric fuse is a protective device used in series with an electric circuit or an electric appliance to save it from damage due to overheating produced by strong current in the circuit or application. Fuse wire is generally made from an alloy of lead and tin which has high resistance and low melting point. It is connected in series in an electric installation. If a circuit gets accidentally short-circuited, a large current flows, then fuse wire melts away which causes a break in the circuit. The power through fuse (F') is equal to heat energy lost per unit area per unit time (h) (neglecting heat lose from ends of the wire).

$$P = I^2R = h \times 2\pi rl \left[R = \frac{\rho l}{\pi r^2}\right]$$

Where r and l are the length and radius of fuse wire, respectively.

A battery is described by its e. m. f. (E) and internal resistance (r). Efficiency of a battery (η) is defined as the ratio of the output power to the input power

$$\eta = \frac{\text{output power}}{\text{input power}} \times 100\%$$



But $I = \frac{E}{R+r}$, input power $= EI$

Output power $= EI - I^2r$

Then $\eta = \left(\frac{EI - I^2 r}{EI}\right) \times 100 \left(1 - \frac{Ir}{E}\right) \times 100$

$= 1 - \left(\frac{E}{R+r}\right)\left(\frac{r}{E}\right) \times 100$

$\eta = \left(\frac{R}{R+r}\right) \times 100$

We know that output power of a source is maximum when the external resistance is equal to internal resistance, i.e., $R = r$.

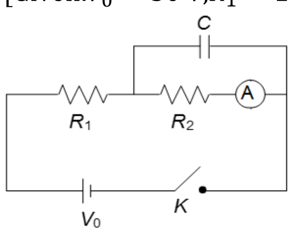
552. Two fuse wires of same potential material are having length ratio 1: 2 and ratio 4: 1. Then respective ratio of their current rating will be

a) 8 : 1 b) 2 : 1 c) 1 : 8 d) 4 : 1

Paragraph for Question Nos. 553 to - 553

In the connection shown in the figure, initially the switch K is open and the capacitor is uncharged. Then the switch is closed and the capacitor is charged up to the steady state and the switch is opened again. Determine the values indicated by the ammeter.

[Given:$V_0 = 30$ V,$R_1 = 10$ k Ω, $R_2 = 5$ k Ω]

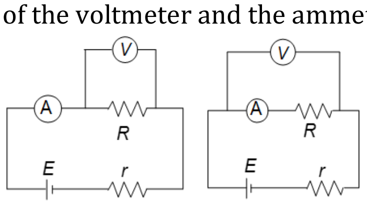


553. Just after closing the switch

a) 2 mA b) 3 mA c) 0 mA d) None of these

Paragraph for Question Nos. 554 to - 554

Resistance value of an unknown resistor is calculated using the formula $R = V/I$ where V and I are the readings of the voltmeter and the ammeter, respectively. Consider the circuits below. The internal resistances of the voltmeter and the ammeter ($R_V$and R_G, respectively) are finite and non-zero



(a) (b)

Let R_A and R_B be the calculated values in the two cases A and B, respectively

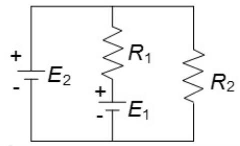
554. The relation between R_A and the actual value of R is

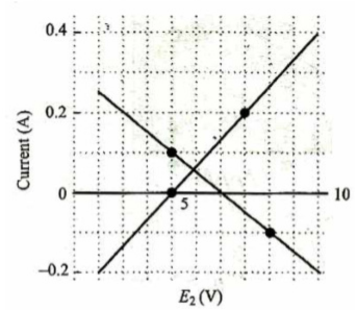
a) $R > R_A$ b) $R < R_A$

c) $R = R_A$ d) Dependent upon E and r

Paragraph for Question Nos. 555 to - 555

In the circuit given in the figure, both batteries are ideal. e. m. f. E_1 of battery 1 has a fixed value, but e.m.f. E_2 of battery 2 can be varied between 1.0 V and 10.0 V. the graph gives the currents through the two batteries as a function of E_2, but are not marked as which plot corresponds to which battery. But for both plots, current is assumed to be negative when the direction of the current through the battery is opposite to the direction of that battery's e. m. f. (direction of e. m. f. is from negative to positive.)

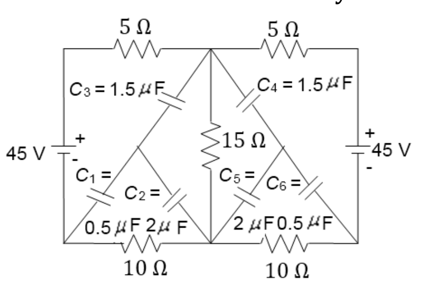




555. The value of e. m. f. E_1 is
a) 8 V b) 6 V c) 4 V d) 2 V

Paragraph for Question Nos. 556 to - 556

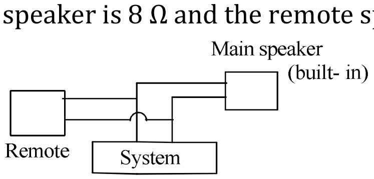
The circuit shown in a steady state:



556. The charge in capacitor C_1 is
a) 20 μC b) 30 μC c) 40 μC d) 10 μC

Paragraph for Question Nos. 557 to - 557

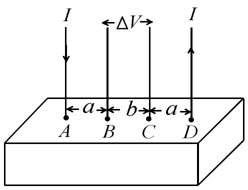
Most of the times we connect remote speakers to play music in another room along with the but-in speakers. These speakers are connected in parallel with the music system
At the instant represented in the picture. The voltage across the speakers is 6.00 V. the resistance of the main speaker is 8 Ω and the remote speaker has resistance 4Ω



557. The equivalent resistance of the speakers is
a) 12 Ω b) 7/3 Ω c) 8/3 Ω d) 0.375 Ω

Paragraph for Question Nos. 558 to - 558

Consider a block of conducting material of resistivity $'\rho'$ shown in the figure. Current $'I'$ enters at $'A'$ and leaves from $'D'$. We apply superposition principle to find voltage $'\Delta V'$ developed between $'B'$ and $'C'$. The calculation is done in the following steps:
(i) Take current $'I'$ entering from $'A'$ and assume it to spread over a hemispherical surface in the block
(ii) Calculate field $E(r)$ at distance $'r'$ from A by using Ohm's law $E = \rho\, j$, where j is the current per unit area at $'r'$
(iii) From the $'r'$ dependence of $E(r)$, obtain the potential $V(r)$ at r
(iv) Repeat (i), (ii) and (iii) for current $'I'$ leaving $'D'$ and superpose results for $'A'$ and $'D'$

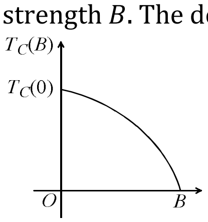


558. For current entering at A, the electric field at a distance $'r'$ from A is

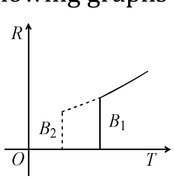
a) $\frac{\rho I}{r^2}$ b) $\frac{\rho I}{2\pi r^2}$ c) $\frac{\rho I}{4\pi r^2}$ d) $\frac{\rho I}{8\pi r^2}$

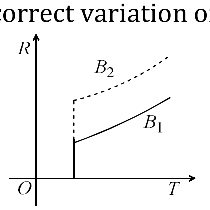
Paragraph for Question Nos. 559 to - 559

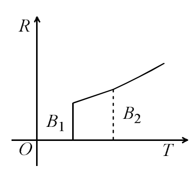
Electrical resistance of certain materials, known as superconductors, changes abruptly from a nonzero value to zero as their temperature is lowered below a critical temperature $T_C(0)$
An interesting property of superconductors is that their critical temperature becomes smaller than $T_C(0)$ if they are placed in a magnetic field, i.e., the critical temperature $T_C(B)$ is a function of the magnetic field strength B. The dependence of $T_C(B)$ on B is shown in the figure

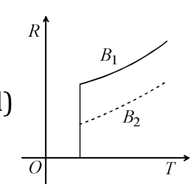


559. In the graphs below, the resistance R of a superconductor is shown as a function of its temperature T for two different magnetic fields B_1 (solid line) and B_2 (dashed line). If B_2 is larger than B_1, which of the following graphs shows the correct variation of R with T in these fields

a) 

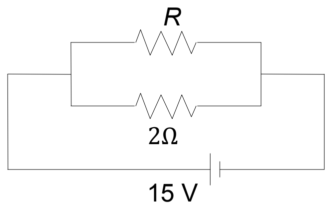
b) 

c) 

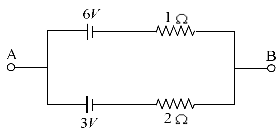
d) 

Integer Answer Type

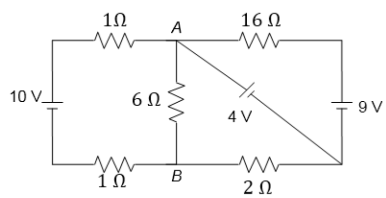
560. If in the circuit shown in the figure, power dissipation is 150 W, then find the value of R (in Ω)



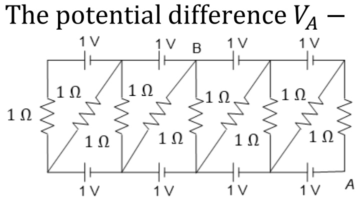
561. Two batteries of different emf and different internal resistances are connected as shown. The voltage across AB in volts is



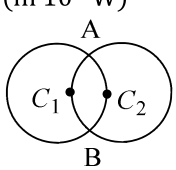
562. Find the potential difference (in V) between points A and B shown in the circuit



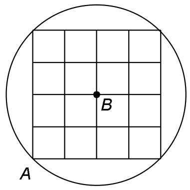
563. A 5 m potentiometer wire having 3 Ω resistance per metre is connected to a storage cell of steady e.m.f. 2 V and internal resistance 1 Ω. A primary cell is balanced against 3.5 m of it. When a resistance of $32/n$ Ω is put in series with the storage cell, the null point shifts to the centre of the last wire, i.e., 4.5m. What is 'n'?
564. The potential difference $V_A - V_B$ for the circuit shown in the figure is $-(22/x)$ V. Find the value of x



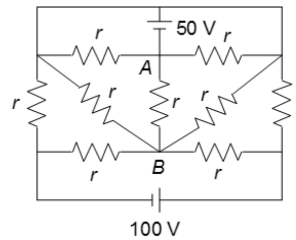
565. An electric current of 2.0 A passes through a wire of resistance 25Ω. How much heat will be developed in 1 min?(in$\times$ 10^3J)
566. Three identical resistors are connected in series. When a certain potential difference is applied across the combination, the total power dissipated is 27 W. How many times the power would be dissipated if the three resistors were connected in parallel across the same potential difference?
567. Two circular rings of identical radii and resistance of 36 Ω each are placed in such a way that they cross each other's center C_1 and C_2 as shown in the figure. Conducting joints are made at intersection points A and B of the rings. An ideal cell of e.m.f. 20 V is connected across A and B. Find the power delivered by cell (in 10^2 W)



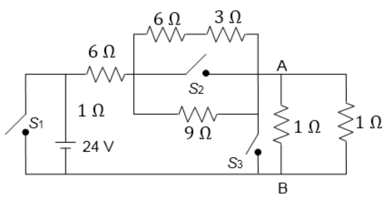
568. A 10 m long nichrome wire having 80 Ω resistance has current carrying capacity of 5 A. This wire can be cut into equal parts and equal parts can be connected in series or parallel. What is the maximum power which can be obtained as heat by the wire from a 200 V mains supply? (in kW)
569. A finite square grid, each link having resistance r, is fitted in a resistanceless conducing circular wire. Determine the equivalent resistance between A and B (in Ω) if $r = (80/7)$ Ω



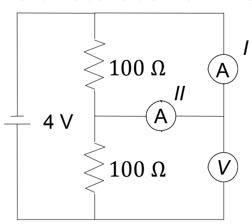
570. In the give circuit, each resistance is$r = 18.75\Omega$. The current (in A) in the resistance connected across A and B is '....'A



571. If the switches S_1, S_2 and S_3 in the figure are arranged such that the current through the battery is minimum, find the voltage across points A and B (in V)

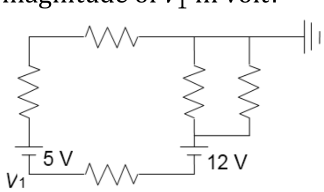


572. In the figure, ammeter (I) reads a current of 10 mA, while the voltmeter reads a potential difference of 3 V. The ammeters are identical, the internal resistance of the battery is negligible. (consider all ammeters and voltmeters as non-ideal)



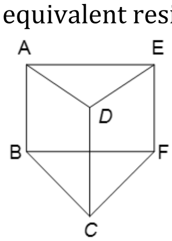
The resistance of ammeter is $m \times 10^2\ \Omega$. What is the value of m?

573. In the circuit shown, each resistance is 2Ω. The potential V_1 is as indicated in the circuit. What is the magnitude of V_1 in volt?



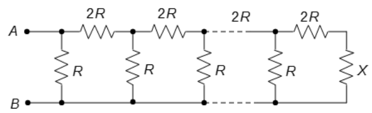
574. In the above question, the reading of ammeter is $200/x$ mA. What is the value of x?

575. Nine wires each of resistance $r = 5\ \Omega$, are connected to make a prim as shown in the figure. Find the equivalent resistance of the arrangement across AB (in Ω)

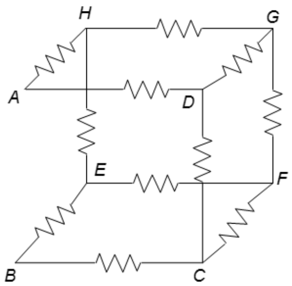


576. A dynamo develops 0.5 A at 6 V. Find the energy which it generates in 1 Sec

577. At what value of the resistance in the circuit shown in the figure will the total resistance between points A and B be independent of the number of cells? If $R = \left(\sqrt{3} + 1\right)\Omega$, then the value of x will be "......"Ω

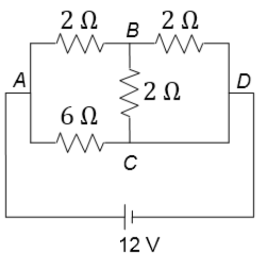


578. Eleven equal wires, each of resistance (15/7) Ω, form the edges of an incomplete skeleton cube. Find the total resistance between points A and B of the vacant edge (in Ω)

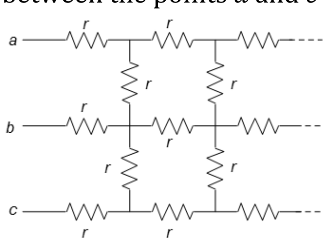


579. A heating coil is rated 100 W, 220 V. The coil is cut in half and two pieces are joined in parallel to the same source. Now what is the energy (in $\times 10^2$J) liberated per second?

580. Find current in the branch CD of the circuit (in ampere).



581. In the infinite grid if the value of each resistance is $r = 2(\sqrt{5} - 1)\Omega$. Find the equivalent resistance between the points a and c (in Ω)

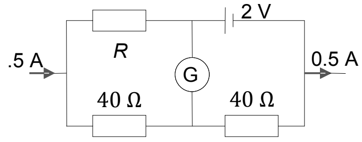


582. A galvanometer together with an unknown resistance in series is connected across two identical batteries of each 1.5 V. When the batteries are connected in series, the galvanometer records a current of 1 A and when the batteries are connected in parallel, the current is 0.6 A. In this case, internal resistance of the battery is $\frac{1}{'*'}\Omega$. What is the value of '*'?

583. A potentiometer wire of length 10 m and resistance 30 Ω is connected in series with a battery of e.m.f. 2.5 V, internal resistance 5 Ω and an external resistance R. If the fall of potential along the potentiometer wire is 50 μ V/mm, then the value of R is found to be $23n\Omega$. What is n?

584. The maximum current in a galvanometer can be 10 mA. Its resistance is 10Ω. To convert it into an ammeter of 1 A, what resistance should be connected in parallel with galvanometer (in$10^{-1}\Omega$)?

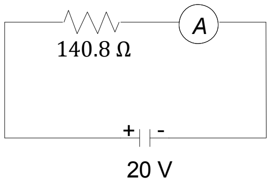
585. In the circuit shown in the figure, the internal resistance of the cell is negligible. For value of $R = 40/x\ \Omega$, no current flows through the galvanometer. What is x?



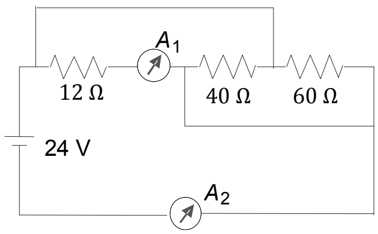
586. The current in a conductor and the potential difference across its ends are measured by an ammeter and a voltmeter, respectively. The voltmeter draws negligible currents. The ammeter is accurate but the voltmeter has a zero error (that is, it does not read zero when no potential difference is applied). Calculate the zero error if the readings for two difference conditions are 1.75 A, 14.4 V and 2.75 A, 22.4 V. (in ×

10^{-1}V)

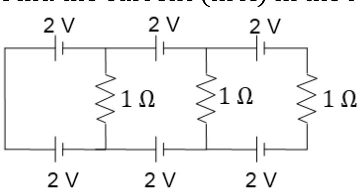
587. The ammeter shown in the figure. Consists of 480 Ω coil connected in parallel to 20 Ω shunt. The reading of the ammeter comes out to be $\frac{1}{'*'}$ A. What is '*'?



588. Find the reading of the ammeter A_1 (in A) connected as shown in the network



589. Find the current (in A) in the rightmost resistor shown in figure



: ANSWER KEY :

1)	a	2)	b	3)	c	4)	b	189)	a	190)	a	191)	c	192)	d
5)	a	6)	b	7)	d	8)	b	193)	a	194)	c	195)	d	196)	d
9)	b	10)	c	11)	a	12)	b	197)	b	198)	b	199)	c	200)	d
13)	b	14)	c	15)	a	16)	a	201)	a	202)	d	203)	b	204)	b
17)	a	18)	c	19)	b	20)	a	205)	c	206)	a	207)	c	208)	b
21)	a	22)	c	23)	c	24)	a	209)	d	210)	a	211)	d	212)	b
25)	c	26)	a	27)	a	28)	a	213)	c	214)	b	215)	b	216)	a
29)	d	30)	b	31)	b	32)	b	217)	b	218)	d	219)	d	220)	b
33)	a	34)	d	35)	a	36)	b	221)	a	222)	b	223)	d	224)	d
37)	a	38)	b	39)	a	40)	b	225)	c	226)	d	227)	b	228)	d
41)	b	42)	b	43)	a	44)	a	229)	c	230)	b	231)	a	232)	c
45)	b	46)	a	47)	a	48)	d	233)	c	234)	c	235)	a	236)	c
49)	a	50)	b	51)	c	52)	d	237)	c	238)	c	239)	c	240)	d
53)	b	54)	c	55)	d	56)	d	241)	c	242)	c	243)	d	244)	b
57)	c	58)	c	59)	b	60)	b	245)	a	246)	a	247)	a	248)	d
61)	a	62)	d	63)	b	64)	d	249)	c	250)	b	251)	d	252)	d
65)	c	66)	d	67)	b	68)	a	253)	d	254)	b	255)	b	256)	a
69)	a	70)	b	71)	d	72)	d	257)	a	258)	c	259)	b	260)	b
73)	b	74)	b	75)	d	76)	a	261)	a	262)	d	263)	c	264)	b
77)	c	78)	a	79)	a	80)	d	265)	d	266)	b	267)	b	268)	a
81)	a	82)	b	83)	b	84)	c	269)	a	270)	c	271)	b	272)	c
85)	b	86)	c	87)	b	88)	c	273)	d	274)	c	275)	d	276)	b
89)	c	90)	a	91)	b	92)	b	277)	b	278)	d	279)	b	280)	b
93)	d	94)	c	95)	b	96)	c	281)	b	282)	b	283)	c	284)	a
97)	a	98)	a	99)	d	100)	c	285)	d	286)	b	287)	b	288)	c
101)	a	102)	a	103)	c	104)	a	289)	a	290)	a	291)	d	292)	a
105)	b	106)	c	107)	b	108)	d	293)	a	294)	b	295)	b	296)	a
109)	b	110)	b	111)	d	112)	b	297)	d	298)	c	299)	a	300)	a
113)	d	114)	b	115)	a	116)	b	301)	b	302)	d	303)	b	304)	c
117)	a	118)	d	119)	c	120)	a	305)	b	306)	c	307)	b	308)	c
121)	c	122)	b	123)	b	124)	b	309)	a	310)	b	311)	b	312)	b
125)	d	126)	c	127)	c	128)	c	313)	c	314)	a	315)	a	316)	c
129)	c	130)	a	131)	a	132)	c	317)	c	318)	b	319)	a	320)	c
133)	c	134)	d	135)	d	136)	b	321)	b	322)	a	323)	b	324)	b
137)	b	138)	a	139)	d	140)	c	325)	b	326)	a	327)	b	328)	b
141)	b	142)	b	143)	a	144)	d	329)	c	330)	c	331)	a	332)	d
145)	b	146)	a	147)	c	148)	c	333)	b	334)	a	335)	d	336)	b
149)	a	150)	d	151)	c	152)	b	337)	b	338)	c	339)	a	340)	b
153)	a	154)	d	155)	b	156)	a	341)	d	1)	c, d	2)	b,c	3)	d
157)	a	158)	b	159)	d	160)	b		4)	b ,c ,d					
161)	c	162)	b	163)	d	164)	b	5)	a, c	6)	a,c	7)	a ,b ,c	8)	
165)	a	166)	c	167)	b	168)	a		a,d						
169)	a	170)	a	171)	b	172)	c	9)	a,d	10)	a,d	11)	a,b,d	12)	
173)	b	174)	c	175)	b	176)	a		b, c						
177)	c	178)	b	179)	d	180)	a	13)	a,b,c,d	14)	a,b,d	15)	a,b,c,d	16)	
181)	b	182)	a	183)	c	184)	b		b,c						
185)	d	186)	c	187)	d	188)	a	17)	a,b,d	18)	a,b,d	19)	a,d	20)	

a,b,d
21) a,b,d 22) a, c, d 23) a, b, d 24)
b, c, d
25) b,c,d 26) c 27) a,b,c 28)
a,c
29) b,d 30) a,b,d 31) a,d 32)
a, c
33) a, c, d 34) a, b, c, d 35) a,b,c,d
36) a , d
37) a, b, c, d 38) a, b, c, d 39)
a,d 40) a,c,d
41) a,b,c,d 42) a,b,c,d 43) a,b 44) d
45) b,c 46) a,b 47) a, b, c 48)
b, c
49) a,c 50) b,c 51) b,c 52)
a,c,d
53) b,d 54) a,b,d 55) a,d 56)
a, c
57) a,b,c 58) a,b,d 59) a,d 60)
b,c
61) a,b,d 62) b,c 63) a, d 64)
b, c, d
65) a,c 66) b,d 67) a,c 68)
a, d
69) b,c 70) a,d 71) a, b, d 1) a
2) c 3) b 4) d
5) b 6) a 7) d 8) b
9) a 10) e 11) a 12) a
13) a 14) d 15) a 16) b
17) a 18) c 19) a 20) d
21) d 22) a 23) d 24) a
25) b 26) b 27) c 28) c
29) c 30) d 31) a 32) a
33) d 34) a 35) d 36) d
37) c 38) d 39) d 40) a
41) a 42) a 43) b 44) a

45) c 46) a 47) a 48) c
49) a 50) a 51) a 52) b
53) a 54) a 55) a 56) d
57) a 58) c 59) a 60) d
61) c 62) b 63) d 64) d
65) c 66) c 67) a 68) a
69) d 70) a 71) a 72) c
73) a 74) b 75) d 76) a
77) a 78) a 79) c 80) c
81) d 82) d 83) b 84) a
85) a 86) a 87) a 88) a
89) c 90) b 91) d 92) b
93) c 1) d 2) a 3) a
4) b
5) a 6) c 7) d 8) c
9) b 10) d 11) a 12) a
13) a 14) a 15) c 16) a
17) c 18) b 19) c 20) b
1) a 2) b 3) a 4) a
5) d 6) c 7) d 8) a
9) b 10) c 11) d 12) a
13) d 14) a 15) c 16) a
17) b 18) d 19) b 20) a
21) c 22) d 23) b 24) b
25) c 26) b 27) a 28) c
29) a 30) b 31) d 32) c
33) b 34) a 1) 6 2) 5
3) 6 4) 7
5) 9 6) 6 7) 9 8) 1
9) 2 10) 6 11) 2 12) 1
13) 1 14) 9 15) 3 16) 3
17) 3 18) 2 19) 3 20) 4
21) 4 22) 8 23) 3 24) 5
25) 1 26) 9 27) 4 28) 8
29) 2 30) 0

: HINTS AND SOLUTIONS :

1 **(a)**

$P = V^2/R$. If P is more, R is less. $R = \rho\, \ell/a$. For less R, $'a'$ is more. So, the 100 W bulb has thicker element

3 **(c)**

Both the length and the cross-sectional area are doubled. So, the resistance remains unaffected

4 **(b)**

In series combination, I is constant, therefore

$V \propto R$

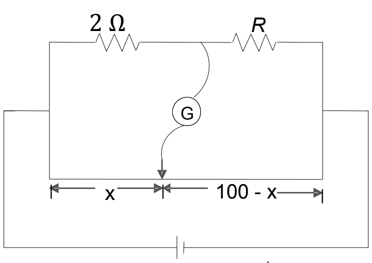
$$\frac{V_{AB}}{V_{CA}} = \frac{R_{AB}}{R_{CA}} = \frac{\rho \frac{I}{\pi a^2}}{\rho \frac{l}{\pi (2a)^2}} \Rightarrow \frac{V_{AB}}{V_{CA}} = \frac{4}{1}$$

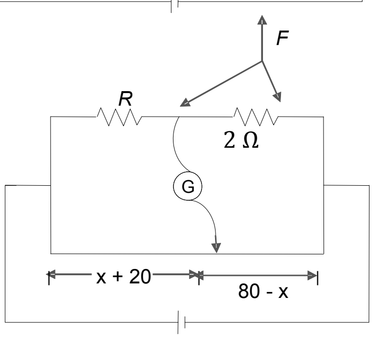
5 **(a)**

$R > 2\Omega$

$\therefore\ 100 - x > x$

Applying, $\frac{P}{Q} = \frac{R}{S}$





We have

$$\frac{2}{R} = \frac{x}{100 - x} \quad \ldots.(i)$$

$$\frac{R}{2} = \frac{x + 20}{80 - x} \quad \ldots\ldots..(ii)$$

Solving Eqs. (i) and (ii), we get

$R = 3\Omega$

6 **(b)**

By symmetry, we see that the current in the left and right arms should be the same. It means no current should flow from A to B

7 **(d)**

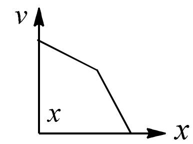
$Q = \frac{V^2}{R} t$. When R is halved, then Q is doubled

8 **(b)**

The potential of point G should be kept zero

9 **(b)**

From relation$E = \rho J$, the magnitude of electric field is greater in right rod as compared to left rod. Therefore, magnitude of potential gradient in the right rod is greater (remember is continuous)



Therefore, the variation is shown by the figure

10 **(c)**

The voltage across the capacitor is

$V = \frac{Q}{C} = \frac{1\times10^{-5}}{1\times10^{-6}} = 10\text{ V}$

Thus, the current flowing through the resistor after the switch is closed will be

$I = \frac{V}{R} = \frac{10}{10} = 1\text{ A}$

11 **(a)**

Resistance of each part $= R/2n$

For $'n'$ such part connected in series, equivalent resistances, say

$$R_1 = n = \left[\frac{R}{2n}\right] = \frac{R}{2}$$

Similarly, equivalent resistance, say R_2, for another set of n identical, respectively, in parallel resistances would be

$$\frac{1}{n}\left(\frac{R}{2n}\right) = \frac{R}{2n^2}$$

For getting maximum of R_1 and R_2, the resistances should be connected in series and hence,

$$R_{\text{eq}} = R_1 + R_2 = \frac{R}{2}\left(1 + \frac{1}{n^2}\right)$$

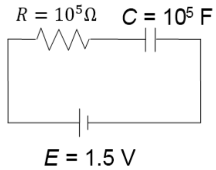
12 **(b)**

When X is connected to Y, the balance length l is proportional to the p.d. across the 100 Ω resistor. When X is connected to Z, the balance length is proportional to the p.d. across the 100 Ω resistor and resistor R

$$\frac{100 + R}{100} = \frac{588}{400} \Rightarrow R = 47\Omega$$

13 **(b)**

For the capacitor to get charged up to 0.75 V, the charge on the plates should be as follows



$q = CE[1 - e^{-t/RC}]$

$0.75 \times 10^{-5} = 10^{-5} \times 1.5\left[1 - e\dfrac{-t}{10^5 \times 10^{-5}}\right]$

$\dfrac{1}{2} = [1 - e^{-t}] \Rightarrow e^{-t} = \dfrac{1}{2}$

Taking log on both sides, we get

$-t = -\ln 2 \Rightarrow t = 0.693$ s

14 **(c)**

Applying $P = \frac{V^2}{R}$

$R_1 = 1\,\Omega, R_2 = 0.5\,\Omega$ and $R_3 = 2\,\Omega, V_1 = V_2 = V_3 = 3$ volt

$\therefore \quad P_1 = \dfrac{(3)^2}{1} = 9$ W

$P_2 = \dfrac{(3)^2}{0.5} = 18$ W and

$P_3 = \dfrac{(3)^2}{2} = 4.5$ W

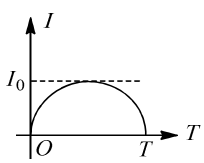
$\therefore \quad P_2 > P_1 > P_3$

15 **(a)**

$v_d = \frac{eE}{m}\tau = \frac{e\tau}{m}\frac{V}{l} \Rightarrow v_d \propto V$. If V is doubled, v_d also gets doubled

16 **(a)**

Time period: $T_0 = 2T, \omega = \frac{2\pi}{T_0} = \frac{\pi}{T}$



$I = I_0 \sin \omega t = I_0 \sin\left(\dfrac{\pi}{T}t\right)$

$Q = \displaystyle\int_0^T I dt \Rightarrow Q = I_0 \int_0^T \sin\left(\dfrac{\pi}{T}t\right) dt$

$= \dfrac{-I_0}{\pi/T}\left[\cos\left(\dfrac{\pi}{T}t\right)\right]_0 = \dfrac{2TI_0}{\pi}$

$= I_0 = Q\pi/2T$

Heat $= \int_0^T I^2 R dt = \int_0^T \sin^2\left(\frac{\pi}{T}t\right) R dt = Q^2\pi^2 R/8T$

17 **(a)**

The electric current through ideal voltmeter is zero. According to the loop rule,

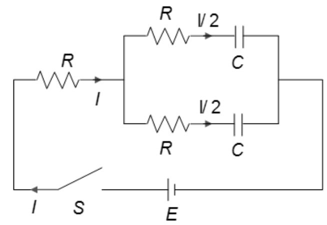
$E - 1 \times I - 1 \times I = 0 \Rightarrow I = \dfrac{E}{2} = \dfrac{2}{2} = 1$ A

Reading of the voltmeter $= V_A - V_B$

$= [1 \times I] = [1 \times 1] = 1$ V

18 **(c)**

Applying KVL, we get



$\dfrac{I}{2} = \dfrac{dq}{dt} \Rightarrow I = 2\dfrac{dq}{dt}$

$E - IR - \dfrac{1}{2}R - \dfrac{q}{C} = 0$

$E - \dfrac{3}{2}IR - \dfrac{q}{C} = 0$

$E - \dfrac{3}{2} \times 2\dfrac{dq}{dt}R - \dfrac{q}{C} = 0$

$q_{(f)} = EC(1 - e^{-1/3RC})$

19 **(b)**

For the maximum power, external resistance is equal to internal resistance. Therefore, $2R = 4$ or $R = 2\,\Omega$

20 **(a)**

For a given wire, $R = \rho L/s, L \times s =$ volume$= V =$constant.

Therefore, $R = \frac{\rho L^2}{V} \Rightarrow R \propto L^2$

$\frac{\Delta R}{R} = 2\frac{\Delta L}{L} = 2(0.1\%) = 0.2\%$ increase

21 **(a)**

$\frac{X}{Y} = \frac{20}{80} = \frac{1}{4}$ or $Y = 4X$

$\frac{4X}{Y} = \frac{l}{100-l}$ or $\frac{4X}{4X} = \frac{l}{100-l}$ or $l = 50$ cm

22 **(c)**

$a(T) = \dfrac{1}{R_0}\dfrac{dR}{dT} \Rightarrow (3T^2 + 2T) = \dfrac{1}{R_0}\dfrac{dR}{dT}$

$\Rightarrow dR = R_0(3T^2 + 2T)dT$

$\Rightarrow \displaystyle\int_{R_0}^{R} dR = R_0\left[3\int_0^T T^2 dT + 2\int_0^T T\, dT\right]$

$\Rightarrow R = R_0[1 + T^2 + T^3]$

23 **(c)**

A careful observation will reveal that one end of each resistor is connected to A and the other end of each resistor is connected to B. Hence, the resistors are in parallel. So $R_{\text{eq}} = R/5$

24 **(a)**

Effective resistance across the voltmeter = 200/2 = kΩ

Total resistance across d.c. supply = 400 + 100 = 500 kΩ

Thus, the voltage across the voltmeter = 100/500(60 V) = 12 V

25 **(c)**

From work-energy theorem, we get $\Delta = \varepsilon i - i^2 r$

26 **(a)**
The current in 2 Ω resistor will be zero because it is not a part of any closed loop

27 **(a)**
All the four resistance are in parallel to E. So current in them flows independently. Hence, no change in current flowing in A after closing the switch

28 **(a)**
$P = i^2R$

Current is same, so $P \propto R$

In the first case I is $3r$, in second case it is $\frac{2}{3}\ r$, in third case it is $\frac{r}{3}$ and in fourth case the net resistance is $\frac{3r}{2}$.

$R_{III} < R_{II} < R_{IV} < R_I$

$\therefore P_{III} < P_{II} < P_{IV} < P_I$

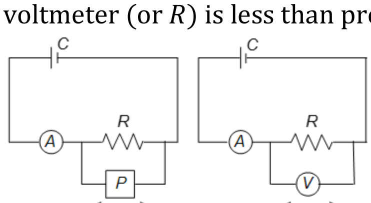
29 **(d)**
E.m.f =6 V; total resistance = 6 Ω, I =6/6=1 A
For the direction of current, look at the direction of e.m.f of the cell of 10 V

30 **(b)**
Let current in 5 Ω resistor be I_1 and in 4 Ω resistors be I_2, then $I_2/I_1 = 1/2$. The heat generated in the 5 Ω resistor is 10 cal s^{-1} = given
$I_1^2 \times 5 = 10 \Rightarrow I_2^2 = 1/2$
Heat in the 4 Ω resistor will be $(I_2)^2 \times 4 = 2$ cal s^{-1}

31 **(b)**
Since current $IneAv_d$ through both the rods is the same,
i.e. $2(n)eAv_L = ne(2A)v_R$
$\Rightarrow \dfrac{v_L}{v_R} = 1$

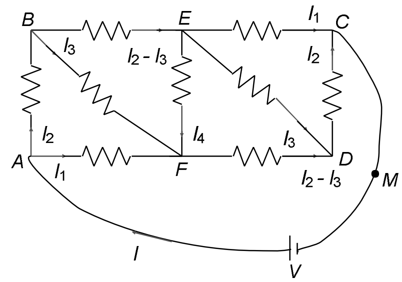
32 **(b)**
$Q = 0.1\, Q_0 = Q_0\, e^{-t/\tau}$
or $e^{t/\tau} = 10$ or $t/\tau =$ In $10 = 2.303$

33 **(a)**
Effective resistance of R and V is less than effective resistance R and P, hance p.d. across voltmeter (or R) is less than previous value



Also overall resistance decreases, so overall current increase, hence reading of ammeter increase

34 **(d)**
At junction E or F:
$I_1 + I_3 + I_4 = I_2 - I_3 \Rightarrow I_1 - I_2 + 2I_3 + I_4 = 0$
Loop $AFBA$ or loop $ECDE$
$rI_1 = rI_2 + rI_3 \Rightarrow I_1 = I_2 + I_3$



Loop $BEFB$ or loop $EDFE$:
$r(I_2 - I_3) + rI_4 = rI_3 \Rightarrow I_2 - 2I_3 + I_4 = 0$
Loop $AFDCMA$ or $ABECMA$:
$V = rI_1 + r(I_2 - I_3) + rI_2 \Rightarrow V = rI_1 + 2rI_2 - rI_3$
Solve to get $I_1 = 2V/5r, I_2 = V/3r$
$$R_{eq} = \frac{V}{I} = \frac{V}{I_1 + I_2} = \frac{V}{2V/5r + V/3r} = \frac{15r}{11}$$

35 **(a)**
Effective resistance across voltmeter = 50 kΩ.
Total resistance across the dc supply = 450 k Ω
Current drawn from supply $\frac{1000\ V}{450k\ \Omega} = \frac{1}{450}$ A.
potential
Difference across voltmeter $= \frac{50\times1000}{450}$ V $= \frac{1000}{9}$ V
$= 111$ V

36 **(b)**
Current required by each bulb,
$I = \dfrac{P}{V} = \dfrac{100}{220}$ A
If n bulbs are joined in parallel, then
$nI = I_{\text{fuse}}$ or $n \times \frac{100}{220} = 10$ or $n = 22$

37 **(a)**
$$\frac{q^2}{2C} = \frac{q_0^2 e^{-2t/RC}}{2C} \Rightarrow U_0 e^{-2} = \frac{U_0}{e^2}$$

38 **(b)**
On connecting the switch, the current drawn by the resistances through the battery will increase. This will decrease the terminal potential difference ($V = E - Ir$) across the cell and hence the potential diff. across A will also decrease. So the current through A will decrease

39 **(a)**
Initial charge on capacitor : $Q_1 = 2 \times 100 =$ 200 μC
Final charge: $Q_2 = 2 \times 300 = 600$μC

$\Delta U=\frac{1}{2}C[300^2-100^2]$=80000 μJ

Heat $=W_b-\Delta U=40000$ μJ=0.04 J

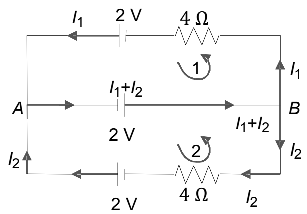
40 **(b)**

For series connection, $I_{\min}=\frac{N\varepsilon}{Nr}=\frac{\varepsilon}{r}$

For parallel connection, $I_{\max}=\frac{\varepsilon}{(r/N)}=\frac{N\varepsilon}{r}$

41 **(b)**

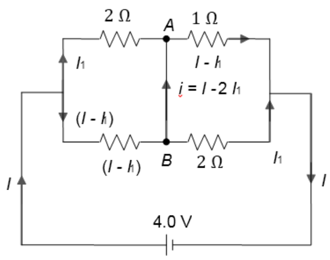
For loop (1), $2+2-4I_1=0\Rightarrow I_1-1\text{A}$



For loop (2),$-2-2+4I_2=0\Rightarrow I_2=1$ A

So, the current from A to B is $I_1+I_2=2\text{A}$

42 **(b)**



Using KVL, we get

$2l_1-(I-I_1)=0\Rightarrow I=3I_1$

and $(I-I_1)+2I_1=4$

Solving, we get $l_1=1$ A and $I=3$ A

Therefore, current through $AB=I-2I_1=(3-2)\text{A}=1$ A

43 **(a)**

power $P=I^2R=\left(\frac{V}{R+3r}\right)^2R\Rightarrow P\propto V^2$

Power ratio $=\left(\frac{V_1}{V_2}\right)^2=\left(\frac{4.5}{1.5}\right)^2=3^2=9$

44 **(a)**

At null point, R_1/R_2=R_3/R_4= $x/(100-x)$. If radius of the wire is doubled, then the resistance of AC will change and the resistance of CB will also change. But since R_1/R_2 does not change, so R_3/R_4 should also not change at null point. Therefore, point C does not change

45 **(b)**

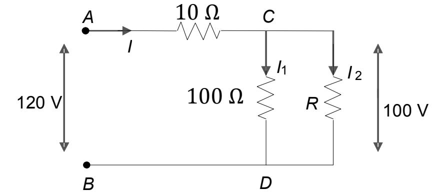
Current in circuit, $i=\frac{\varepsilon}{R+r}$

p.d. across cell = p.d. across $R=iR=\frac{\varepsilon R}{R+r}$

Set up two equations with the given data and solve for ε, r

46 **(a)**

Potential difference across C and D =100 V



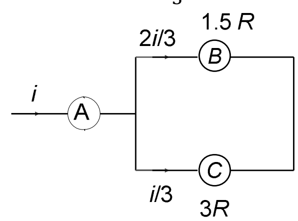
Hence $I_1=\frac{100}{100}=1\text{A}, V_{AC}=120-100=20$ V

And $I=\frac{20}{10}=2\text{A}$. Hence, $I_2=2-1=1$ A

$R=100/I_2=100\ \Omega$

47 **(a)**

$V_A=iR, V_B=\frac{2i}{3}\times1.5R=iR, V_C=(i/3)(3R)=iR$



48 **(d)**

Compensation external resistance

$$G-\frac{SG}{S+G}=3663-107.7=3555.3\ \Omega$$

49 **(a)**

The condition for delivering maximum power is that the external resistance is equal to the internal resistance

50 **(b)**

Final charge on capacitor $q_f=CE$

Charge flown = $CE-CE/2=CE/2$

Work done by battery: $W_b=E(CE/2)=\frac{1}{2}CE^2$

Change in energy of capacitor is

$$\Delta U=\frac{1}{2C}\left[q_f^2-q_0^2\right]$$

$$=\frac{1}{2C}[(CE)^2-(CE/2)^2]=\frac{3CE^2}{8}$$

Heat = $W_b-\Delta U=\frac{1}{8}CE^2$

51 **(c)**

$Q=Q_0e^{-t/\tau}$ and potential difference across C is proportional to Q. For the p.d. to fall by 10%, Q must also fall by 10 %.

$Q=0.9Q_0=Q_0e^{-t/\tau}$

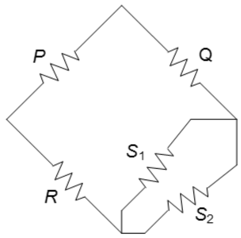
or $e^{t/\tau}=\frac{10}{9}$ or $\frac{t}{\tau}=$ In $\left(\frac{10}{9}\right)$

52 **(d)**

Using the condition for Wheatstone bridge to be balanced,

We get

$$\frac{P}{Q}=\frac{R}{\frac{S_1S_2}{S_1+S_2}}\text{ or }\frac{P}{Q}=\frac{R(S_1+S_2)}{S_1S_2}$$



53 **(b)**

$E_1 \propto 64$

$E_1 - E_2 \propto 8$

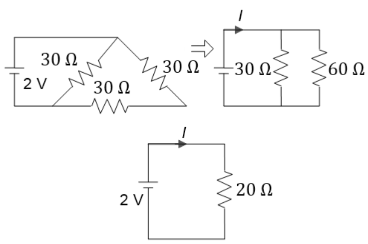
$E_2 \propto l$

$\therefore 64 - l = 8$ or $l = 64 - 8 = 56$ cm

54 **(c)**

$\frac{1}{R_{\text{eq}}} = \frac{1}{30} + \frac{1}{60} = \frac{90}{30 \times 60}, R_{\text{eq}} = 20\ \Omega\ V = IR$

$I = \frac{2}{20} = 0.01$ A



55 **(d)**

$R_{\text{total}} = 2 + \frac{6 \times 1.5}{6 + 1.5} = 3.2\text{k}\Omega$

(a)$I = \frac{24\text{V}}{3.2k\Omega} = 7.5\text{mA} = I_{R_1}$

$I_{R_2} = \left(\frac{R_L}{R_L + R_2}\right) I$

$I = \frac{1.5}{7.5} \times 7.5 = 1.5\text{mA}$

$I_{R_L} = 6\text{mA}$

$(b) V_{R_L} = (I_{R_L})(R_L) = 9V$

$(c)\ \frac{P_{R_1}}{P_{R_2}} = \frac{(I_{R_1}^2)R_1}{(I_{R_2}^2)R_2} = \frac{(7.5)^2(2)}{(1.5)^2(6)} = \frac{25}{3}$

(d) When $R_1$and $R_2$are interchanged, then

$\frac{R_2 R_L}{R_2 + R_L} = \frac{2 \times 1.5}{3.5} = \frac{6}{7} k\Omega$

Now potential difference across R_L will be

$V_L = 24 \left[\frac{\frac{6}{7}}{6 + \frac{6}{7}}\right] 3V$

Earlier it was 9V

Since, $P = \frac{V^2}{R}$ or $P \propto V^2$

In new situation potential difference has been decreased three times. Therefore, power dissipated will decrease by a factor of 9.

56 **(d)**

As $V = \varepsilon - Ir$

From graph it is clear that slope $= -r = -y/x$

Or $r = y/x$

57 **(c)**

$k = 0.05\ \text{mV/cm} = 5\ \text{mV/m}$

$I = \frac{kl}{r} = \frac{5 \times 10^{-3} \times 1}{5} = 10^{-3}\text{A}$

Now, $2 = I = (R + r) \Rightarrow 2 = 10^{-3}(R + 5) \Rightarrow R =$ $1995\ \Omega$

58 **(c)**

It is a case of weak current

59 **(b)**

If collision frequency increases, it means more number of collisions per unit time. This will decrease relaxation time. But $R = \propto \frac{1}{\tau}$, so R increases

60 **(b)**

If N be the initial number of turns in the coil ad r be the radius of coil, then its resistance,

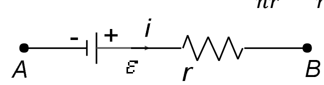
$R = \rho \frac{L}{A} = \rho \frac{N\ 2\ \pi\ r}{A}$ or $\frac{V^2 tA}{4.2\rho N 2\pi r} = Q = msd\theta$

Or $\frac{t}{n} = \frac{msd\theta \times 4.2\rho\pi r}{V^2 A} = \text{constant}$

Or $\frac{t_1/N_1}{t_2/N_2} = 1$ or $t_2 = \frac{N_2}{N_1}\ t_1 = \left(\frac{\frac{9}{10}N_1}{N_1}\right) t_1 = \frac{9}{10} \times 16$ min

61 **(a)**

Current in circuit, $i = \frac{n\varepsilon}{nr} = \frac{\varepsilon}{r}$



The equivalent circuit of one cell is shown in Fig. The p.d across the cell is $V_A - V_B = -\varepsilon + ir =$ $-\varepsilon + \frac{\varepsilon}{r}.r = 0$

62 **(d)**

In series $\quad i = \frac{2E}{2 + R}$

$\therefore \quad J_1 = i^2 R = \left(\frac{2E}{2 + R}\right)^2 .R$

In parallel

$i = \frac{E}{0.5 + R}$

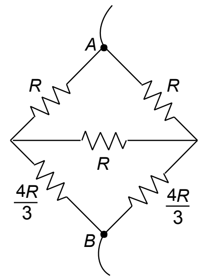
$J_2 = i^2 R = \left(\frac{E}{0.5 + R}\right)^2 .R$

$\frac{J_1}{J_2} = 2.25 = \frac{4(0.5\ + R)^2}{(2\ + R)^2}$

Solving we get, $R = 4\ \Omega$

63 **(b)**

$R_{AB} = \frac{7}{6}R$



64 **(d)**

Power consumed by each lamp = 24 W

Hence using $R = (V^2/P)$ we find

$R = (36/24) = 1.5\ \Omega$

65 **(c)**

Power of the heater P =1000W

Potential difference $V = 100\ V$

Therefore, resistance $R_1 = \frac{V^2}{P} = \frac{100\times100}{1000} = 10\Omega$

Now resistance of the circuit is

$$R_2 = 10 + \frac{10R}{10+R} = \frac{100+20R}{10+R}$$

Therefore, power $= \frac{V^2}{R_2} = 625$ W

$$R_2 = \frac{V^2}{625} \Rightarrow \frac{100+20R}{10+R} = \frac{625}{100\times100} \Rightarrow R_2 = 15\Omega$$

66 **(d)**

When a steady current flows in a metallic conductor of non-uniform cross section, then drift speed $V_d = I/n_e A$ and electric field $E = I/\sigma A \Rightarrow V_d \propto 1/A$ and $E \propto 1/A$. It implies only current remains is constant

67 **(b)**

Let the edge be $2I$, a and I in decreasing order

$$R_{\max} = \rho\frac{2I}{aI} = \frac{2\rho}{a}$$

$$R_{\min} = \rho\frac{I}{2Ia} = \frac{\rho}{2a}, \frac{R_{\max}}{R_{\min}} = 4$$

68 **(a)**

The current density at P is higher than that at Q. For the same current flowing through the metallie conductor PQ, the cross-sectional area at P is narrower than that at Q. The resistance per length r is given by $r = \rho\frac{1}{A}$, where ρ is the resistivity and A is the cross-sectional area of the conductor PQ. Thus, r is inversely proportional to the cross-sectional area A of the conductor

69 **(a)**

$I = I_0 - kt$, at $t = T, I = 0 \Rightarrow k = I_0/T$

So $I = I_0 - \frac{I_0 t}{T}$, $q = \int_0^T I dt = I_0\int_0^T\left(1 - \frac{t}{T}\right)dt$

$$\Rightarrow q = \frac{I_0 T}{2} \Rightarrow I_0 = \frac{2q}{T}$$

Heat $= \int_0^T I^2 R dt = I_0^2 R\int_0^T\left(1 - \frac{T}{T}\right)^2 dt = \frac{4q^2R}{3T}$

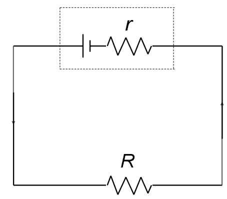
70 **(b)**

$V = E - ir$. When $i = 0$, the potential reading is 2 V. Hence e.m.f. =2 V

When $V = 0, i = 5$ A. This gives $r = 0.4\Omega$

71 **(d)**

Let current I flow through the circuit



Energy dissipated in load $= I^2R$

Energy dissipated in the complete circuit= $I^2(r + R)$

Therefore, the efficiency $= \frac{I^2R}{I^2(R+r)} = \frac{R}{R+r}$

72 **(d)**

Resistance of bulb $= \frac{1.5\times1.5}{4.5}\Omega = 0.5\Omega$

Resistance of parallel combination, $R = \frac{1\times\frac{1}{2}}{1+\frac{1}{2}}\Omega = \frac{1}{3}\Omega$

Now, $r = \frac{E-V}{V}R \Rightarrow \frac{8}{3} = \frac{E-1.5}{1.5}\times\frac{1}{3} \Rightarrow E = 13.5$ V

73 **(b)**

No current flows through the capacitor branch in steady state. Total current supplied by the battery

$$i = \frac{6}{2.8+1.2} = \frac{3}{2}$$

Current through 2 Ω resistor $= \frac{3}{2}\times\frac{3}{5} = 0.9A$

74 **(b)**

Applying the junction rule to O, we get

$-I_1 - I_2 - I_3 = 0 \Rightarrow I_1 + I_2 + I_3 = 0$ ...(i)

Now if V_0 is the potential at point O, then

$I_1 = \frac{(V_0 - V_1)}{R_1}; I_2 = \frac{(V_0 - V_2)}{R_2}$ and $I_3 = \frac{(V_0 - V_3)}{R_3}$;

So substituting these values of I_1, I_2 and I_3 in Eq. (i), we get

$$V_0\left[\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right] - \left[\frac{V_1}{R_1} + \frac{V_2}{R_2} + \frac{V_3}{R_3}\right] = 0$$

$$V_0 = \left[\frac{V_1}{R_1} + \frac{V_2}{R_2} + \frac{V_3}{R_3}\right]\left[\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right]^{-1}$$

75 **(d)**

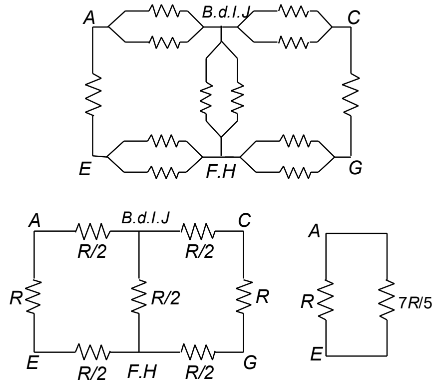
When a steady current flow in a metallic conductor of non-uniform cross section then the drift speed is $V_d = I/neA$ and the electric field $E = I/\sigma A$

$\Rightarrow V_d \propto \frac{1}{A}$ and $E \propto \frac{1}{A}$

⇒ Only current remains constant

76 **(a)**

The figure can be redrawn as



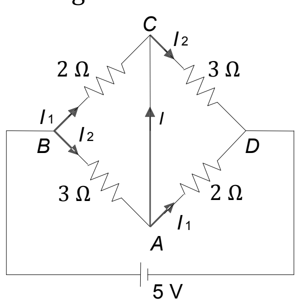
$$\Rightarrow R_{\text{eq}} = \frac{7R}{12}$$

77 **(c)**

$$i_g = \frac{V}{G+R} \Rightarrow 10^{-3} = \frac{2.5}{10+R} \Rightarrow R = 2490\ \Omega$$

78 **(a)**

The figure can be redrawn as:



p.d. across each resistance will be 2.5 V,

$$I_1 = \frac{2.5}{2} = 1.25\text{A}, I_2 = \frac{2.5}{3} A$$

$$I = I_2 - 1_1 = \frac{2.5}{3} - \frac{2.5}{2} = \frac{-2.5}{6} = -\frac{5}{12}\ \text{A}$$

79 **(a)**

$$P_1 = I^2(3R), P_{\text{II}} = I^2\left(\frac{2R}{3}\right), P_m = I^2\left(\frac{R}{3}\right)$$

$$P_{\text{IV}} = I^2\left(\frac{3R}{2}\right)$$

∴ III< II < IV < I

80 **(d)**

For maximum current, net resistance of cells must be equal to 2.5 Ω

i.e., $\frac{n(0.5)}{m} = 25$ (i)

and $m \times n = 45$ (ii)

solving, we get $n = 15, m = 3$

81 **(a)**

$$V_1 = E - ir = 50 - \frac{50}{220} \times 20$$

$=50 - 4.6 = 45.4$ V

Now, $V_2 = 50 - \frac{50}{\;} \times 20 = 44.4$ V

Percentage change $= \frac{V_1 - V_2}{V_1} \times 100 = 2.27$ (also see the question)

82 **(b)**

As potential gradient k in the potentiometer wire will be less than $(\varepsilon\varepsilon/100)$ (V cm^{-1})

Because of the presence of r. So for the battery of e.m.f. $\varepsilon/2$, the balance point I will be greater than 50 cm as shown

$$I = \frac{e/2}{k(< e/100)} \Rightarrow l > 50 \text{ cm}$$

83 **(b)**

Let R be the resistance of the wire and let R' be the resistance of the wire. Energy released in t second $= (3V^2)/R \times t$

$\Rightarrow R' = 2R$ (as length is twice)

Therefore, energy released in t seconds $= \frac{(NV^2)}{2R} \times t$

But $Q = mc\Delta T$

$\therefore\ Q' = \frac{(N^2V^2)}{2R} \times t$

$\therefore mc\Delta T = \frac{(9V^2)}{R} \times t$ ...(i)

Applying $Q' = m'c\Delta T$

$2mc\Delta T = \frac{(N^2V^2)}{2R} \times t$ ...(ii)

Dividing Eq. (ii) by Eq. (i), we get

$$\frac{mc\Delta T}{2mc\Delta T} = \frac{9V^2 \times t/R}{N^2V^2t/2R}$$

$$\therefore\ \frac{1}{2} = \frac{9 \times 2}{N^2} \Rightarrow N = 6$$

84 **(c)**

$I = I_0 e^{-t/RC}$ or $\frac{I_0}{2} = I_0 e^{-t/RC} \Rightarrow t = RC \text{ In } 2$

or $10^{-6} \times \text{In}4 = (2+r) \times 0.5 \times 10^{-6} \text{ In } 2$

Solve to get $r = 2\Omega$

85 **(b)**

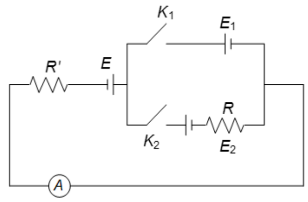
If we remove R, then we find that the p.d. across AD is less than that across AB. So, the potential of D is higher than that of B. So on connecting R, the current will go from high potential to low potential, i.e., D to B

86 **(c)**

Since current I is independent of R_6, it follows that the resistances R_1, R_2, R_3 and R_3 must form a balanced Wheatstone bridge

87 **(b)**

$$I = \frac{E - E_1}{R'} = \frac{E - E_2}{R + R'}$$



$$\frac{E-E_2}{E-E_2}=\frac{R'}{R+R'}$$
$$\frac{E-E_2}{E-E_2}=\frac{R}{R'}$$
$$I=\frac{E_1-E_2}{R}$$

88 **(c)**

When hot, $R=\frac{V^2}{P}=\frac{200\times200}{100}=400\Omega$

Hence, when cold, the resistance is 40 Ω

89 **(c)**

In the case of discharging $I=I_0e^{-t/RC}$

Or $2.5\times10^{-6}=\frac{q_0}{RC}e^{-t/RC}$

Or $2.5\times10^{-6}=5\times10^{-6}e^{-t/10}$ or $e^{t/10}=2$

Taking log on both the sides, we get

$\frac{t}{10}=\text{In }2$ or $t=10\text{ In }2=6.9\cong7$ sec

90 **(a)**

Energy consumed in 9.5 min is

$2.5\times1000\times9.5\times60$ J = 1425000 J

Heat usefully consumed is

$3\times4.2\times1000\times(100-15)$J = 1071000 J

Loss = 3.54×10^5J

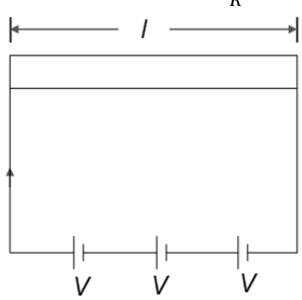
91 **(b)**

Let R be the resistance of rod

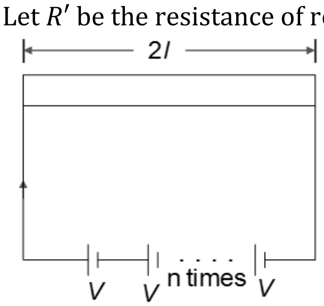
Energy released in t seconds = $\frac{(3V^2)}{R}\times t$

$$\therefore Q=\frac{(9V^2)}{R}\times t$$

But $Q=mc\Delta T=\frac{(9V^2)}{R}\times t$ (i)



Let R' be the resistance of rod



$\Rightarrow R'=2R$ (as length is twice)

Therefore, energy released in t seconds

$=\frac{(NV^2)}{2R}\times t$

$$\therefore Q'=\frac{(N^2V^2)}{2R}\times t$$

Applying $Q'=m'c\Delta T$, we get

$2mc\Delta T=\frac{(N^2V^2)}{2R}\times t$ (ii)

Diving Eq. (ii) by Eq. (i), we get

$$\frac{mc\Delta T}{2mc\Delta T}=\frac{9V^2\times t/R}{N^2V^2t/2R}$$

$$\therefore\frac{1}{2}=\frac{9\times2}{N^2}\Rightarrow N^2=18\times2$$

$\therefore N=6$

92 **(b)**

$$\frac{I_1}{I_2}=\frac{R_2}{R_1},\frac{I_1}{I_2}=\frac{\rho L_2}{A_2}\times\frac{A_1}{\rho L_1}$$

Or $\frac{I_1}{I_2}=\left(\frac{L_2}{L_1}\right)\left(\frac{A_1}{A_2}\right)$ or $\frac{I_1}{I_2}=\left(\frac{L_2}{L_1}\right)\left(\frac{\pi r_1^2}{\pi r_2^2}\right)$

$$=\frac{L_2r_1^2}{L_1r_2^2}=\frac{3}{4}\left(\frac{2}{3}\right)^2=\frac{3}{4}\times\frac{4}{9}=\frac{1}{3}$$

93 **(d)**

96500 *coulombs* of charge is needed to deposit one gram equivalent of an element at an electrode

94 **(c)**

Charge = area under the current-time graph

$q_1=2\times1=2, q_2=1\times2=2$ and $q_3=\frac{1}{2}\times2\times2=2$

$q_1:q_2:q_3=2:2:2=1:1:1$

95 **(b)**

According to Kirchhoff's first law, a junction can act neither as a source of charge nor as a sink of charge. This supports the law of conservation of charge. According to Kirchhoff's second law, the energy per unit charge transferred to the moving charges is equal to the energy per unit charge transferred from them. This supports the law of conservation of energy

96 **(c)**

The rate of heat developed is given by

$\frac{V^2}{R}=\frac{(210)^2}{20}=2205\text{ Js}^{-1}=\frac{2205}{4.2}\text{ cals}^{-1}$

Let m be the amount of ice melting per sec and , then

$m\times80=\frac{2205}{4.2}$ or $m=6.56\text{ gs}^{-1}$

97 **(a)**

Current in $AB=I=\frac{e}{R+r}$

p.d. across $AB=IR=\frac{eR}{R+r}$

to obtain balanced point: $\frac{eR}{R+r}>\frac{e}{3}\Rightarrow R>r/2$

98 **(a)**

The current taken by the silver voltameter

$$I_1 = \frac{n}{Zt} = \frac{1}{11.2 \times 10^{-4} \times 30 \times 60} = 0.496\ A$$

and by copper voltameter

$$I_2 = \frac{1.8}{6.6 \times 10^{-4} \times 30 \times 60} = 1.515\ A$$

The current $I = (I_1 + I_2) = 2.011\ A$

Power $P = IV = 2.011 \times 12 = 24.132\ J/sec$

99 **(d)**

$V_A + 3 - 3 - 18 = V_B$ or $V_A - B_B = 18$ V

100 **(c)**

$$R_s = \frac{SG}{S+G} = \frac{111 \times 3663}{111 + 3663} = 107.7\ \Omega$$

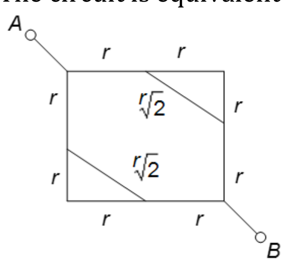
101 **(a)**

The equivalent resistance of resistors is

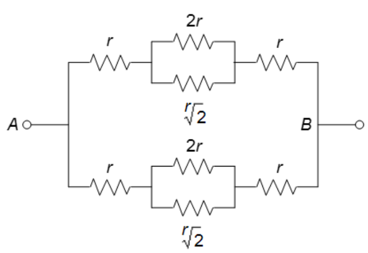
$R = 2 + \frac{4}{2} + \frac{15}{3} = 9\Omega, I = \frac{E}{r+R} = \frac{10}{1+9} = 1A$

102 **(a)**

The circuit is equivalent to



Let each half side has resistance $\rho r d/2$



On solving, we get

$$R = \frac{1}{2}\left[2r + \frac{(2r(r\sqrt{2}))}{(2+\sqrt{2})r}\right] = r\sqrt{2}$$

$= \rho d/\sqrt{2}$

103 **(c)**

$$a = \frac{1}{R_1}\frac{dR_1}{dt} \Rightarrow a = \frac{1}{R_1}R_0[a + 2\beta t]$$

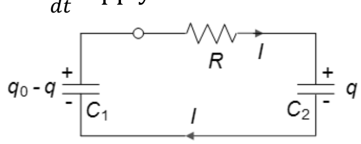
$$= \frac{R_0[\alpha + 2\beta t]}{R_0[1 + \alpha t + \beta t^2]} = \frac{\alpha + 2\beta t}{1 + \alpha t + \beta t^2}$$

104 **(a)**

Maximum current flows through bulb 1

105 **(b)**

$I = \frac{dq}{dt}$: apply Kirchhoff's law: $\frac{q_0 - q}{C_1} = IR + \frac{q}{C_2}$



$$\frac{q_0}{C_1} - q\left[\frac{C_1 + C_2}{C_1 C_2}\right] = \frac{dq}{dt}R$$

$$\int_0^q \frac{dq}{\frac{q_0}{C_1} - q\left(\frac{C_1+C_2}{C_1C_2}\right)} = \int_0^t \frac{dt}{R}$$

Solve to get: $q = \frac{q_0 C_2}{C_1 + C_0}\left[1 - e^{\frac{t(C_1+C_2)}{C_1C_2R}}\right]$

106 **(c)**

Here, $I_1 = \frac{V}{R}e^{-t/RC}$, $I_2 = \frac{V}{R}e^{-t/2RC}$

$$\therefore\ \frac{I_1}{I_2} = e^{-t/2RC + t/2RC} = e^{-t/2RC} = \frac{1}{e^{t/2RC}}$$

From this expression, it is clear that when t increases, ratio decreases

107 **(b)**

If P is disconnected, R_{eq} of circuit increases hence less current is drawn. Therefore,

$0 + 2\ iR_1 - x$

Therefore, a i decreases, x increases

108 **(d)**

Use resistance in parallel and series combination

109 **(b)**

$$P = \frac{V^2}{R}, \frac{P_1}{R_2} = \frac{R_2}{R_1} \Rightarrow r_2 = 2r_1$$

110 **(b)**

C discharges through $R + R$ in series

111 **(d)**

Suppose V is the voltage of the supply and R is the resistance of each bulb

Now, $R_P = R/3$ and current in ammeter,

$I = V/R_P = 3V/R$,

Provided all three bulbs are working properly

If one bulb has broken down, then

$R_P = \frac{R}{2}$ and $I = 2\frac{V}{R}$

Therefore, current decreases and since current through each bulb is V/R the same as before, brightness of bulbs is not affected

112 **(b)**

$$H = \int_0^4 \frac{E^2}{R}dt = \int_0^4 \frac{(6t)^2 dt}{12} = 14\ \text{J}$$

113 **(d)**

L is the latent heat of vaporization of water, the heat required for producing 1 g of steam,

$L = 540$ cal $= 540\ \times 4.2 = 2268$ J

Energy supplied $= 1080$ Js^{-1}

Time required to boil 100 g of water

$t = 540 \times 4.2\ \times 100/1080 = 210$ s

114 **(b)**

In case of internal resistance measurement by potentiometer,

$$\frac{V_1}{V_2} = \frac{l_1}{l_2} = \frac{[ER_1/(R_1 + r)]}{[ER_2/(R_2 + r)]} = \frac{R_1(R_2 + r)}{R_2(R_1 + r)}$$

Here $l_1 = 2\text{m}, l_2 = 3 \text{ m}, R_1 = 5\ \Omega$ and $R_2 = 10\ \Omega$

$\therefore\ \frac{2}{3} = \frac{5(10+r)}{10(5+r)}$ or $r = 10\ \Omega$

115 **(a)**

The current in the circuit $I = (12/12) = 1$ A

Potential across d and $c = 12$ V -3×1 V $= 9$ V

Capacitance across $d$and e is $C = \frac{1\times2}{1+2} = \frac{2}{3}\mu$F

Therefore, charge on either capacitor is

$\frac{2}{3} \times 9 = 6\mu$C

116 **(b)**

$$U = \frac{1}{2}CV^2 = \frac{1}{2}C(2IR)^2 = 2I^2R^2C$$

117 **(a)**

Let resistors P, Q and R have resistance r. The effective resistance across the source is

$R_{\text{eff}} = r + r \parallel r = r + \frac{(r)(r)}{r+r} = r + \frac{r}{2} = \frac{3r}{2}$

Current drawn from source is

$I_S^2\ R_{\text{eff}} = 12$

$\Rightarrow\ \ I_2 = \sqrt{\frac{12}{R_{\text{eff}}}} = \sqrt{\frac{8}{r}}$ A

Since Q and R have equal resistance r, each draws a current of I which is given by

$I = \frac{1}{2}I_s = \sqrt{\frac{2}{r}}$ A

Head dissipation in R can now be determined and is given by

$I^2 r = \left(\frac{2}{r}\right) r = 2$ W

118 **(d)**

$$H = I^2Rt = \frac{1}{\pi r^2}t$$

119 **(c)**

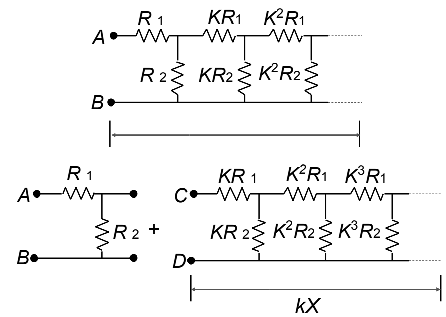
$$2 = \frac{12}{\frac{R}{3} + 0.6} \Rightarrow \frac{R}{3} + 0.6 = 6 \Rightarrow R = 16.2\Omega$$

120 **(a)**

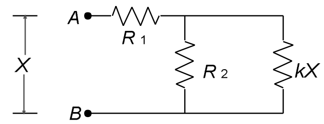
The value of $E =$ Potential gradient × length (5 mV/m)(60 cm)=3 mV

121 **(c)**

When each element of the circuit is multiplied by a factor k, then the equivalent resistance also becomes k times. Let the equivalent resistance between A and B be



So the equivalent circuit becomes



$$X = R_1 + \frac{kXR_2}{kX + R_2}$$

For $k = \frac{1}{2}\ \Rightarrow X = \frac{(R_1-R_2)+\sqrt{R_1^2+R_2^2+6R_1R_2}}{2}$

122 **(b)**

We know that $R = \frac{V}{I_g} - G$

The voltmeter give the full-scale deflection for potential difference V. Its resistance is G. Hence, $I_g = (V/G)$.

Given that $V = nV$

$$\therefore R = \frac{nV}{(V/G)} - G = (n-1)G$$

123 **(b)**

$v_d = \frac{eE}{m}\tau = \frac{e\tau}{m}\frac{V}{l} \Rightarrow v_d \propto 1/l$. If l is doubled, v_d gets halved

124 **(b)**

As the capacitors are identical, each of them finally have charge $Q/2$

Initial energy of the system $= E_i = \frac{Q^2}{2C}$

Final energy of the system$= E_f = 2\left[\frac{(Q/2^2)}{2C}\right] = \frac{Q^2}{4C}$

Heat produced = loss in energy $= E_i = E_f = \frac{Q^2}{4C}$

125 **(d)**

Potential difference across the central limb = 16 V = potential difference across 16 Ω = potential difference

Across the left limb

Current through 16 Ω= 1 A

Current through the left limb = 1 A and $R = 11\ \Omega$

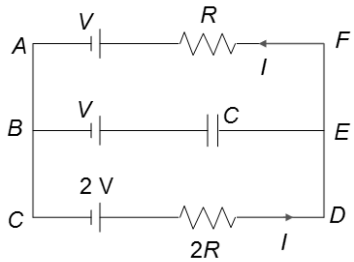
$$\therefore \tau_C = \left(\frac{16}{2} + 2\right)\Omega \times 4(4 \times 10^{-6})F = 40\ \mu\text{s}$$

126 **(c)**

Power lost = 25 × 25 × 10 W = 6250 W = 6.25 kW

127 **(c)**

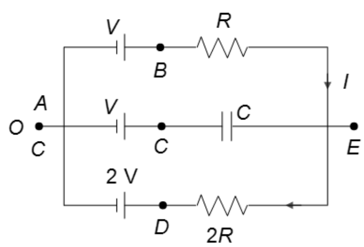
Method I: In this, there will be no current flowing in branch BE in steady condition. Let I be the current flowing in the loop $ABCDEFA$. Applying Kirchhoff's law in the loop moving in anticlockwise direction starting from $C + 2V - I(2R) - I(R) - V = 0 \Rightarrow V = 3IR \Rightarrow I = V/3R$. Applying Kirchhoff's law in the circuit $ABEF/A$ we get on moving in anticlockwise direction starting from B



$+V + V_{\text{cap}} - IR - V = 0$ where V_{cap} is the potential difference across capacitor

$\therefore V_{\text{cap}} IR = \left(\frac{V}{3R}\right) \times R = \frac{V}{3}$

Method II



Let us consider A to be at OV. Then points B, C and D will be at V, V and $2\,V$, respectively. Let the current be flowing in the clockwise direction. Applying Kirchhoff's law in the outer loop, we get $V - IR - I(2R) - 2V = 0$

$\therefore I = -V/3R$. The minus sign here indicates that the current is in the opposite direction to what we have assumed. Applying Kirchhoff's law from A to E via B, we get $V_A + V + IR = V_E$

$\therefore 0 + V + \frac{V}{3R} \times R = V_E = \frac{4\,V}{3}$

Again applying Kirchhoff's law from A to E via C, we get

$V_A + V + V_{\text{cap}} = V_c \;\therefore V_{\text{cap}} = \frac{V}{3}$

128 **(c)**

During charging, $\tau_1 = RC$; during discharging, $\tau_2 = 2RC$

Therefore, ratio $= \frac{\tau_1}{\tau_2} = \frac{1}{2} = 1:2$

129 **(c)**

We will require a voltmeter, an ammeter, a test resistor and a variable battery to verify Ohm's law. Voltmeter which is made by connecting a high resistance with a galvanometer is connected in parallel with the test resistor.

Further, an ammeter which is formed by connecting a low resistance in parallel with galvanometer is required to measure the current through test resistor.

The correct option is (c).

130 **(a)**

$H = V^2 t/R$. When voltage is halved, the heat becomes one-fourth. Hence, time taken to heat the water becomes four times

131 **(a)**

A and B are effectively in parallel and hence give the same reading every time

132 **(c)**

Initially, all three capacitors are in parallel

$E_1 = \frac{1}{2} \times 3CV^2 = \frac{3}{2} CV^2$

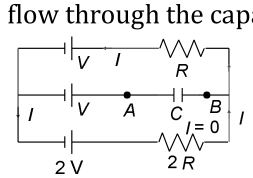
When key is closed, two capacitors are in series

$E_f = \frac{1}{2} C \left(\frac{V}{2}\right)^2 \times 2 = \frac{CV^2}{4}$

$\Delta E = E_1 - E_f = \frac{5}{4} CV^2$

133 **(c)**

In the steady-state conduction, no current will flow through the capacitor C



Current in the outer circuit, $I = \frac{2V - V}{2R + R} = \frac{V}{3R}$

Potential difference between A and B is

$$V_A - V + V + IR = V_B \Rightarrow V_B - V_A = IR + \left(\frac{V}{3R}\right) R = \frac{V}{3}$$

134 **(d)**

$R_{200} = \frac{200 \times 200}{100} = 400\Omega$

So, $400 = R_0[1 + 0.005 \times 2000]$

$\therefore R_0 = \frac{400}{11}\Omega \approx 36\ \Omega$, Hence, current $I = \frac{200}{R_0} = 5.5\text{A}$

135 **(d)**

$R = \frac{1}{\sigma} \times \frac{t}{4\pi R^2}$

Using values, $R = 5 \times 10^{-11}\Omega$

136 **(b)**

$P = \frac{V^2}{R}$ or $P = \frac{V^2 a}{\rho \ell} = \frac{V^2 \pi r^2}{\rho \ell}$

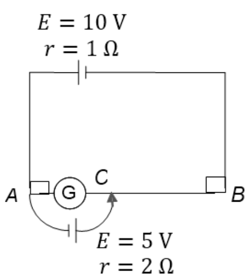
137 **(b)**

The given problem may be approached in a simplified manner by the following considerations. Since the resistances R and R are in series with the battery in the steady state, the potential difference across R(which charges the capacitor) will have the maximum value of $E/2$. Also if the battery is absent, and the (charged) capacitor were to discharged, the two resistors R and R will be connected in parallel, i.e. the effective resistance across the capacitor is $R/2$ and hence the time constant in the circuit is $\tau = RC/2$. Thus, the growth of the potential in the capacitor will be given by

$$V(t) = \frac{E}{2}\left[1 - \exp\left(-\frac{t}{\tau}\right)\right] = \frac{E}{2}\left[1 - \exp\left(-\frac{2t}{RC}\right)\right]$$

138 **(a)**

Potential difference across AC is zero



$5 - 2I = 0$

$I = 2.5A$

Let the resistance of part BC be r

Applying KVL, we get

$10 + 5 - 2I - Ir - I = 0$

$2.5r = 7.5 \Rightarrow r = 3\Omega$

As resistance of part $AB = 9\Omega$,

Length $AC = 66.7$ cm

139 **(d)**

$P = VI \Rightarrow 50 = 5 \times I \Rightarrow I = 10$ A

Power lost in cable $= I^2R = 10 \times 10 \times 0.2 = 2$ W

Power supplied to the tape recorder = 50 W – 2 W = 48 W

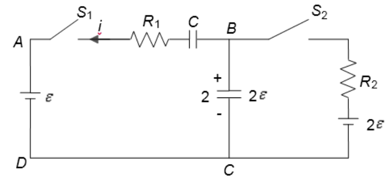
140 **(c)**

Let the length of each wire be l and A be the area of cross section of each wire. Let us consider a single rod of same dimension (i.e., length $2l$, Area A) as of composite rod. If resistance of the single rod is the same as that of composite rod, then the resistivity of single rod will become equivalent resistivity of the composite rod. Therefore,

$$R = R_1 + R_2 \Rightarrow \frac{\rho 2l}{A} = \frac{\rho_1 l}{A} + \frac{\rho_2 l}{A} \Rightarrow \rho = \frac{\rho_1 + \rho_2}{2}$$

141 **(b)**

Just before S_1 is closed, the potential difference across capacitor 2 is 2ε



Just after S_1 is closed, the potential differences across capacitors 1 and 2 are 0 and 2ε, Respectively. Applying KVL to loop $ABCD$ immediately after S_1 is closed,

$\varepsilon = -iR_1 + 02\varepsilon, i = \frac{E}{R_1}$ towards left

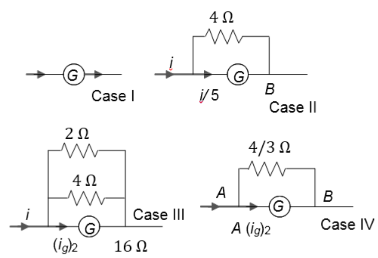
142 **(b)**

$P/Q = R/S$. If P is increased then either R or Q should be increased or S should be decreased

143 **(a)**

When only 4 Ω resistance is shunted $(i_g) = i/5$

$G \times i/5 = 4 \times (4/5) \Rightarrow G = 16\Omega$



144 **(d)**

Voltage across 5 Ω=10 V

$\therefore\ I = \frac{10}{5}$ A=2 A

145 **(b)**

When current is doubled, heating effect increase four times. Now, $Q \propto \Delta T$. So, ΔT increases four times

146 **(a)**

Current flowing through both the bars is equal. Now, the heat produced is given by

$H = I^2Rt$

$H \propto R$ or $\frac{H_{AB}}{H_{BC}} = \frac{R_{AB}}{R_{BC}}$

$= \frac{(1/2r)^2}{(1/r)^2} \qquad \left(\text{as } R \propto \frac{1}{A} \propto \frac{1}{r^2}\right)$

$= \frac{1}{4}$ or $H_{BC} = 4H_{AB}$

147 **(c)**

In element A, the resistance remains constant up to the potential drop of 10 V. further increase in the voltage does not increase this current (which is constant at 1 A). This means that the ratio V/R_A= constant and this resistance R_A increases linearly with voltage

In element$B$, the resistance decreases gradually up to 15 V and afterwards the resistance R_B increase linearly with voltage. When both A and B

in series, the curret in the circuit will increase nonlinearly up to 1 A when the total voltage drop across A and B becomes $10 + 15 = 25$ V. Further increase in this voltage does not bring about any change in the current as shown in option (c). the voltage drop across A will go on increasing while that across B remains fixed at 15 V

148 **(c)**

v_d is independent of thickness

149 **(a)**

Total range is doubled, i.e., $4I_g$

Now shunt required, $S = \frac{I_g}{4I_g - I_g} \times G = 10\ \Omega$

$\frac{1}{30} + \frac{1}{x} = \frac{1}{10} \Rightarrow x = 15\ \Omega$

150 **(d)**

Initial charging rate = initial current in the line of capacitor

$= i = 2E/5R$

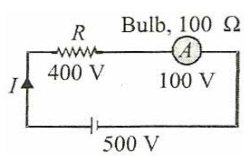
Steady state p. d. across capacitor is

$V_0 = \frac{2}{3}E \Rightarrow q_0 = CV_0 = \frac{2}{3}EC$

$t = \frac{q_0}{i} = \frac{(2/3)EC}{2E/5R} = \frac{5}{3}RC$

151 **(c)**

Resistance of bulb: $R_b = \frac{V^2}{P} = \frac{(100)^2}{100} = 100\ \Omega$



If bulb consumes 100 W, then p. d. across the bulb should be 100 V. So $I = 100/100 = 1$ A. And p.d. across $R = 500 - 100 = 400$ V

So $R = \frac{400}{I} = \frac{400}{1} = 400\ \Omega$

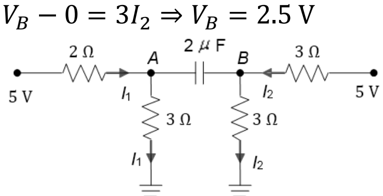
152 **(b)**

$I_1 = \frac{5}{2+3} = 1$ A

$I_2 = \frac{5}{3+3} = \frac{5}{6}$A

$V_A - 0 = 3I_1 \Rightarrow V_A = 3$V

$V_B - 0 = 3I_2 \Rightarrow V_B = 2.5$ V



Potential difference across capacitor is

3 V – 2.5 V = 0.5 V = 1/2 V

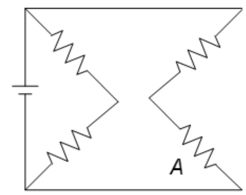
$q = CV = 2 \times 1/2 = 1$ μC

153 **(a)**

In a Wheatstone bridge, the deflection in the galvanometer does not change if the battery and galvanometer are interchanged

154 **(d)**

This is a dc circuit because the battery is the only source of voltage. Hence, the capacitor behave like open circuits. An equivalent circuit is then two parallel sets of two identical series resistor (see Fig.). The voltage drop across each parallel branch must be the battery voltage of 3 V. since the resistor are identical, there is an equal voltage drop of 1.5 V across each resistor. In particular, there is a drop of 1.5 V across resistor A



155 **(b)**

Circuit is forming a Wheatstone bridge, so $R = 2R$

For the maximum power transfer, $2R = r$

156 **(a)**

As both bulbs are in series, current through them will be the same. But resistance of 25 W bulb is more. Hence from the relation $P = I^2R$, the 25 W bulb will glow more brightly

157 **(a)**

$3 = IR_1$ or $3 = 1 \times R_1$ or $R_1 = 3\ \Omega$

When points A and B are connected by a conducting wire, R_2 is short-circuited.

$\therefore 10.5 = I'R_1$ or $10.5 = I' \times 3$

$\therefore \quad I' = \frac{10.5}{3} = 3.5$A

But $10.5 = E - I'r$ or $10.5 = 12 - 3.5\,r$

$\therefore r = \frac{1.5}{3.5} = \frac{3}{7}\ \Omega$

158 **(b)**

$P = 200 \times 3.75$ W $= 750$ W ≈ 1 hp

159 **(d)**

At $t = 0$, the potential difference across the top 2 μF capacitor = 0. Therefore, $I = 10/2 = 5$ A

160 **(b)**

$P = \frac{V^2}{\rho\frac{\ell}{a}} \Rightarrow P \propto \frac{1}{\ell}, P' \propto \frac{1}{\ell - \frac{10}{100}\ell}$

$\frac{P'}{P} = \frac{10}{9} \Rightarrow \left(\frac{P'}{P} - 1\right) \times 100 = \left(\frac{10}{9} - 1\right) \times 100$

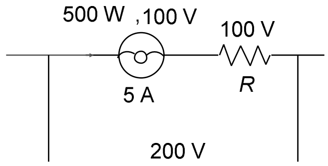
$\frac{P' - P}{P} \times 100 = \frac{100}{9} \approx 11$

161 **(c)**

When the car is started, the starter draws high current, then due to this high current, large potential is dropped across the internal resistance of the battery, so terminal p.d. ($V = E = Ir$) becomes less, due to which light dims

162 **(b)**

$P = VI, I = \frac{P}{V}$ or $I = \frac{500\text{W}}{100\text{V}}$= 5 A



Now, $5\,R = 100$ or $R = 20\ \Omega$

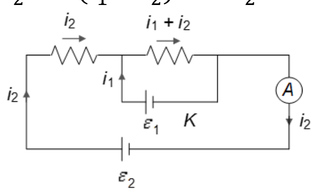
163 **(d)**

When $r = 0$ the terminal potential difference in the arm containing R_1 remains unchanged, so the ammeter reading does not change

164 **(b)**

$R(i_1 + i_2) = E_1$

$i_2 R + (i_1 + i_2)R = E_2$



$$i_2 = \frac{E_2 - E_1}{R}$$

[Initially, $E = E_2/R$]

165 **(a)**

Since all the three resistors are in series the same current will flow through them. Their resistance are given by $R = V^2/P$

$$R_{40} = \frac{240 \times 240}{40} = 1440\Omega$$

$R_{60} = 960\Omega$ and $R_{100} = 576\Omega$

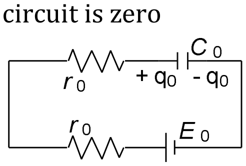
Total resistance $R = 2976\Omega$

$I = \frac{240}{2976} = 0.0806\text{A}$

Potential difference across the 40 W bulb = 1440 × 0.0806 = 116 V

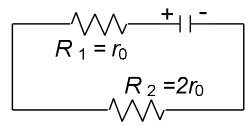
166 **(c)**

Step I: when the switch is at position 1: Since circuit is in the steady state, the current through circuit is zero



According to the loop rule, $E_0 - \frac{q_0}{C_0} = 0 \Rightarrow q_0 = C_0 E_0$

Step II: When the switch is at position 2: In this case, the total energy stored on the capacitor appears as heat energy in the resistor



$\therefore \Delta H = I^2 RT, \therefore \Delta H \propto R$

$$\therefore \frac{\Delta H_1}{\Delta H_2} = \frac{R_1}{R_2} = \frac{r_0}{2r_0} = \frac{1}{2} \Rightarrow \Delta H_2 = 2\Delta H_1$$

But $\Delta H = \Delta H_1 + \Delta H_2 = \frac{\Delta H_1}{2} + \Delta H_2 = \frac{3}{2}\Delta H_2$

$$\therefore \Delta H_2 = \frac{2}{3}\Delta H = \frac{2}{3} \times \frac{1}{2} C_0 E_0^2 = \frac{1}{3} C_0 E_0^2$$

167 **(b)**

$\frac{I_g}{I} = \frac{S}{S+G}$ or $\frac{1}{34} = \frac{S}{S+G}$

$\therefore\ S = (G/33) = (3663/33) = 111\ \Omega$

168 **(a)**

$$i = \frac{(n-2)\varepsilon}{nr}$$

$V_B - V_A = -ir + \varepsilon = \varepsilon - \frac{(n-2)\varepsilon}{nr} r = \varepsilon\Big[1 -$

n−2n= 2εn

169 **(a)**

The resistance in the middle plays no part in the charging process of C, as it does not alter either the potential difference across the RC combination or the current through it

170 **(a)**

Net resistance of circuit, $R = \frac{10\times5}{10+5} + \frac{10\times5}{10+5} = \frac{20}{3}\Omega$

Heat generated in circuit per minute is

$Q = I^2 Rt = (10)^2 \times \frac{20}{3} \times (10 \times 60) = 4 \times 10^5\text{J} = \frac{4\times10^5}{4.2\times10^3}$ kcal

$m = \frac{Q}{L} = \frac{4\times10^5}{4.2\times10^3\times80} = 1.19$ kg

171 **(b)**

Let a current of x ampere pass through the voltmeter; then $(4-x)$ ampere passes through the resistance R

Therefore, voltmeter reading is

20= $(4-x)R$, i.e., $R = \frac{20}{4-x}$, i.e., $R > 5\ \Omega$

172 **(c)**

$$R = \frac{\rho(L)}{A} = \frac{\rho L}{tL} = \frac{\rho}{t}$$

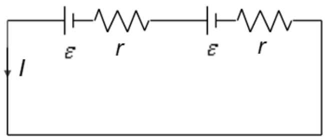
ie, R is independent of L.

Hence the correct option is (c).

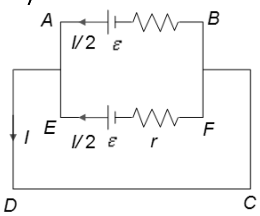
173 **(b)**

When the terminals of a single cell are directly connected, current obtained is $I = \varepsilon/r$.

If both are connected in series, then $I = 2\varepsilon/2r = \varepsilon/r$

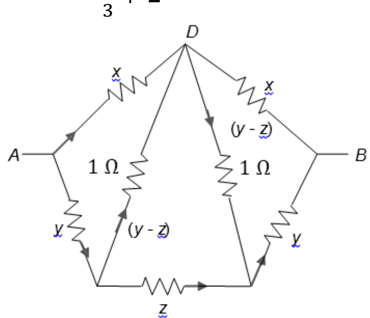


If both are connected in parallel then, apply Kirchhoff's law for loop $ABCD$: $\varepsilon - \left(\frac{I}{2}\right)r = 0 \Rightarrow 2\varepsilon/r$

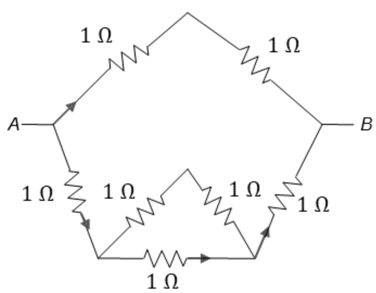


174 **(c)**

$$R_{\text{equal}} = \frac{\frac{8}{3}\times 2}{\frac{8}{3}+2} = \frac{16}{14} = \frac{8}{7}\Omega$$

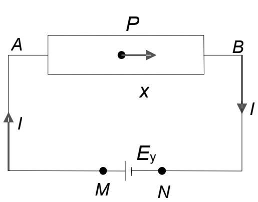


The charge x passing between A and D will entirely pass to $DA2$. So, we can detach the circuit at point D and shown in Figure



175 **(b)**

If we move from P to B, the potential will decrease. From B to N, there is no change in the potential. From N to M, the potential will increase, but increase in potential will be $E - Ir (< E)$

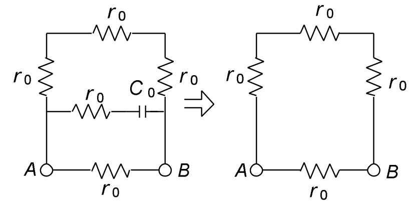


Finally, we return to the same potential at P

176 **(a)**

In the steady state, the current through capacitor branch is zero. So, the capacitor branch may be removed

$$R_{\text{eq}} = \frac{r_0 \times 3r_0}{r_0 + 3r_0} = \frac{3}{4}r_0$$



177 **(c)**

Notice the polarities of the batteries. The batteries will cancel each other and finally there will be no current anywhere in the circuit

178 **(b)**

Let σ is the surface charge density. Length entering per unit time into the sphere 0.30m/s

Area entering per unit time into the sphere is $0.50 \times 0.30\ \text{m}^2/\text{s} = 0.15\text{m}^2/\text{s}$

Charge entering per unit time into the sphere is $\sigma(0.15)$

This is equal to the current which is given to be 10^{-4} A

$$\Rightarrow \sigma(0.15) = 10^{-4} \Rightarrow \sigma = \frac{100}{15} \times 10^{-4}$$
$$= 6.7 \times 10^{-4}\text{C/m}^{-2}$$

179 **(d)**

$$P = VI; I = \frac{P}{V} = \frac{250 \times 1000}{10000}\text{A} = 25\text{A}$$

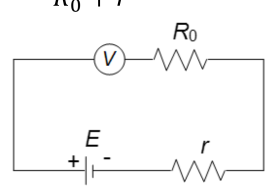
180 **(a)**

$R_0 = 2500\ \Omega$

$E = 125$ V

When r I connected in series

$$i = \frac{E}{R_0 + r}$$

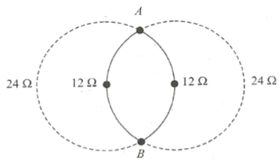


Reading in voltmeter $= E - ir = 100$

$$\therefore 100 = 125 - \frac{125}{2500 + r} \times r$$

$$\Rightarrow \quad r = 625\ \Omega$$

181 **(b)**



Form Figure, we get

$AC_1 = AC_2 = C_1C_2 =$ radius

$\angle AC_1B = 120°$

The resistances of the four sections are 24, 12, 12 and 24 Ω

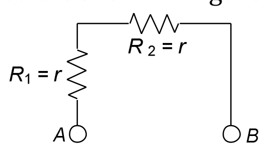
Hence, equivalent resistance R across AB is

$\frac{1}{R} = \frac{1}{24} + \frac{1}{12} + \frac{1}{12} + \frac{1}{24}$ or $R = 4\Omega$

Therefore, power $= \frac{v^3}{R} = \frac{(20)^2}{4} = 100$ W

182 **(a)**

In the steady state, no current is flowing through the capacitor branch, so the capacitor branches may be removed from the circuit, the equivalent circuit is shown in figure



$\therefore R_{AB} = R_1 + R_2 = r + r = 2r$

183 **(c)**

The bridge is balanced and the current in the ADC is larger than in the art ABC. Also $I = 0$

184 **(b)**

When switch S_1 is open

$\frac{6}{E} = \frac{L}{2}\Big/L = \frac{1}{2}$

$\therefore \; E = 12$ V

When switch S_2 is closed, we get

$\frac{6 \times 10}{10 + r} = \frac{5L}{12L}E = \frac{5}{12} \times 12 = 5$

$\therefore 10 + r = 12$ or $r = 2\Omega$

185 **(d)**

For balanced meter bridge (null deflection), we get

$\frac{55}{R} = \frac{20}{80}$ or $R = 220\Omega$

186 **(c)**

The equivalent capacitance C_{eq} is

$\frac{1}{C_{\text{eq}}} = \frac{1}{2} + \frac{1}{3} = \frac{5}{6}$

$C_{\text{eq}} = \frac{6}{5}\,\mu\text{F}$

The charge that flows from P to Q is

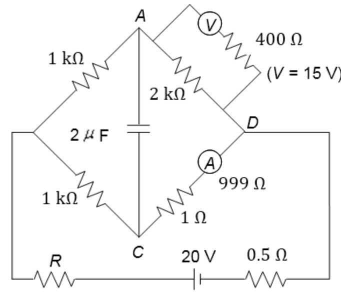
$Q = C_{\text{eq}}\text{V}$

$= \frac{6}{5} \times 5$

$= 6\mu C$

187 **(d)**

From figure



$V_A - V_D = 15$ V

and $V_C - V_D = iR$

$= 15 \times 10^{-3} \times (1 + 999) = 15$V

$V_A - V_C = 15 - 15 = 0$

Energy stored $= 0$

188 **(a)**

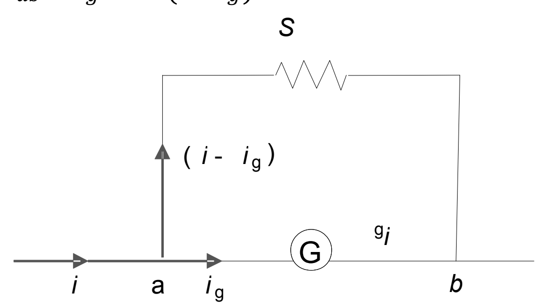
$Q = at - bt^2 \;\Rightarrow\; i = dQ/dt = a - 2bt$

$i = 0$ for $t = t_0 = a/2b$, i.e., current flows from $t = 0$ to $t = t_0$

The heat produced $= \int_0^{t_0} i^2 \; R\,dt = a^3R/6b$

189 **(a)**

$V_{ab} = i_g.G = (i - i_g)S$



$\therefore \;\; i = \left(1 + \frac{G}{S}\right)i_g$

Substituting the values we get,

$i = 100.1$mA

190 **(a)**

This is a case of balanced Wheatstone bridge

191 **(c)**

$V = E - \frac{E}{R + r}r \Rightarrow V = E - \frac{E}{r + r}r \Rightarrow V = \frac{E}{2}$

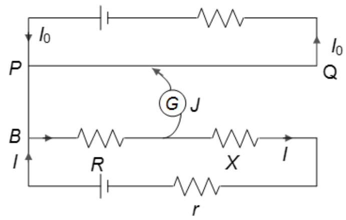
192 **(d)**

In steady state, there will be no current in any branch

So A and D will be at the same potential. Hence, charge on capacitor between A and D will be zero

193 **(a)**

In potentiometer wire, potential difference is directly proportional to length, let the potential drop of unit length of a potentiometer wire be K



For zero deflection, the current will flow independently in two circles:

$IR = K \times 10$ (i)

$IR + IX = K \times 30$ (ii)

Subtracting Eq. (ii) from Eq. (i), we get

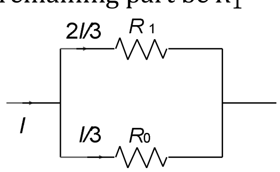
$IX = k \times 20$ (iii)

Dividing Eq. (i) by Eq. (ii), we have

$\frac{R}{X} = \frac{1}{2}$

194 **(c)**

We will solve this problem by the superposition principle. Let current I Enters at A, then current $I/6$ will flow through AB. Now, in the second case, let the current is extracted from B, again current $I/6$ will flow through AB, Now, if simultaneously current enters at A and leaves at B, then the current $I/6 + I/6 = I/3$ should flow through AB and current $I - I/3 = 2I/3$ will flow through the remaining part. Let the resistance of the remaining part be R_1



Now $\frac{R_0 I}{3} = \frac{R_1 2I}{3} \Rightarrow R_1 = \frac{R_0}{2}$

$$R_{eq} = \frac{R_1 R_0}{R_1 + R_0} = \frac{(R_0/2)R_0}{(R_0/2) + R_0} = \frac{R_0}{3}$$

195 **(d)**

$(0.1 + 0.3 + 0.6)\, i_1 = (9 + 0.9) \times 10$

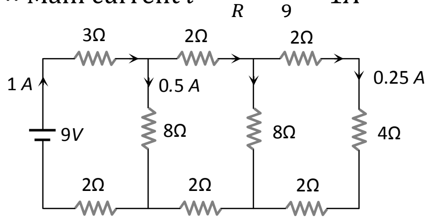
$i = 99$ mA

$I = (99 + 10)$ mA $= 0.109$ A

196 **(d)**

Equivalent resistance of the circuit $R = 9\Omega$

$\therefore$ Main current $i = \frac{V}{R} = \frac{9}{9} = 1A$



After proper distribution, the current through 4Ω resistance is $0.25\ A$

197 **(b)**

The current through the galvanometer producing full scale deflection is

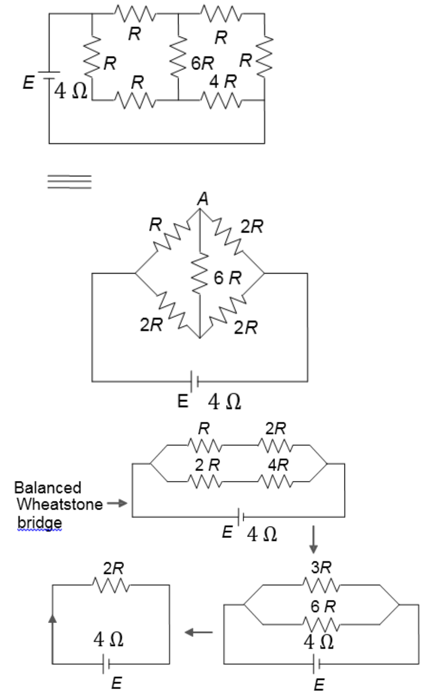
$$I = \frac{V}{R} = \frac{20 \times 10^{-3}}{80} = 2.5 \times 10^{-4} \text{ A}$$

To convert the galvanometer into a voltmeter, a high resistance is connected in series with the galvanometer

$\therefore$ $5\text{V} = (2.5 \times 10^{-4})(R + 80)$ or $R = 19.92$ kΩ

198 **(b)**

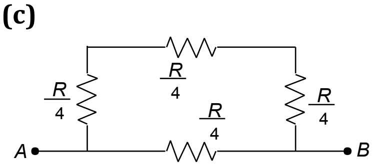
For the maximum power



External resistance = Internal resistance

$\therefore 2R = 4, R = 2$

199 **(c)**



$$R_{AB} = \frac{3R}{16} = \frac{3(16)}{16} = 3\Omega$$

200 **(d)**

We know that resistivity $\rho \propto \frac{1}{\tau}$, where τ is the relaxation time. On increasing the temperature, τ decreases so resistivity or resistance increases

201 **(a)**

Resistors 7Ω and 3Ω are in parallel; 6Ω and 4Ω are in parallel and both in series

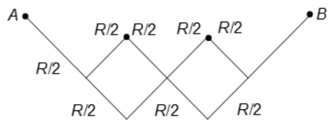
So $R_{eq} = \frac{7\times3}{7+3} + \frac{4\times6}{4+6} = 4.5\Omega$

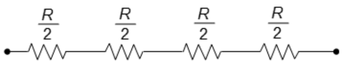
202 **(d)**

$I = nAev_d$ or $v_d \propto \frac{1}{A}$ or $v_d \propto \frac{1}{r^2}$

203 **(b)**

The circuit can be folded about B and redrawn as





Hence, the equivalent resistance between A and B is $2R$

204 **(b)**

When a source is connected, a current starts to flow through the conductor. Let it be$I$. Then current density at a section is equal toI/A, where $A=$ cross-sectional area.

Since cross-sectional area at P is maximum, current desnity at P is minimum.

Since electric field is $\frac{J\prime}{\sigma}\left(-\frac{1}{A\sigma}=\frac{I\rho}{A}\right)$, at P elecric field is

Minimum while that at Q is maximum

Rate of generation of heat per unit length at a section will be equal to$I^2\rho/A$. It is minimum at P and maximum at Q

The mean kinetic energy of free electrons= $\frac{1}{2}mv_d^2$ which is minimum at P and maximum at Q

205 **(c)**

$E=\frac{\lambda}{2\pi\varepsilon_0 r'}$, where λ is the linear charge density of the inner cylinder

And $V=\int_a^b Edl=\frac{\lambda}{2\pi\varepsilon_0}\ln\left(\frac{b}{a}\right)$ (i)

Now, $I=\int\vec{J}.d\vec{A}=\sigma\int\vec{E}.d\vec{A}$

$$=\sigma\int\frac{\lambda}{2\pi\varepsilon_0 r}2\pi rdr$$

Current per unit length will be

$I=\frac{\sigma\lambda}{\varepsilon_0}$ (ii)

From Eq. (i), we get

$$I=\frac{2\sigma\pi\varepsilon_0}{\varepsilon_0 in(b/a)}v=\frac{2\pi\sigma}{\ln(b/a)}v$$

Alternatively,

$$I=\frac{V}{R}\Rightarrow R=\int_{x=a}^{b}\frac{1}{\sigma}\frac{dx}{2\pi x1}=\frac{1}{2\pi r}\ln\left(\frac{b}{a}\right)$$

$$\therefore\quad I=\frac{2\pi\sigma V}{In(b/a)}$$

206 **(a)**

All resistances are in parallel

So, for parallel combination $H=\frac{V^2}{P}t\Rightarrow H\propto\frac{1}{R}$

207 **(c)**

Current through 1 Ω resistance will be 2 A in the upward direction

$V_G-2\times4+3-2\times2+2\times1=V_H\Rightarrow V_G-V_H=$ 7V

208 **(b)**

Potential difference V_P across P as determined from E_2 is same by $V_P=\left(\frac{E_1}{P+Q}\right)P$

Potential V_P across P as determined from $E_2$is same as E_2.because no current is drawn, i.e., $V_P=E_2$

Therefore,

$$E_2=E_1\left(\frac{P}{P+Q}\right)\Rightarrow\frac{E_2}{E_1}=\frac{P}{P+Q}$$

209 **(d)**

$$R=\frac{\rho l}{A}=\frac{\rho l^2}{Al}=\frac{\rho l^2}{V}=\frac{\rho l^2}{m/d}=\frac{\rho dl^2}{m}\text{ or }R\propto\frac{l^2}{m}$$

$$R_1:R_2:R_3=\frac{l_1^2}{m_1}:\frac{l_1^2}{m_2}:\frac{l_3^2}{m_3}=\frac{25}{1}:\frac{9}{3}:\frac{1}{5}=125:15:1$$

210 **(a)**

Using the principle of potentiometer, $V\propto l$

$\therefore\ \frac{V}{E}=\frac{l}{L}$ or $V=\frac{l}{L}E=\frac{30}{100}E=\frac{30E}{100}$

211 **(d)**

$$\frac{I_g}{I}=\frac{S}{S+G}\Rightarrow\frac{I_g}{I}=\frac{(G/10)}{(G/10)+G}=\frac{1}{11}$$

Initially, $a_1=\theta/I_g$ ...(i)

Finally, after the shunt is used,

$\alpha_f=\theta/I$ ....(ii)

$$\therefore\ \frac{a_f}{a_i}=\frac{\theta/I}{\theta/I_g}=\frac{I_g}{I}=\frac{1}{11}$$

So, current sensitivity becomes 1/11-fold

212 **(b)**

$1.45=1.3+Ir_A$

$1.45=1.5-Ir_B$

$Ir_B=0.05$

$Ir_A=0.15$

Dividing we get $\frac{r_B}{r_A}=\frac{1}{3}$

Or $r_A=3r_B$

213 **(c)**

Given: $P_A=60$ W; $P_B=100$ W

We know that current flowing through the bulb,

$$I-\frac{P}{V}$$

We also know that as both the bulbs are connected in parallel, therefore potential difference (V) across both he bulbs is the same.

Thus, $I\propto P$

Since the power of bulb B is greater than that of bulb A, therefore bulb B draws more current than bulb A

214 **(b)**

t_1 is the time of capacitor to discharge from $2V/3$ to $V/3$

For this, $\frac{V}{3} = \frac{2V}{3} e_1^{-t/\tau} \Rightarrow t_1 = \tau \ \text{In}\ 2 = RC \ \text{in}\ 2$

t_2 is time for charging of capacitor from $V/3$ to $2V/3$

So $\int_{VC/3}^{2VC/3} \frac{dq}{VC-q} = \int_0^{t_2} \frac{dt}{RC} \Rightarrow t_2 = RC \ \ln 2$

$T = t_1 + t_2 = 2RC \ \ln 2$

215 **(b)**

$I = Avne$. Number. Of free electrons per unit length $= 1 \times A \times n$

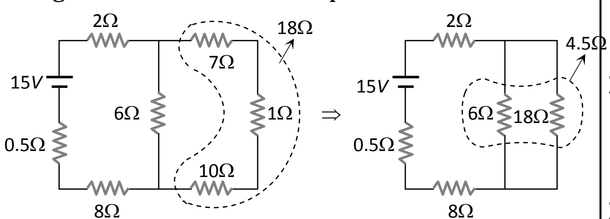
Momentum of each free electron $= mv$

Therefore, momentum per unit length is

$$Anmv = \frac{1}{e} m = \frac{I}{(e/m)} = \frac{I}{s}$$

216 **(a)**

The given circuit can be simplified as follows



On further solving equivalent resistance $R = 15\Omega$

Hence current from the battery $i = \frac{15}{15} = 1A$

217 **(b)**

Watt = volt × ampere

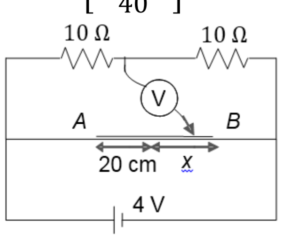
$\Rightarrow \ 60 = 230 \ \times I$ or $I = (6/23)$ A

If n lamps are used in parallel, each allowing 6/23 A, then total current, $n \times (6/23) \leq 5$

Or $n \leq 19.1$ or $n = 19$

218 **(d)**

$$v_P = 2\left[\frac{20+x}{40}\right]$$



$v_Q = 2$

$$v_P - v_Q = \frac{x}{10}$$

$$2 \ \sin \pi r = \frac{x}{10}$$

$x = 20 \ \sin \ \pi t$

$$\frac{dx}{dt} = (20\,\pi \cos \pi t) \text{ cm/s}$$

R is the order of 15,000 Ω. The junctions of the highest two and the lowest two resistances are A and C, and for better sensitivity, the galvanometer will be between these. So error will decrease with the suggested interchange

Alternatively: Let R be not exactly 15,000 Ω. Then some potential difference will be created between points B and D. Let it be ΔV_1. Now suppose the connections are interchanged, then the same type of potential difference will be created between points A and C. Let it be ΔV_2. On calculations, we can find that $\Delta V_2 > \Delta V_1$. So larger current will flow through galvanometer in the second case telling us that value of R needs to be changed. And we will try to put more accurate value of R. In this way, error will decrease

220 **(b)**

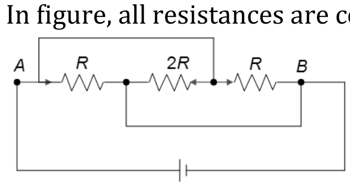
Resistance is the reciprocal of gradient of $I - V$ graph. If the resistance decreases with the temperature rise (which occurs when voltage is increases), the graph becomes more steep.

221 **(a)**

$I \propto \frac{1}{r^2}$; $V \propto \frac{1}{r^2}$ for metallic sphere, at inside, at inside point

222 **(b)**

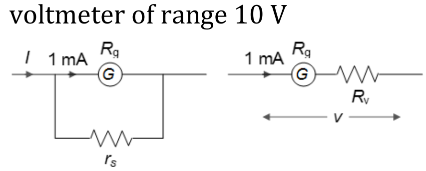
In figure, all resistances are connected in parallel



So, $R_{\text{eq}} = \frac{2R \times R/2}{2R + R/2}$ and current in all resistance flows from positive terminal of battery (means A end) to negative terminal of battery (means B end)

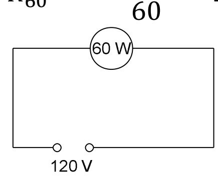
223 **(d)**

With these diagrams, we can easily find that the maximum equivalent resistance will be across voltmeter of range 10 V



224 **(d)**

$$R_{60} = \frac{120 \times 120}{60} \Omega = 240 \ \Omega$$

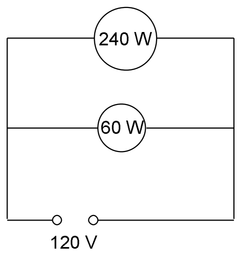


Current $= \frac{120}{240+6}$ A $= \frac{120}{246}$ A

Voltage across bulb $= \frac{120}{246} \times 240\text{V} = 117.1$ V

$R_{240} = \dfrac{120 \times 120}{240} \Omega = 60\Omega$

Resistance of parallel combination $= \frac{60\times240}{60+240} \Omega =$ 48Ω



Total resistance = (48+6) Ω = 54Ω

Current $I = \frac{120}{54}$ A

Voltage across parallel combination is

$\frac{120}{54} \times 48\text{V} = 106.7$ V

Change in voltage = (117.1−106.7) V = 10.4 V

225 **(c)**

After long time, current through the capacitor = 0

Therefore, current through the 6 Ω resistor,

$i = \dfrac{12-4}{8} = 1$ A

Voltage across capacitor, $V = 4 + (6)(1) = 10$ V

Charge on the capacitor, $Q = (10)(10) = 100$ μC

After the insertion of the dielectric, we get

$$C' = \frac{A\varepsilon_0}{\frac{d}{3}+\frac{d}{3}+\frac{d}{3(2)}} = \frac{A\varepsilon_0}{d}\left[\frac{1}{\left(\frac{1}{3}+\frac{1}{3}+\frac{1}{6}\right)}\right]$$

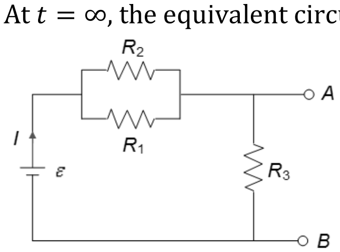
$$= (10)\left(\frac{1}{(5/6)}\right) = \frac{5}{6}(10) = 12\ \mu\text{F}$$

Hence, voltage across the capacitor remains the same. Charge on the capacitor,

$Q' = (12)(10) = 120$ μC

226 **(d)**

At $t = \infty$, the equivalent circuit is



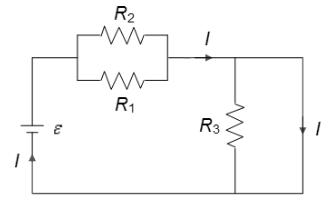
$$\therefore\ I = \frac{\varepsilon}{R_3 + \frac{R_1R_2}{R_1+R_2}} = \frac{10}{1+\frac{(2)(2)}{2+2}} = \frac{10}{1+1} = 5\text{ A}$$

Also, $I_{R_1}R_1 = I_{R_2}R_2 \Rightarrow \frac{I_{R_1}}{I_{R_3}} = \frac{R_2}{R_1}$

$\therefore\ V_{AB} = IR_3 = (5)(1) = 5$ V

$\therefore\ Q_{\max} = CV_{AB} = 5\mu$C

At $t = 0$, the equivalent circuit is

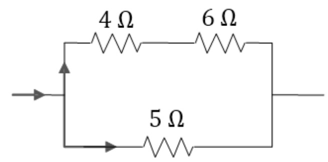


$\therefore\ I_{R_3} = 0$

and $I_{R_1}R_1 = I_{R_2}R_2 \Rightarrow \frac{I_{R_1}}{I_{R_2}} = \frac{R_2}{R_1}$

227 **(b)**

Let I_1 be the current flowing in 5 Ω and $(I - I_1)$ in 4 Ω and 6 Ω



The heat generated in the 5 Ω resistor is

10 cal/s = 4.2 × 10

J/s ∴ $4.2 \times 10 = I_1^2 R$

$\therefore I_1 = \sqrt{\frac{4.2\times10}{5}} = \sqrt{8.4} = 2.9$ A (i)

Since AB and CD are in parallel, therefore the potential difference remains the same between C and D, and between A and B

$\therefore (I - I_1)(4+6) = I_1 \times 5$ on solving using I_1 from Eq. (i) we get $(I - 2.9)10 = 2.9 \times 5$

$\therefore I - 2.9 = 1.45$

$\therefore I = 4.35$. Heat released per second in 4 Ω will be $(4.35 - 2.9)^2 \times 4 =$ A2.4 J/s = 2 cal/s

228 **(d)**

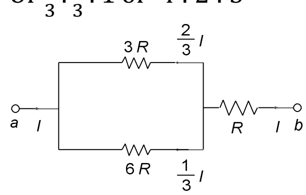
Copper is a metal, whereas germanium is semi conductor

229 **(c)**

Let current flow from b to a as shown (Figure)

Ratio is $\left(\frac{2}{3}I\right)^2 3R : \left(\frac{1}{3}I\right)^2 6R : I^2R$

Or $\frac{4}{3} : \frac{2}{3} : 1$ or 4 : 2 : 3



230 **(b)**

A careful analysis would show that the voltage along R is 1.03 V

1.03 =1× R or $R = 1.03$ Ω

231 **(a)**

The ratio $\frac{AC}{CB}$ will remain unchanged.

232 **(c)**

Potential drop across 1Ω = $\frac{2\times1}{\ldots}$ V. This potential drop exists across capacitor

$\therefore Q = CV = \frac{4}{3}\mu C$

233 **(c)**

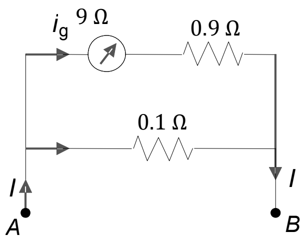
For cell A, the current i flows opposite to the direction of its e.m.f

$$\text{p.d} = \varepsilon + ir = \varepsilon + \frac{(n-2)\varepsilon}{nr} r = \varepsilon\left[1 + \frac{n-2}{n}\right]$$
$$= \varepsilon\left(\frac{2n-2}{n}\right)$$

234 **(c)**

$i_g = 10\text{mA} = 0.01 \text{ A}$

$V_A - V_B = (I = i_g)0.1 = i_g(9 + 0.9)$ or $I = \frac{10\times 0.01}{0.1} = 1 \text{ A}$



235 **(a)**

Resistance 9 Ω and 3 Ω are in parallel. Their equivalent resistance is

$\frac{9\times 3}{9+3} = \frac{9}{4}\Omega$

Now 18 Ω, 3 Ω, 6 Ω and $\frac{9}{6}\Omega$ are in parallel. Their equivalent resistance will be 1 Ω. This will be in series with 4/5 Ω. So, net $R_{eq} = 1 + \frac{4}{5} = \frac{9}{5}\Omega, I = \frac{E}{R_{eq}} = \frac{18}{9/5} = 10$ A.

Resistances near C and D will have no current in them

236 **(c)**

Let the resistance of the two heaters be denoted by R_1 and R_2 respectively. Then

$R_1 = \left(\frac{V^2}{P_1}\right)$ and $R_2 = \left(\frac{V^2}{P_2}\right)$

If the resistance of the series combination is denoted by R_s and the corresponding power by R_s, then $R_s = R_1 + R_2$

Or $\frac{V^2}{P_s} = \frac{V^2}{P_1} = \frac{V^2}{P_2}$

Or $P_s = \frac{P_1 P_2}{P_1 + P_2} = \frac{1000\times 1000}{2000} = 500$ W

237 **(c)**

The lower limit is zero volt (0 V) when X is at the lower end of the 4 kΩ resistor.That is

$$V = \left(\frac{25}{1K + 4K}\right)4K = \left(\frac{25}{5}\right)4 = 20V$$

Thus, the limits are 0 and 20 V

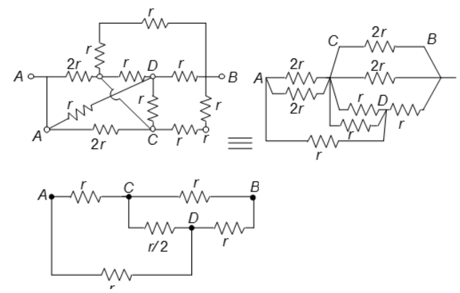
238 **(c)**

In this option, e. m. f. is least and resistance is maximum, so bulbs will be dimmest in this option

239 **(c)**

Initial rate of discharging means initial current which is equal to V/R, where V is initial potential. Here V and R are the same for both

240 **(d)**



$\equiv r$ (By Wheatstone balanced bridge concept)

241 **(c)**

Resistance is halved. Current is doubled

242 **(c)**

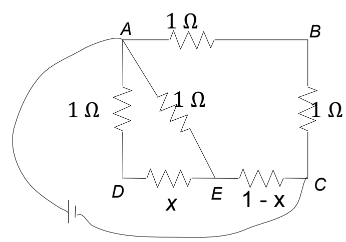
$Q = Q_0(1 - e^{-t/\tau}) \Rightarrow \; Q_0/10 = Q_0(1 - e^{-t/\tau})$

or $e^{-t/\tau} = 0.1$ or $e^{t/\tau} = 10/9 \Rightarrow t = \tau \text{In}(10/9)$

243 **(d)**

Equivalent resistance between A and E is

$y = \frac{x+1}{x+2}$



For B and E to be equipotent, we get

$\frac{R_{AE}}{R_{AB}} = \frac{R_{EC}}{R_{BC}} \Rightarrow \frac{x+1}{(x+2)\times 1} = \frac{1-x}{1}$

Solve to get $x = \sqrt{2} - 1\Omega$

Now $\frac{CE}{ED} = \frac{1-x}{x} = \sqrt{2}\Omega$

244 **(b)**

Energy stored In capacitor when it is charged up to 2 V is

$\frac{1}{2}\times 10\times 2^2 = 20\mu J = u_1$(suppose)

Energy stored in capacitor when it is charged up to 4 V is

$\frac{1}{2}\times 10\times 4^2 = 80\mu J = u_2$(suppose)

Increase in charge = 40 – 20 = 20 μC

Energy drawn from cell = 20 × 4 = 80 μJ = u (suppose)

Heat produced $= u_1 + u - u_2$

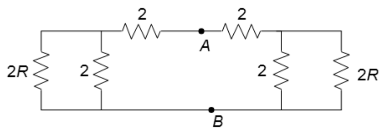
$= 20 + 80 - 80 = 20\mu J$

245 **(a)**

The equivalent circuit can be redrawn as shown In Figure

Let $R = \frac{2R \times 2}{2R+2} + 2$

Or $R = \frac{2R}{R+1} + 2$



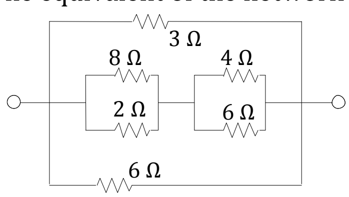
Or $R = \frac{2R+2R+2}{R+1} \Rightarrow R = \frac{2+4R}{R+1}$

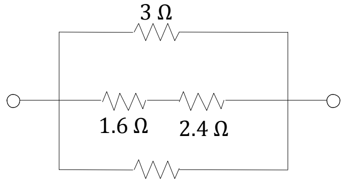
$R^2 - 3R - 2 \Rightarrow R = \frac{3+\sqrt{17}}{2}$

$R_{AB} = \frac{R}{2} = \frac{3+\sqrt{13}}{4}$

246 **(a)**

The equivalent of the network is given in Figure



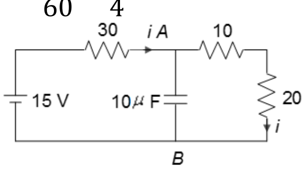


The equivalent of the above network is a parallel combination of 3 Ω, 4 Ω and 6 Ω, i.e.,

$\frac{1}{R} = \frac{1}{3} + \frac{1}{4} + \frac{1}{6} \Rightarrow R = \frac{4}{3}\Omega$

247 **(a)**

$i = \frac{15}{60} = \frac{1}{4}$ A



$V_{AB} = \frac{1}{4} \times 30 = 7.5$ V

$q = eV = 10 \times 7.5 = 75$ μC

248 **(d)**

In first two circuit diagrams, corrections have to be made while third one is absolutely wrong. So, none of the circuit diagrams is giving correct value of R

249 **(c)**

Momentum of each charge carrier moving with a drift velocity v is mv.

Total number of charge carriers in the sample is $N = n(Al)$, where n is the number of charge carriers per unit volume and A is area of cross section of the conductor

Total momentum $= p = N(mv) = nAlmv$

Further, we have $v = I/neA$

$\Rightarrow p = nAlm\left(\frac{I}{neA}\right) \Rightarrow p = l\left(\frac{m}{e}\right)I$

Since $F = \frac{dp}{dt}$

$\Rightarrow F = \frac{l}{s}\dot{I} \Rightarrow \frac{F}{l} = \frac{\dot{i}}{s}$ [$\because s =$ specific charge $= e/m$]

250 **(b)**

$R = \frac{V^2}{P}$

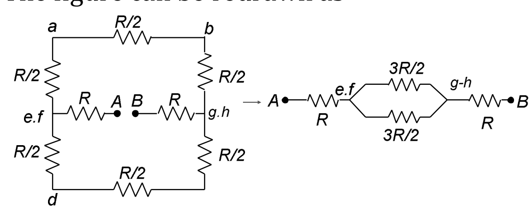
or $R \propto \frac{1}{P}$

$\therefore \frac{1}{R_{100}} > \frac{1}{R_{60}} > \frac{1}{R_{70}}$

Hence, the correct option is (d)

251 **(d)**

The figure can be redrawn as



$R_{AB} = R + \frac{3R}{4} + R = \frac{11R}{4}$

252 **(d)**

Let the resistance of the lamp filament be R. Then $100 = (220)^2/R$. When the voltage drops, expected power is $P = (220 \times 0.9)^2/R'$

Here, R' will be less than R, because now the rise in temperature will be less. Therefore, P is more than $(220 \times 0.9)^2/R = 81$W. But it will not be 90 % of the earlier value, because fall in temperature is small. Hence, option (d) is correct

253 **(d)**

$U = \frac{1}{2}CV^2 = \frac{1}{2} \times 100 \times 10^{-10} \times 200 \times 200$ J

$= 2$J

254 **(b)**

Total resistance is

$\left(\frac{5 \times 15}{5+15} + 1.25\right) = \left(\frac{75}{20} + 1.25\right)\Omega$

$= (3.75 + 1.25)\Omega = 5\Omega$

$I = \frac{20}{}$ A $= 4$ A

Current through 5 Ω $= \frac{15}{20} \times 4$ A $= 3$ A

Voltmeter reading = Potential drop across 1.25 Ω

$= 4\times 1.25$ V $= 5$ V

255 **(b)**

$Q = Q_0(1 - e^{-t/\tau}) = 0.9Q_0$

or $e^{-t/\tau} = 0.1\ e^{t/\tau} = 10$

256 **(a)**

$$V_{AB} = I.R_{AB} = \frac{I.\rho.L_{AB}}{A_1} = \frac{I.\rho\left(\frac{L}{2}\right)}{\pi(2r)^2} = \frac{I\ \rho.\left(\frac{L}{2}\right)}{\pi 4r^2}$$

$$V_{AB} = \frac{I\ \rho.L}{8\pi r^2}$$

$$V_{BC} = I.R_{BC} = \frac{I.\rho.L}{A_2}$$

$$= \frac{I.\rho.\frac{L}{2}}{\pi(r^2)} = \frac{I.\rho.L}{2\pi r^2} \Rightarrow \frac{V_{AB}}{V_{BC}} = \frac{\frac{I.\rho.L}{8\pi r^2}}{\frac{I.\rho.L}{2\pi r^2}} = \frac{2}{8} = \frac{1}{4}$$

$$V_{AB} = \frac{V_{BC}}{4}$$

Now for power loss

$P_{AB} = V_{A.B}.I$

$P_{BC} = V_{BC}.I$

$$\frac{P_{AB}}{P_{BC}} = \frac{V_{AB}}{V_{BC}} = \frac{1}{4} \Rightarrow V_{AB} = \frac{P_{BC}}{4}$$

257 **(a)**

Consider two extreme cases: (i) When the resistance of the rheostat is zero, the current through Q is zero since Q is short-circuited. The circuit is then essentially a battery in series with lamp P. (ii) When the resistance of the rheostat is very large, almost no current flows through it. So, the currents through P and Q are almost equal. The circuit is essentially a battery in series with lamps P and Q

258 **(c)**

Initially, $R_{\text{eq}} = 5R/3$. Finally, $R_{\text{eq}} = 3R/2$

Equivalent resistance decreases, so current increases in circuit and in '1' also. Hence, brightness of '1' increases. It means p. d. across '1' increases, so across '2' p. d. decreases, hence brightness of 2 decreases.

Initially, p. d. across '4' is $V_{4i} = \frac{1}{2}\left[\frac{(2R/3)\varepsilon}{2R/3+R}\right] = \frac{\varepsilon}{5}$

Finally, $V_{4f} = \frac{(R/2)\varepsilon}{R/2+R} = \frac{\varepsilon}{3}$

Since, $V_{4f} > V_{4i}$; hence, brightness of 4 increases

259 **(b)**

Clearly, $E_2 = IY$

$2 = \frac{12}{500+Y}Y$ or $500 + Y = 6Y$

Or $5Y = 500$ or $Y = 100$ Ω

260 **(b)**

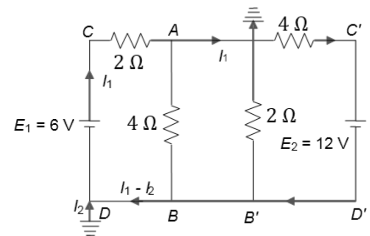
Sensitivity of potentiometer means the smallest potential difference it can measure. It can be increased by reducing the potential gradient. The same is possible by increasing the length of the potentiometer

261 **(a)**

$$P = i^2R, \frac{dP}{P} = 2\frac{dI}{I} = 2 \times 0.5\% = 1\%$$

262 **(d)**

$E_1 = (2+4) \times = 6$ V, $E_2 = (2+4) \times 2 = 12$ V



There will be no current in AB and$A'B'$, because all these points are at the same potential

From D to A': $V_D + 6 - 2I_1 = V_A$, but $V_D = V_A' = 0$

$\Rightarrow\ I_1 = 3$ A

For outermost loop : $6 - 12 = 2I_1 + 4(I_1 - I_2) \Rightarrow I_2 = 6$A

Current through $C'A' = I_1 - I_2 = 3 - 6 = -3$A

263 **(c)**

$$R_{AB} = 16\ \Omega, V_{AB} = \frac{R_{AB}\varepsilon_0}{R + R_{AB}} = \frac{16 \times 12}{8 + 16} = 8\text{ V}$$

Current in the loop of $\varepsilon_1$and ε_2:

$$I = \frac{\varepsilon_2 + \varepsilon_1}{r_1 + r_2} = \frac{4+2}{2+6} = \frac{3}{4}\text{A}$$

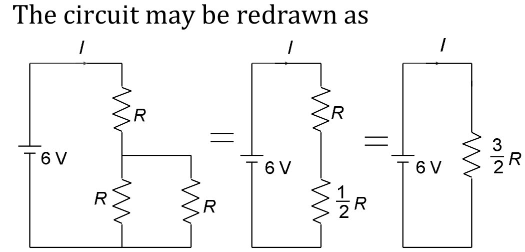
$$\varepsilon_1 - Ir_1 = V_{AB} = \frac{AN}{AB}(V_{AB}) \Rightarrow 2 - \frac{3}{4} \times 2$$

$$= \frac{AN}{4} \times 8$$

$$\Rightarrow\ AN = \frac{1}{4}m = 25$$

264 **(b)**

The circuit may be redrawn as



Current is given by $I = \frac{6}{\frac{3}{2}R} = \frac{4}{R}A$

Therefore, current through the voltmeter is $I/2$ or $2/R$ A

Hence, the reading of the voltmeter is $(2/R)$ (R)

or 2 V

265 **(d)**

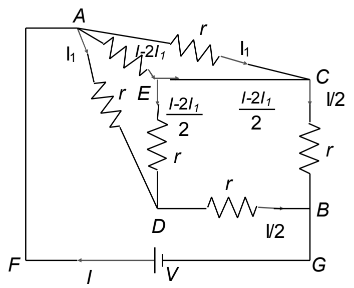
$E_1 \propto 300, E_1 - E_2 \propto 100$

$\frac{E_1}{E_1 - E_2} = 3$ or $E_1 = 3E_1 - 3E_2$

or $3E_2 = 2E_1$ or $\frac{E_1}{E_2} = \frac{3}{2}$

266 **(b)**

The figure can be redrawn as shown. Connect a battery between A and B. Now $R_{\text{eq}} = \frac{V}{1}$



In $ACEA$: $I_1 r = \frac{I - 2I_1}{2} r + (I - 2I_1)r \Rightarrow 3I = 8I_1$

In $FACBGC$: $V = I_1 r + \frac{1}{2} r \Rightarrow V = \frac{3}{8} Ir + \frac{1}{2} r \Rightarrow V = \frac{7r}{8} I$

$\Rightarrow R_{\text{eq}} = \frac{V}{I} = \frac{7r}{8}$

267 **(b)**

Heat produced $\propto I^2$, initial heat produced $= k(20)^2$, final

$kI'^2 = 2 \times k \times (20)^2 \Rightarrow I' = 20\sqrt{2}$ A

268 **(a)**

$V = E - Ir_1, V = 0$

$\therefore \ E = Ir_1$

Total e. m. f. $= Ir_1 = Ir_1 = 2Ir_1$

Total resistance $= R + r_1 + r_2$

Now, $I = \frac{2Ir_1}{R + r_1 + r_2}$

Or $R + r_1 + r_2 = 2r_1$

Or $R = 2r_1 - r_1 - r_2$ or $R = r_1 - r_2$

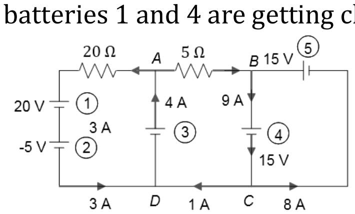
269 **(a)**

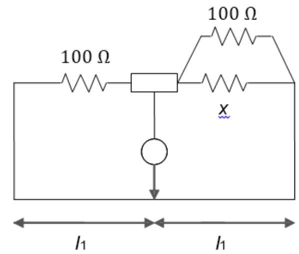
$I = \frac{k}{NBA} \theta$. Given that $I_1 = I_2$

$\therefore \ \frac{K\theta_1}{N_1 B A_1} = \frac{K\theta_2}{N_2 B A_2}$. So $\frac{\theta_1}{\theta_2} = \frac{A_1 N_1}{A_2 N_2}$

270 **(c)**

Applying kirchhoff's law at A, C, D, the direction of the currents in each branch will be as shown in Figure. Now, it is clear from the figure that the batteries 1 and 4 are getting charged





The Wheatstone bridge is in balanced condition, so

$$\frac{100}{l_1} = \frac{\frac{100x}{100 + x}}{l_2}$$

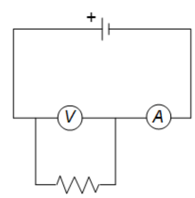
$$\therefore \ \frac{l_1}{l_2} = 2 \Rightarrow x = 100\ \Omega$$

272 **(c)**

$$S = \frac{i_g G}{(I - i_g)} = \frac{0.01 \times 1}{1 - 0.01} = \frac{1}{99} \Omega$$

273 **(d)**

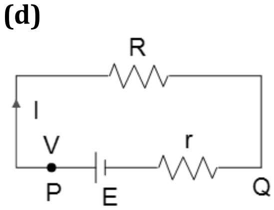
When a resistance is joined in parallel with the voltmeter, the total resistance of the circuit decreases. Current will increase, so ammeter reading will increase. The equivalent resistance across the voltmeter decrease and hence its reading will decrease



274 **(c)**

Initially, when switch is open, V_2 and V_3 will be out of circuit of they are short-circuited. So no p.d. across V_2 and V_3. On closing the switch, all three voltmeters will be in parallel, Now, there is some p.d. across V_2 and V_3. So p.d. across V_2 and V_3 increases and p.d. across V_1 remains the same

275 **(d)**



$V = IR$ (i)

$V = E - Ir$ (ii)

Eliminate I from Eqs. (i) and (ii), we get

$$V = \frac{ER}{R + r} = \frac{E}{1 + r/R}$$

Now at $R = 0, V = 0$; $R = \infty, V = E$

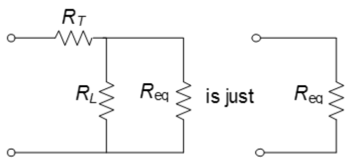
For this (d) is the suitable graph

276 **(b)**

$\frac{3-(-15)}{200+1000}$mA $= 0.015$mA
Potential at X is thus
$V_X = 3 - (200 \times 10^3)(0.0.15 \times 10^{-3}) = 0$

277 **(b)**
From the hint, the equivalent resistance of the circuit is

$$R_r + \frac{1}{1/R_L + 1/R_{eq}} = R_{eq}$$



$$R_r + \frac{R_L R_{eq}}{R_L + R_{eq}} = R_{eq}$$

$$R_T R_L + R_T R_{eq} + R_L R_{eq} = R_L R_{eq} + R_{eq}^2$$

$$R_{eq}^2 - R_T R_{eq} - R_T R_L = 0$$

$$R_{eq} = \frac{R \pm \sqrt{R_T^2 4(1)}\,(-R_T R_L)}{2(1)}$$

Only the positive sign in physical.

$$R_{eq} = \frac{1}{2}\left(\sqrt{4R_L R_T + R_T^2} + R_T\right)$$

For example, if $R_T = 1\Omega$ and $R_L = 20\ \Omega$, $R_{eq} = 5\ \Omega$

278 **(d)**
Here, $R_{20} = 20, R_{500} = 60\Omega, \mathrm{R_t} = 25\Omega$,
$\because \quad \mathrm{R_t} = \mathrm{R_0}(1 + \alpha \mathrm{t})$
Where α is the temperature coefficient of resistance.
$\therefore \quad R_{20} = R_0(1 + \alpha \times 20)$
$or \quad 20 = R_0(1 + \alpha \times 20) \quad ..(\mathrm{i})$
$R_{500} = R_0(1 + \alpha \times 500)$
$or \quad 60 = R_0(1 + \alpha \times 500) \quad ...(\mathrm{ii})$
Dividing Eq. (ii) by Eq. (i), we get

$$\frac{60}{20} = \frac{1 + \alpha \times 500}{1 + \alpha \times 20}$$

or $\quad 3 + 60\alpha = 1 + 500\alpha$

or $\quad \alpha = \frac{2}{440} = \frac{1}{200}°\mathrm{C}^{-1}$

Again, $R_{20} = R_0(1 + \alpha \times 20)$

or $\quad 20 = R_0\left(1 + \frac{1}{220} \times 20\right) ...(\mathrm{iii})$

$\quad R_t = R_0(1 + \alpha t)$

$\quad 25 = R_0\left(1 + \frac{1}{220} \times t\right) \quad ..(iv)$

Dividing Eq. (iv) by Eq (iii), we get

$$\frac{25}{20} = \frac{\left(1 + \frac{1}{220} \times t\right)}{\left(1 + \frac{1}{220} \times 20\right)} \Rightarrow 4 + \frac{4t}{220} = 5 + \frac{100}{220}$$

or $\quad t = 80°\mathrm{C}$

279 **(b)**
means the potential drop across CB due to E_1 is equal to that of the e.m.f. E_2. And this is the reading of the voltmeter

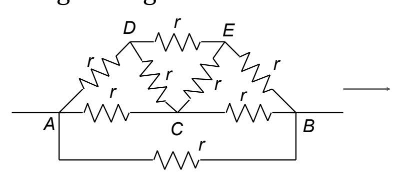
280 **(b)**
Let both the batteries are connected in series. Power output is maximum when external resistance is 2 Ω. Current in the circuit = 4 V/4 Ω = 1 A and power in the external circuit $= (1)^2 \times 2 = 2$ W

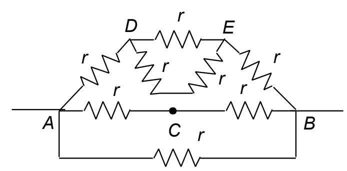
281 **(b)**
For resistors in series connection, current (I) is the same through the resistors.
$I = \frac{5-3}{R_1} = \frac{3-2}{R_2} = \frac{2}{R_3}$, i.e., $R_1 : R_2 : R_3 = 2 : 1 : 2$

282 **(b)**
Charge on capacitor at any time
$q = Qe^{-t/\tau} \quad ...(\mathrm{i})$
Differentiating Eq. (i) w.r.t. time. We get the current
$I = -\frac{dq}{dt} = \frac{Q}{\tau} e^{-t/\tau} \quad ...(\mathrm{ii})$
Required ratio: $q/I = \tau$ [by dividing Eq. (i) by Eq. (ii)]

283 **(c)**
With each rotation, charge Q crosses any fixed point P near the ring. Number of rotations per second $= \omega/2\pi$. Therefore, charge crossing P per second is current$= Q\omega/2\pi$

284 **(a)**
The given figure can be redrawn as shown.





We have broken the circuit at C and then connected as shown the in figure. It is because the whole of the current from DC will go to CE and that from AC will go to CB. Now solve to get $R_{AB} = 8r/15$

285 **(d)**
E_1 Could be balanced if positive terminal of E_1 would be connected to A

286 **(b)**
Power $= \frac{V^2}{R}$
Or $V = \sqrt{PR} = \sqrt{2 \times 10} = \sqrt{20} = 2\sqrt{5}$ V

cannot exceed $2\sqrt{5}$ V. Note that the resistance of parallel combination is half of 10 Ω. Thus, the maximum possible voltage between A and B is $3\sqrt{5}$ V

287 **(b)**

In the first case,

$= \frac{(3E)^2}{R} t = (m)s\Delta T$ (i)

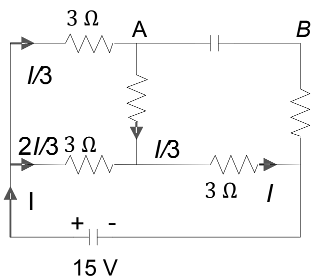
When the length of the wire is doubled, resistance ad mass both are doubled. Therefore, in the second case,

$\frac{(NE)^2}{2R} t = (2m)s\Delta T$ (ii)

Dividing Eq. (ii) by Eq. (i), we get $N = 6$

288 **(c)**

In the steady state, no current flow through C



$15 = 3 \times 2I/3 + 3I \Rightarrow I = 3\ A$

$V_A - 3I/3 - 3I = V_B$

$\Rightarrow V_A - V_B = 4I = 4 \times 3 = 12$ V

289 **(a)**

The circuit is symmetrical about the axis POQ. Both the vertical $2R$ are useless

$$\therefore \frac{1}{R_{PQ}} = \frac{1}{4R} + \frac{1}{4R} + \frac{1}{2r} \Rightarrow R_{PQ} = \frac{2Rr}{R+r}$$

290 **(a)**

$E = j\rho$ [j =current density]

$j = \frac{I}{\pi r^2}$ [r = radius of c.s. at distance 'x' from left end]

$$r = \left[a + \frac{(b-a)}{l} x\right]$$

Hence, $E = \frac{Vl^2\rho}{\pi R[al+(b-a)x]^2}$

291 **(d)**

No current will flow in the branch containing capacitor. Hence no energy stored on the capacitor

292 **(a)**

New length is $2I$, if the original length is I. Clearly, the new cross-sectional area is $a/2$, if a is the initial cross-sectional area. This is because the volume of the wire has to remain constant. Now,

$R' = \rho \frac{2I}{a/2} = 4R$

Increase in resistance $= 4\,R - R = 3R$

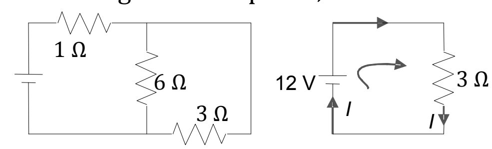
Percentage increase in resistance $= \frac{3R}{R} \times 100 = 300\%$

293 **(a)**

$$\frac{(20R)/(20+R)}{5} = \frac{20}{10} \Rightarrow R = 20\Omega$$

294 **(b)**

At $t = 0$, the capacitor behaves as a short circuit. The corresponding circuit is shown in Figure. According to the loop rule,



$12 - 3I = 0;\ \therefore I = 4$ A

295 **(b)**

The voltage per unit length on the metre wire PQ is

$\frac{6.00\text{mV}}{0.60\text{m}}$ or 10 mV/m

Hence, potential across the metre wire PQ is 10 mV/m (1m) = 10 mV. Current drawn from the driver cell is

$I = \frac{10\text{mV}}{5\Omega} = 2\text{mA}$

Resistance of the resistor R is

$$R = \frac{2\text{V} - 10\text{mV}}{2\text{mA}} = \frac{1990\text{mV}}{2\text{mV}} = 995\ \Omega$$

296 **(a)**

In the steady state, no current flows through the capacitor

297 **(d)**

Uncharged capacitor behaves as a short circuit just after closing the switch. But charged capacitor behaves as the battery of e.m.f. V just after closing the switch

$$\therefore I = \frac{q_0}{C_1(2R)} = \frac{q_0}{2RC_1} = \frac{V}{2R}$$

298 **(c)**

If V is the potential difference applied across P and Q, the current through M is determined by

Circuit	Current
(a)	$V/4$
(b)	$3\,V/8$
(c)	$V/2$
(d)	V/3

Hence, circuit arrangement (c) gives the largest reading in ammeter M

299 **(a)**

Recall the condition for maximum power flow through a circuit

300 **(a)**

2 kW × 30 h = 60 kWh = 60 units

301 **(b)**

Heat developed, $H = \frac{V^2}{R} t$

Heat developed will be doubled when R is halved

Further, $R = \rho\ell/(\pi r^2)$

$H = V^2 \pi r^2 t/\rho\ell$. So, heat produced will be doubled when both the length and radius of the wire are doubled

302 **(d)**

$P = V^2/R$. If V is halved, P is reduced by a factor of 4

So, new power is (1000/4) W, i.e., 250 W

303 **(b)**

The current will pass through only resistance part of the circuit. Hence, $I = \frac{9}{1+6+2} 1$A.

Potential drop across 3 μF capacitance is

$V_{AB} = V_{AB} + V_{Bc} = 1 \times 6 + \frac{1}{2} \times 1 = 6.5$ V

(Apply current division for current in branch BC which is 1/2 A)

304 **(c)**

Current through $R = \frac{12}{500+R}$

Voltage across $R = \frac{12R}{500+R}$

Since galvanometer shows zero deflection, so

$\frac{12R}{500+R} = 2 \Rightarrow R = 100\Omega$

305 **(b)**

Let I be the current in the circuit, then

$I \times 4000 = 30$ V

If voltmeter is put across 3000 Ω resistance, then reading of voltmeter

$= I \times 3000 = \frac{30}{4000} \times 3000 = 22.5$ V

306 **(c)**

$U_1 = \frac{1}{2} C\varepsilon_1^2$

$U_f = \frac{1}{2} C\varepsilon_2^2, \Delta U = \frac{1}{2} C(\varepsilon_2^2 - \varepsilon_1^2)$

$Q_{in} = +C\varepsilon_1, Q_f = -C\varepsilon_2, \Delta Q = |Q_f - Q_i|$

$= C(\varepsilon_2 + \varepsilon_1)$

Work done by battery $W_b = \varepsilon_2 \Delta Q = C(\varepsilon_2 + \varepsilon_1)\varepsilon_2$

Heat generated $= W_b - \Delta U$

$= C\varepsilon_2^2 + C\varepsilon_1\varepsilon_2 - \frac{1}{2} C(\varepsilon_2^2 - \varepsilon_1^2)$

$= \frac{1}{2} C(\varepsilon_2^2 + \varepsilon_1^2 + 2\varepsilon_1\varepsilon_2) = \frac{1}{2} C(\varepsilon_1 \varepsilon_2)^2$

307 **(b)**

Let R be the resistance of each lamp. If E is the applied e.m.f. then the current in the circuit I_1 is given by

$I_1 = \frac{E}{R + (R+2)} = 2E/3R$

Current flowing through L_2 and L_3 is

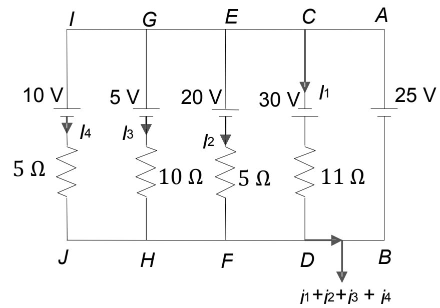
$\frac{1}{2}\left[\frac{2E}{3R}\right] = \frac{E}{3R}$

When L_3 is fused, the whole current flows through L_1 and L_2. Thus $I_2 = \left(\frac{E}{2R}\right)$

So, current through L_1 decreases and the current through L_2 increases

308 **(c)**

Applying KVL in loop $CDBAC, EFBAE, GHBAG$ and $IJBAI$, we get



$30 - i_1 \times 11 = -25 \Rightarrow i_1 = 5$A

$20 + i_2 \times 5 = 25 \Rightarrow i_2 = 1$ A

$5 - i_3 \times 10 = -25 \Rightarrow i_3 = 3$ A

$10 + i_4 \times 5 = 25 \Rightarrow i_4 = 3$A

Current through 25 V cell is $i_1 + i_2 + i_3 + i_4 =$ 12 A

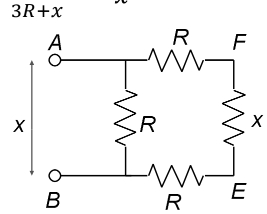
309 **(a)**

After disconnecting B_2 and B_3, the whole of potential difference will be across B_1. Hence, potential difference across B_1 increases, so its brightness increases

310 **(b)**

Let the resistor to be connected across CD be x. Then the equivalent resistance across EF should be x and also across AB should be x. So we get

$\frac{(2R+x)R}{3R+x} = x$



Solve to get $x = (\sqrt{3} - 1)R$

311 **(b)**

$V \alpha I^n, n > 1 \quad V = kI^n$

$P = VI = kI^{n+1}$. Here $n + 1 > 0$

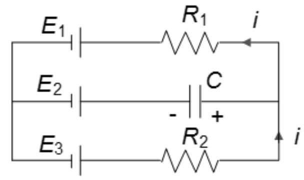
312 **(b)**

$P = \frac{V^2}{R} \Rightarrow P \propto \frac{1}{R}$

313 **(c)**

$i = \dfrac{2.5 - 1}{30} = 0.05\text{A}$

$-20i + 2.5 = V_{\text{capacitor}} + 1$



$V_{\text{capacitor}} = 0.5\text{ V}$

$q^{(-)} = CV = 10 \times 0.5 = 5$

314 **(a)**

$S = R_1 + R_2, P = \dfrac{R_1R_2}{R_1 + R_2}$

$\therefore S = nP$

$\Rightarrow R_1 + R_2 = \dfrac{nR_1R_2}{R_1 + R_2} \Rightarrow n = \dfrac{(R_1 + R_2)^2}{R_1R_2} \Rightarrow n$

$= \dfrac{R_1}{R_2} + \dfrac{R_2}{R_1} + 2$

$\Rightarrow n = \left(\sqrt{\dfrac{R_1}{R_2}} - \sqrt{\dfrac{R_2}{R_1}}\right)^2 + 4$

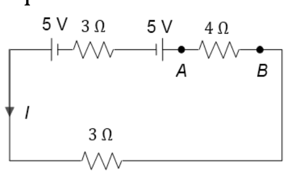
Hence $n_{\text{min}} = 4$, for $R_1 = R_2$

315 **(a)**

Either apply Kirchhoff's law or solve analytically

316 **(c)**

Equivalent circuit



$I = \dfrac{5 - 5}{8} = 0 \Rightarrow V_A - V_B = 0$

So, current will be only in the smaller loop containing the 6 V and 4 V battery. So, current through the 6 V battery is

$I' = \dfrac{6 - 4}{4} = \dfrac{1}{2}\text{A}$

317 **(c)**

Total resistance $= \frac{nV^2}{P}$. Power$= \frac{V^2P}{nV^2} = \frac{P}{n}$

318 **(b)**

$R_2 = R_1(1 + \alpha\Delta T)$

$2 = 1(1 + 00125 \times \Delta T) \Rightarrow \Delta T = \dfrac{1}{0.00125} = 800$

$\Rightarrow T_2 - T_1 = 800 \Rightarrow T_2 = 800 + T_1 = 800 + 300$

$= 1100\text{ K}$

319 **(a)**

Heat in calories $= \frac{210\times5\times60}{4.2} = 15{,}000$

320 **(c)**

$i = \frac{dq}{dt}$ =slope of $q - t$ graph

$= -5$ (which is constant)

Amount of heat generated in time $t = i^2RT \propto t$

321 **(b)**

Using the concept of balanced wheat stone bridge, we have

$\dfrac{P}{Q} = \dfrac{R}{S}$

$\dfrac{x}{52 + 1} = \dfrac{10}{48 + 2}$

$x = \dfrac{10 \times 53}{50}$

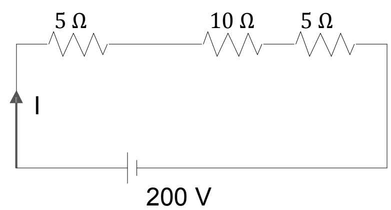
$= 10.6\Omega$

322 **(a)**

Potential difference = 0. Therefore, charge = 0

323 **(b)**

Resistors 20 Ω, 100Ω and 25 Ω will be in parallel. Their equivalent is 10Ω



$I = \dfrac{200}{5 + 10 + 5} = 10\text{ A}$

p.d. across 10 Ω, 10 $I = 10 \times 10 = 100$ V

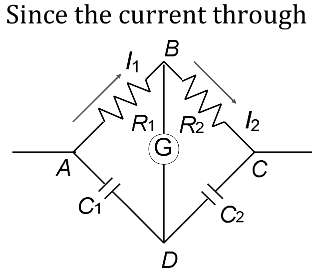
This will be the voltmeter reading. Also, this will be the p.d. across each of 20 Ω, 100 Ω, and 25 Ω resistors

Ammeter reading = current through 25 Ω $= \frac{100}{25} = 4$ A

324 **(b)**

In the steady state, no current is passing through the capacitor. Let the charge on each capacitor be q.

Since the current through galvanometer is zero.



$\therefore I_1 = I_2$

The potential difference between the ends of the galvanometer will be zero.

$\therefore V_A - V_B = V_A - V_D$

$I_1R_1 = \frac{q}{C_1}$ ...(i)

Similarly, $V_B - V_C = V_D - V_c$

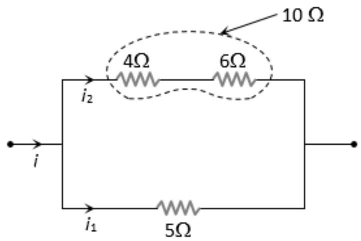
$I_2R_2 = \frac{q}{C_2}$ ... (ii)

Dividing Eq. (i) by Eq. (ii), we get

$\frac{I_1R_1}{I_2R_2} = \frac{q/C_1}{q/C_2} = \frac{C_2}{C_1} \Rightarrow \frac{C_1}{C_2} = \frac{R_2}{R_1}$

325 **(b)**

$\frac{i_1}{i_2} = \frac{R_2}{R_1} = \frac{10}{5} = \frac{2}{1}$



Also heat produced per *sec i.e.* $\frac{H}{t} = P = i^2R$

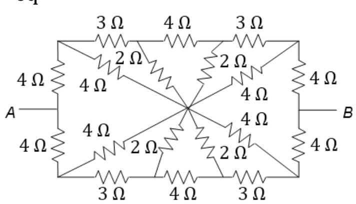
$\Rightarrow \frac{P_5}{P_4} = \left(\frac{i_1}{i_2}\right)^2 \times \frac{5}{4} = \left(\frac{2}{1}\right)^2 \times \frac{5}{4} = \frac{5}{1} \Rightarrow P_4 = \frac{10}{5}$

$= 2cal/s$

326 **(a)**

Across the dotted line, the circuit is symmetric

$R_{\text{eq}} = 6\Omega$



327 **(b)**

Resistance across AC is more than CB

328 **(b)**

$P = V^2/R$. R is reduced by a factor of 4. So, P is increased by a factor of 4

329 **(c)**

The resistance of the square X is given b

$R_X = \rho\frac{L}{Lt} = \frac{\rho}{t}$

Where ρ is the resistivity on the metal. Similarly, for $R_y, R_Y = \rho\frac{2L}{(2L)t} = \frac{\rho}{t}$ same as before. Hence, $\frac{R_x}{R_Y} = 1$

330 **(c)**

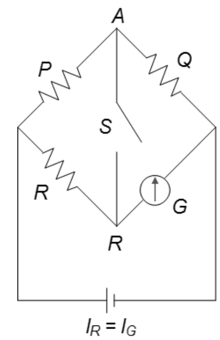
$E = 4$ V, total resistance = (1+0.9+1.9) Ω = 3.8Ω

Now, $I = \frac{4}{3.8}$A

Again, the terminal potential difference across A is $2 - \frac{4}{3.8} \times 1.9 = 2 - 2 = 0$

331 **(a)**

Since opening or closing the switch does not affect the current through G, it means that in both the cases there is no current passing through S. This means that potential at A is equal to potential at B and it is the case of balanced Wheatstone bridge



$I_P = I_Q I_R = I_G$ and (a) is the correct option

332 **(d)**

We know that $I = neAv_d$. Here I is the same in both the cases. n will also be the same in both cases because the material is the same. The value of n depends upon the nature of material only and not on the dimensions. Hence $v_d \propto 1/A$. Here the radius is doubled so the area becomes four times. Hence, the drift velocity becomes one-fourth, i.e., $v_d/4$

333 **(b)**

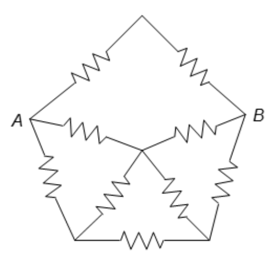
When Wheatstone bridge is balanced, then

$\frac{P}{Q} = \frac{R}{S}$ or $\frac{P}{R} = \frac{Q}{S}$

If the galvanometer is replaced with a cell in balanced Wheatstone bridge, the condition for balanced bridge will be $P/R = Q/S$, which is there Hence, balance point will remain unchanged, where galvanometer shows no current

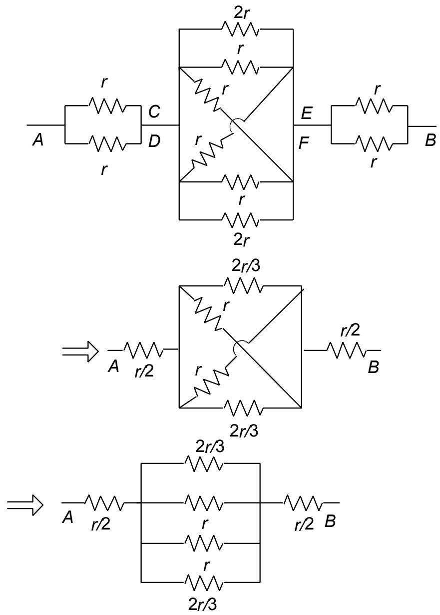
334 **(a)**

Equivalent circuit, $R_{\text{net}} = \frac{8R}{11}$



335 **(d)**

We can find that points C, D, E and F are equipotential. So the resistance between C and D and between E and F will be useless. The circuit is redrawn as



$\Rightarrow R_{AB} = 1.2r$

336 **(b)**

$50 = 10\,[R + r]$

$R + r = 5\,\Omega$

$$\eta = \frac{R}{R+r} \Rightarrow 0.25 = \frac{R}{R+r}$$

$R + r = 4R$

$\Rightarrow r = 3R$

Then $R = 5/4 = 1.2\Omega$ and $r = 3.75\,\Omega$

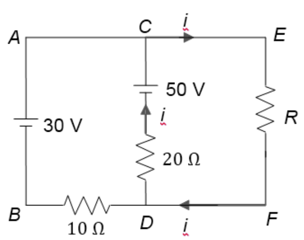
337 **(b)**

When switch S_2 is closed, the whole of current shall flow through the connecting wire only which is supposed to have zero resistance

338 **(c)**

$$i = \frac{50}{20+R}$$

Potential drop across R =potential drop across AB



$$\frac{50}{20+R}R = 30 \;\Rightarrow R = 30\,\Omega$$

339 **(a)**

$$r = \frac{l_1 - l_2}{l_2}R = \frac{240-120}{120} \times 2\Omega = 2\Omega$$

340 **(b)**

The heat supplied under these conditions is the change in internal energy $Q = \Delta U$. The heat supplied $Q = i^2Rt\ 1 \times 1 \times 100 \times 5 \times 60 =$

341 **(d)**

$$\frac{V^2}{R}t = ms\Delta T$$

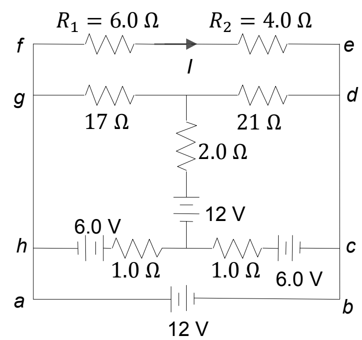
For first case: $\frac{(3E)^2}{(\rho L/A)t} = 2ms\Delta T$

For second case: $\frac{(NE)^2}{\rho 2L/A}t = 2ms\Delta T$

Dividing, we get $N = 6$

342 **(c, d)**

Note that points a, h, g and f have the same potential. They are connected by conducting wires without any circuit elements between them. Similarly, points b, c, d and e have the same potential. Hence, the potential drop across branch e and f, a and b is the same. The two resistors (6Ω and $4\,\Omega$ in series) are directly connected across the terminals of 12 V battery



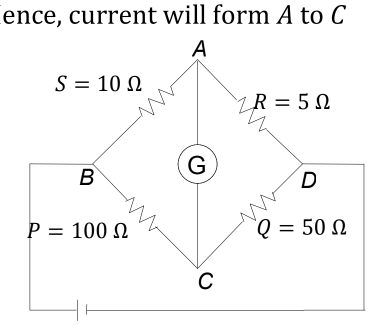
The current $I = \frac{V}{R_1+R_2} = \frac{12}{10} = 1.2$ A

Hence, $V_1 = (1.2)(6) = 7.2$ V, $V_2 = (1.2)(4) = 4.8\,V$

343 **(b,c)**

If P is slightly increased, potential of C will decrease

Hence, current will form A to C



if Q is slightly increased, potential of C will increase, hence current will flow from C to A

344 **(d)**

In the balanced condition of Wheatstone bridge,

$10X = 7 \times 40$

$$X = \frac{7 \times 40}{10} = 28\Omega$$

345 **(b ,c ,d)**

7Ω reistor is short-circuited, so no current will flow through it. Potential difference across each of 3 $\Omega$and 6 Ω is 12 V, so we can find current in them

346 **(a, c)**

Resistors 4 Ω and 6 Ω are short − circuited.

Therefore, no current will flow through these resis the battery is $I = (20/2) = 10$ A

This is also the current passing in wire AB from B to A

Power supplied by the battery is

$P = EI = (20)(10) = 200$ W

Potential difference across the 4 Ω resistance

= potential difference across the 6 Ω resistance

347 **(a,c)**

For changing a battery the external voltage generator must provide an output voltage V greater than emf of battery E. In charging state

or $I = \left(\frac{V-E}{R+r}\right)$

348 **(a ,b ,c)**

Potential difference across resistance = Potential difference across the terminals of the battery

So $V = E - Ir$

This is an equation of a straight line. Comparing this with the given graph, we can see that $E = 10$ V and $r = 5\Omega$

Also $I_{\max} = \frac{E}{r} = \frac{10}{5} = 2$ A

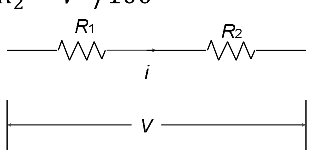
When external resistance $R = 0$

349 **(a,d)**

Let $V = 200$ V; R_1 and R_2= resistance of the 25 W and 100 W bulbs.

$P_1 = 25 = V^2/R_1$ or $R_1 = V^2/25$ and

$R_2 = V^2/100$



When the bulbs are joined in series, the current is

$$I = \frac{V}{R_1 + R_2}$$

Power in the 25 W bulb = $R_1 I^2$ and in the 100 W bulb = $R_2 I^2$

350 **(a,d)**

In series combination $H \propto R$. Since $R_1 = R_2$ therefore equal amount of heat must be produced in them. The rise of temperature due to heat may be equal if they have same thermal capacity.

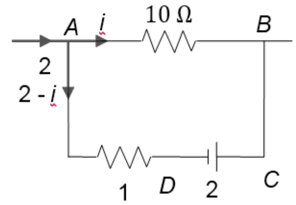
351 **(a,d)**

Potential difference between the terminals of 9V battery = 16V − 9V = 7V.

Consequently, current in 2Ω resistor = $\frac{7V}{2\Omega} = 3.5$A

352 **(a,b,d)**

Let the currents be as shown in the figure



Applying KVL along ABCDA, we get

$\Rightarrow -10i - 2 + (2 - i)\,1 = 0$

$\therefore\ i = 0$

Potential difference across = $(2 - i)1 = 2 \times 1 = 2$ V

353 **(b, c)**

$P = \frac{V^2}{R}$, therefore $R = \frac{V^2}{P}$ or $R \propto V^2$, i.e.,

$\frac{R_1}{R_2} = \left(\frac{200}{300}\right)^2 = \frac{4}{9}$

When connected in series, potential drop is in the ratio of their resistance. So,

$\frac{V_1}{V_2} = \frac{R_1}{R_2} = \frac{4}{9}$. Now, $P = I^2\ R$

Or $P \propto R$ (in series I is the same)

Or $\frac{P_1}{P_2} = \frac{R_1}{R_2} = \frac{4}{9}$

354 **(a,b,c,d)**

Electric current at a point on the circle $i = fe$, where f =frequency

$$= \frac{\omega}{2\pi} = \frac{V}{2\pi r} = \frac{0.6 \times 10^6 \times \pi}{2\pi \times 5 \times 10^{-11}} = 6 \times 10^{15}\text{rev/s}$$

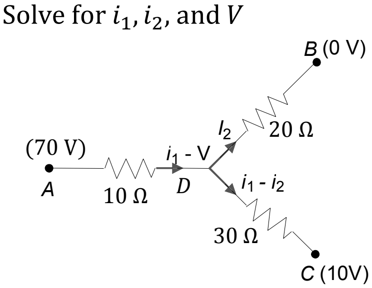
$= 6 \times 10^{15} \times 1.6 \times 10^{-19}$

$= 0.96 \times 10^{-3}$ A = 0.96 mA

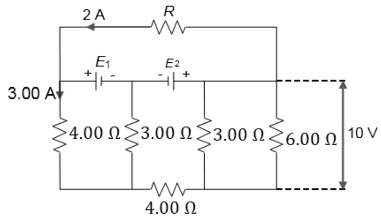
355 **(a,b,d)**

$70 - V = 10i_1, V - 0 = 20i_2, V - 10 = 30(i_1 - i_2)$

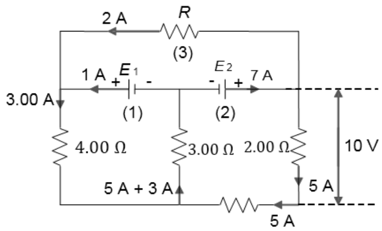
Solve for i_1, i_2, and V



356 **(a,b,c,d)**



After redrawing the circuit



a. I_4 =5 A

b. from loop (1)

$-8(3) + E_1 - 4(3) = 0 \Rightarrow E_1 = 36$ V

From loop (2)

$+4\,(5) + 5(2) - E_2 + 8(3) = 0$

$E_2 = 54$ V

c. from loop (3)

$-2R - E_1 + E_2 = 0$

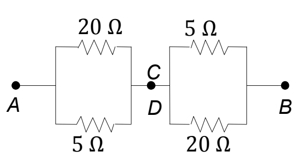
$R = \dfrac{E_2 - E_1}{2} = -36 = 9$ W

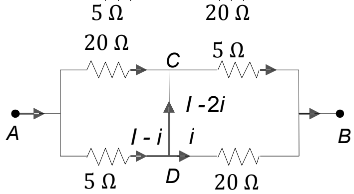
357 **(b,c)**

As $R \propto 1/W$ and actual power consumed $P = V^2/R$, the lasser the resistance (i.e., higher the wattage), the greater the power consumed. If the bulbs are connected in series, actual power $P = i^2R \Rightarrow P \propto R$. Hence, in series connection, low wattage bulbs glow more

358 **(a,b,d)**

As C and D are joined, they must be at the same potential, and may be treated as the same point. This gives the equivalent resistance as 8Ω. If we distribute current in the network, using symmetry





$V_A - V_D = V_A - V_C$

or $20i = 5(I - i)$

or $i = I/5$

$I = 2i = I - \frac{2I}{5} = \frac{3I}{5}$ = current flowing from D to C

359 **(a,b,d)**

Let V be the potential at S.

Then $V_{PS} = 70 - V = 10I_1$

$V_{SQ} = V - 0 = 20I_2$

$V_{SR} = V - 10 = (I_1 - I_2)$

On solving these equations, we get , $V = 40\ V$, $I_1 = 3\ A, I_2 = 2\ A$.

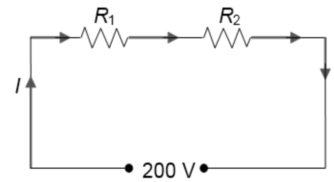
Total power

$= I_1^2 \times 10 + I_2^2 \times 20 + (I_1 - I_2)^2 \times 30 = 200$ W.

360 **(a,d)**

$$R_1 = \frac{V^2}{W_1} = \frac{(220)^0}{25} = (22)^2 \times 4\Omega$$

$$R_2 = \frac{V^2}{W_2} = \frac{(220)^2}{100} = (22)^2\Omega$$



current in the circuit when the, bulbs are connected in series,

$$I = \frac{220}{(22)^2 \times 4 + (22)^2} = \frac{10}{22 \times 5} = \frac{1}{11}\text{A}$$

Hence, $P_1 = I^2R_1 = \left(\frac{1}{11}\right)^2 \times (22)^2 \times 4 = 16$ W

and $P_2 = I^2R_2 = \left(\frac{1}{11}\right)^2 \times (22)^2 = 4$ W

361 **(a,b,d)**

Since $R_1/R_2 = C_2/C_1$, the Wheastone bridge is balanced. Hence, $V_C = V_D$. No current passes through the galvanometer

Hence, option (**a**) is correct

Potential difference across R_1 = potential difference across $C_1 = 4$ V

Potential difference across R_2 = potential difference across $C_2 = 5$ V

Potential difference across 5 Ω is the potential difference across 8 μF capacitor. So, charge across 8 μF capacitor $Q = CV = 8\ \mu\text{F} \times 5$ V= 40 μC

Hence, option (**b**) is correct and so is option (**d**)

362 **(a,b,d)**

An insulator as well as a semiconductor behaves as 100% insulator at 0 K and so current through them at 0 K is zero. Moreover, on applying a potential difference across a $p - n$ diode at room temperature (300 K), current passing through it is finite whether the diode is connected in reverse bias or in forward bias.

363 **(a, c, d)**

$$I = \frac{dQ}{dt} = a - 2bt$$

$I = 0$ for $t = (a/2b)$ and $(dI/dt) = -2b$

364 **(a, b, d)**

We know that the equivalent internal resistance is

$$R_{eq} = \frac{1}{\sum \frac{1}{R}} \Rightarrow R_{eq} = \frac{1}{\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}}$$

and the equivalent e.m.f is

$$E_{eq} = \frac{\sum \frac{E}{R}}{\sum \frac{1}{R}} = \frac{\frac{E_1}{R_1}+\frac{E_2}{R_2}+\frac{E_3}{R_3}}{\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}}$$

Use $E_3 = \frac{E_1R_2+E_2R_1}{R_1+R_2}$ to get

$$E_{eq} = E_3 = \frac{E_1R_2 + E_2R_1}{R_1 + R_2} \Rightarrow E_{eq} = E_3$$

365 **(b, c, d)**

Disregard the capacitors and find the current through G. The potential difference across each capacitor is then found from the potential differences across the resistances in parallel with them

366 **(b,c,d)**

Disregard capacitors and find the current through G. The potential difference across each capacitor is then found from the potential difference across the resistance in parallel with them

367 **(c)**

Both are basic facts

368 **(a,b,c)**

Initial charge (before filling the dielectric slab) is $10\times10 = 100$ μC

Final charge (after filling the dielectric slab) = $10\times30 = 300$ μC

Increase in charge= 20 μC

369 **(a,c)**

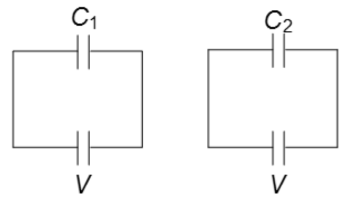
Use symmetry

370 **(b,d)**

During the decay of charge in RC circuit

$I = I_0e^{-t/RC}$ where $I_0 = q_0/RC$

When $t = 0, I = I_0 = q_0/RC$



Since potential difference between the plates is initially the same, therefore I is the same in both the case at $t = 0$ and is equal to $I = \frac{q_0}{RC} = \frac{V}{R}$. Also

$q = q_0e^{-t/RC}$

When $q_0 = \frac{q_0}{2}$, then $\frac{q_0}{2} = q_0e^{-t/RC}$

$\Rightarrow e^{+t/RC} = 2 \frac{t}{RC} = \log_e 2 \Rightarrow t = RC \log_e \Rightarrow t \propto C$

Therefore, time taken for the first capacitor (1 μF) for discharging 50% of initial charge will be less

371 **(a,b,d)**

In case of metal, the current flow will be very-very high

372 **(a,d)**

The last three resistors 2Ω, 4Ω and 2Ω are in series having the equivalent resistance as 2+4+2=8Ω. This will be in series with the 8Ω next to them. So, their equivalent resistance becomes 4Ω. In this way, net equivalent resistance of the circuit becomes R_{eq}= 9Ω. This will be in series with $r = 1$. So, the current through 3Ω is $I = e/(R + r) = 10/(9 + 1) = 1$ A

Further, current will get divided at C and E into half at each point. So, finally the current reaching in 4Ω will be 0.25 A

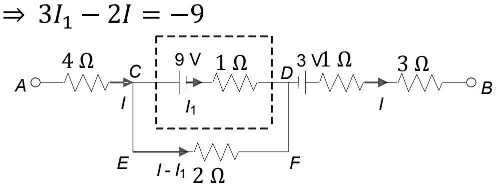
373 **(a, c)**

As the cross sections are in series, so the current in them will be the same. From $I = neAv_d$, we have $v_d \propto 1/A$. At one cross section is more, hence the drift velocity is less

374 **(a, c, d)**

For loop $CEFD$: $-2(I - I_1) + 1I_1 + 9 = 0$

$\Rightarrow 3I_1 - 2I = -9$



From A to B via CD; $V_A - 4I - 9 + 3 - 1I_1 - 1I - 3I = V_B$

But $V_A - V_B = 16$ V, so $8I + I_1 = 10$

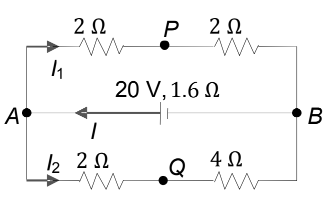
$\Rightarrow I_1 = -2$A, $I = 1.5$A

$I - I_1 = 1.5 + 2 = 3.5$ A
$V_C - 9 - 1I_1 = V_D \Rightarrow V_C - V_D = 7$ V

375 **(a, b, c, d)**
Treat all voltmeters and ammeters as resistances. Draw the circuit and find the currents and potential differences for each section

376 **(a,b,c,d)**
Potential difference across the terminals of the cell is given by$V = E - ir$. Hence, the graph between V and i will be a straight line having negative slope and positive intercept. Hence, (a) is correct
Total electrical power generated is Ei and thermal power generated in the cell is i^2r. hence, thermal power generated in the external circuit is
$P = Ei - i^2r$. so, the graph between P and i is a parabola passing through the origin. Hence, choice (b) is correct.
When terminal potential difference across the cell is V, current flowing through the circuit will be
$i = E - V/R$ and thermal power generated in the external circuit will be equal to $P = V_1 =$
$V\left(\frac{E-V}{r}\right) = \frac{EV}{r} - \frac{V^2}{r}$
Hence, the graph between P and V will be a parabola passing through the origin and have a maximum value of P at$V = E/R$. Hence, choice (d) is correct.
At an instant, thermal power generated in the cell is equal to i^2r and total electrical power generated in the cell
Is equal to Ei. hence, the fraction$\eta = i^2r/Ei =$
$(r/E)i$
Hence, the graph between η and i will be a straight line passing through the origin and have a positive slope. Hence, (c) is correct

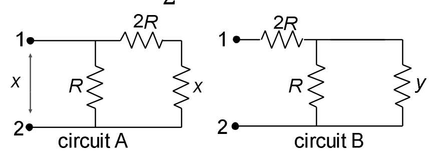
377 **(a , d)**
Resistors 2Ω and 2Ω are in series, 2 Ω and 4 Ω are in series, then their resultant are in parallel. Producing net resistance $R = 2.4\Omega$



$$I = \frac{20}{r + R} = \frac{20}{1.6 + 2.4} = 5 \text{ A}$$
$I_1 + I_2 = 5$ A ...(i)
$V_{AB} = 4I_1 = 6I_2 \Rightarrow 2I_1 = 3I_2$ ...(ii)
From Eqs. (i) and (ii), $I_1 = 3$A, $I_2 = 2$A
$V_A - V_P = 6$ V, $V_A - V_Q = 2I_2 = 4$ V
Thus, $V_Q - V_P = 2$ V

378 **(a, b, c, d)**
a. If V_1 decreases, then potential difference across xz will decrease. So, to have same potential difference, i.e., V_2 across xz, length xz has to be increased or z shoud be moved towards y
b. Is incorrect because for this, z should have been moved towards x
c. Will be incorrect because xz can get warm up if current through it increases which is not possible
d. Is incorrect because there is no current in R_1

379 **(a, b, c, d)**
Circuit *A*: $x = \frac{R(2R+x)}{3R+x} \Rightarrow 3Rx + x^2 = 2R^2 + Rx$
$\Rightarrow x^2 + 2Rx - 2R^2 = 0 \Rightarrow x = \frac{-2R\sqrt{4R^2+8R^2}}{2}$
$$\Rightarrow x = -\frac{2R + 2\sqrt{3R}}{2} \quad \Rightarrow x = (\sqrt{3} - 1)R$$

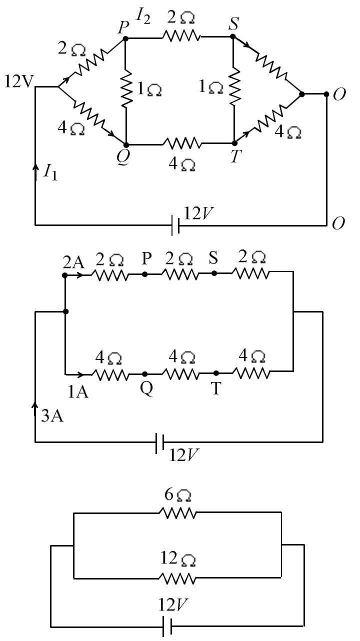


Circuit B: $y = \frac{yR}{y+R} + 2R \Rightarrow y^2 + Ry = yR + 2Ry +$
$2R^2$
$\Rightarrow y^2 - 2YR - 2R^2 = 0 \Rightarrow y = (\sqrt{3} + 1)R$

380 **(a,d)**
$R_{steel} = 2R_{Al}$. In series $H \propto R$ [i is Same]
So, H will be more in steel wire. In parallel $H \propto \frac{1}{R}$
[V is same], so H will be more in aluminium wire

381 **(a,c,d)**
The power supplied by cell $= EI$
When this power is supplied to R and r, it is divided in the
ratio $\left(\frac{R}{R+r}\right)$ and $\frac{r}{(R+r)}$

382 **(a,b,c,d)**
Due to input and output symmetry P and Q and S and T have same potential



$$R_{eq}=\frac{6\times 12}{18}=4\Omega$$

$I_1=\frac{12}{4}=3A\rightarrow$ option (b)

$$I_2=\left(\frac{12}{6+12}\right)\times 3$$

$I_2=2A\rightarrow$ option (d)

$V_P-V_Q\Rightarrow$ Current through $PQ=0\rightarrow$ option (a)

$V_S-V_Q=-4\ i.e.V_Q>V_S\ \rightarrow$ option (c)

383 **(a,b,c,d)**

(a) potential difference across each cell $=V_P-V_Q$

(b) If it is clockwise, then E_2 supplies energy and for the reverse case, E_1 supplies the energy

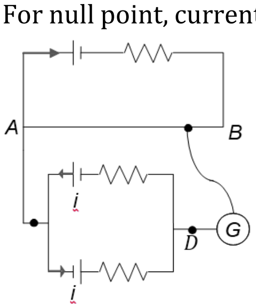
(c) Potential difference $=E=ir$, when battery supplies energy. It is $E+ir$, when battery consumes energy

By KVL, $i=\frac{E_1-E_2}{r_1+r_2}$ (anticlockwise)

$$V_P-V_Q=E_1-ir_1=\frac{E_1r-E_2r}{r_1+r_2}$$

384 **(a,b)**

For null point, current flows in the loop CD only



$$i=\frac{3V}{2\Omega+1\Omega}=1\text{A}$$

$V_{CD}=1\text{V}-1(1)=0$

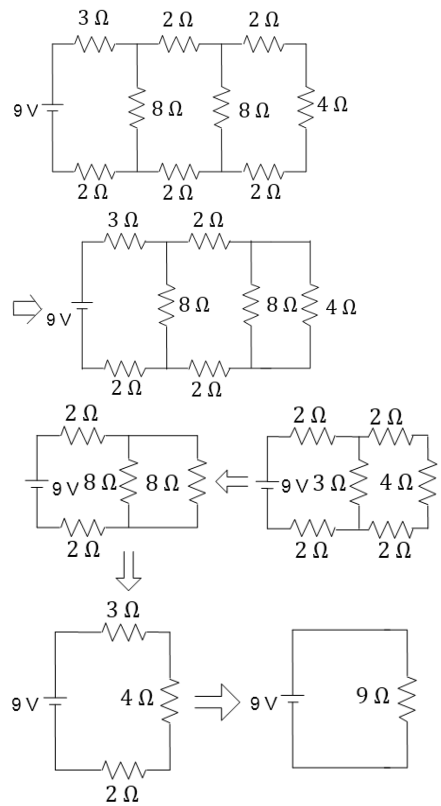
Therefore, option (a) is correct. That is $V_A>V_B$, When jockey touches B, current from A to B

increases the P.D. across the secondary circuit

Therefore, option (b) is correct

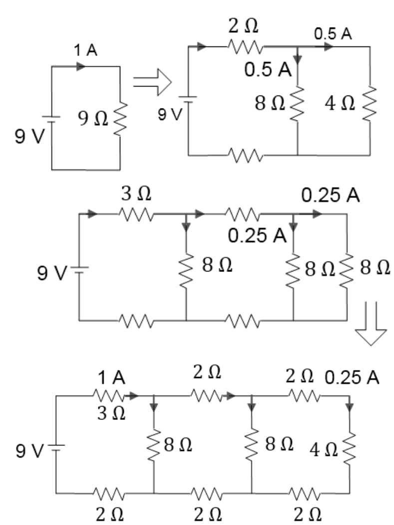
385 **(d)**

The net resistance of the circuit is 9 Ω as shown in Fig



The current flowing in the circuit is $I=V/R=9\ V/9\ \Omega=1.0$ A

The flow of current in the circuit is as follows. Please note that the current gets divided into two equal parts if it passes through two equal resistances



386 **(b,c)**

The potential measures the exact value of e.m.f. of a battery. Therefore, $E=1.55$ V

Also, $1.4 = I = (280)$ $\therefore I = 0.005$ A

Also, $V = E - Ir$ $\therefore r = \frac{(E-V)}{I} = \frac{1.55-1.40}{0.005} = 30\ \Omega$

387 **(a,b)**

$$\frac{R}{(R_1+R_2)} = \frac{L/4}{3L/4}$$

$$3R = (R_1 + R_2)$$

$$\frac{R_1+R_2}{R} = \frac{2/3}{1/3}$$

$$3R = R_2 + R_1$$

$$R = 2R_2 - R_1$$

$$4R = 3R_2$$

$$R_1 = \frac{5R}{3}$$

$$R_2 = \frac{4R}{3}$$

388 **(a, b, c)**

Current through the circuit $I = \varepsilon/(r+R)$

Power dissipated in external resistance is

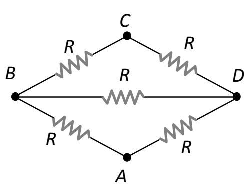
$$P = I^2R = \frac{\varepsilon^2}{(r+R)^2}R$$

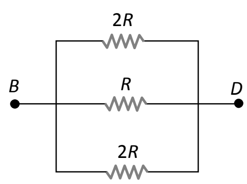
We know that power dissipated is maximum when $r = R$

$$P_{\max} = \frac{\varepsilon^2 r}{(2r)^2} = \frac{\varepsilon^2}{4r} = 9\text{ w}, i = \frac{\varepsilon}{2r} = 3\text{ A}$$

Solve to get, $\varepsilon = 6$ V and $r = 1\ \Omega$

389 **(b, c)**





$$\frac{1}{R_{BD}} = \frac{1}{2R} + \frac{1}{R} + \frac{1}{2R} \Rightarrow R_{BD} = \frac{R}{2}$$

Between A and C circuit becomes equivalent to balanced Wheatstone bridge so $R_{AC} = R$

390 **(a,c)**

$$H = \frac{V^2}{R_1}t_1 = \frac{V^2}{R_2}t_2$$

or $R_1 = \frac{H}{V^2 t_1}$ and $R_2 = \frac{H}{V^2 t_2}$

When heaters are in series,

$H = \frac{V^2 t}{(R_1+R_2)}$ ....(i)

When heaters are in parallel,

$H = \left(\frac{V^2}{R_1} + \frac{V^2}{R_2}\right)t$ ....(ii)

Putting the values of R_1 and R_2 in Eq. (i) , we have $t = t_1 + t_2$.

When the values of R_1 and R_2 is put in (ii), we shall get

$$t = \frac{t_1 t_2}{t_1 + t_2}.$$

391 **(b,c)**

If polarity of E_2 is reversed, then

$I_2 = \frac{E_2}{R_2}$ and $I_1 = \frac{E_1+E_2}{R_1}$

For $I_1 = I_2$, $R_1 > R_2$

392 **(b,c)**

$G = 100\Omega, I_g = 50 \times 10^{-6}\ amp$

For ammeter, a shunt has to be added, so that

$$I_g.G = (I - I_g)S$$

or $S = \frac{I_g.G}{I - I_g}$

Now $I_g = 50 \times 10^{-6}$amp

For option $(c), i.e., I = 5mA$

$I_g <<< I$

Hence, $S = (100)\left[\frac{50\times10^{-6}}{5\times10^{-3}-50\times10^{-6}}\right]$

$S = 1\Omega$

And for voltmeter, a higher resistance is required

$$R = V/I_g - G = \frac{10}{50\times10^{-6}} - 100 = 200\ k\Omega$$

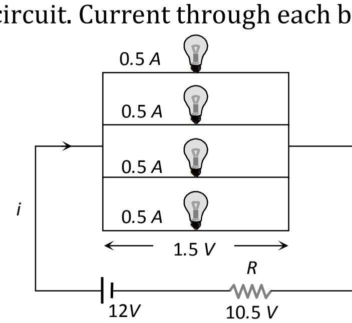
Thus by checking it, only (b) and (c) are correct

393 **(a,c,d)**

All the electrical appliances are connected in parallel. If a switch is used in parallel with an appliance, the current will flow through appliance when switch is off and appliance works. If the switch is closed, the maximum current flows through circuit, the fuse will burnout.

394 **(b,d)**

For normal brightness of each bulb see following circuit. Current through each bulb $= 0.5\ A$



So main current $i = 2A$

Also, voltage across the combination $= 1.5V$

So voltage across the resistance $= 10.5\ V$

Hence for resistance $V = iR \Rightarrow 10.5 = 2 \times R \Rightarrow$ $R = \frac{21}{4}\Omega$

Power dissipated in $R = \frac{(10.5)^2}{21/4} = 21\ W$

395 **(a,b,d)**

Total charge $= \int I dt$ =Area under the curve = 10 C

Average current $=\frac{\int I dt}{\int dt} = 5\text{A}$

Total heat produced $= \int I^2\, dt$

$$= \int_0^2 (-5t+10)^2 1 dt = \frac{200}{3}\text{J}$$

Maximum power $= I^2R$ when I is maximum current $= 100 \times 1 = 1000\text{W}$

396 **(a,d)**

Resistance of upper bulb. $R_1 = 100^2/25 = 400\ \Omega$

Resistance of lower bulb, $R_2 = 200^2/100 = 400\ \Omega$

Equivalent resistance of the circuit: $R_{\text{eq}} = 500\Omega$

Heat lost per second in the circuit is $e^2/R_{\text{eq}} = 200^2/500 = 80\text{J s}^{-1}$

Potential difference across branched AB and CD will be same. Hence, ratio of heat generated in them is

$$\frac{\text{Heat}_{\text{AB}}}{\text{Heat}_{\text{Cd}}} = \frac{R_{\text{CD}}}{R_{\text{AB}}} = \frac{1000}{500} = 2.1$$

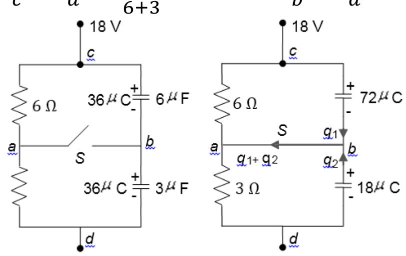
Hence, (c) is incorrect

Since potential difference across branched AB and CD will be the same but their resistances are different, so current in them will be different. AS the resistances of the bulbs are same, so heat generated in them will be different. Hence, (b) is incorrect. Current drawn from the cell is $e/R_{eq} = 200/500 = 0.4\text{ A}$

397 **(a, c)**

When S is opened: $V_c - V_a = \frac{18\times6}{6+3} = 12\text{ V}$

$V_c - V_a = \frac{18\times6}{6+3} = 6\text{ V} \Rightarrow V_b - V_a = 12 - 6 = 6\text{ V}$



Charges flown after S is closed:

$q_1 = 72 - 36 = 36\ \mu\text{C}, q_2 = 36 - 18 = 18\mu\text{C}$

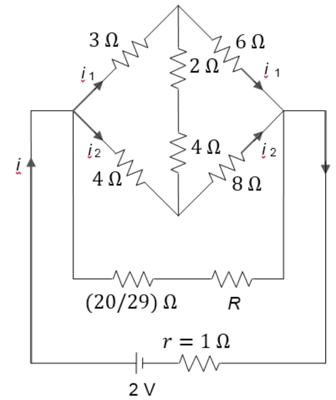
Charges flown through S after it is closed

36+18=54 μC

Final potential of b is 6 V

398 **(a,b,c)**

In the simplified circuit, the circuit is a balanced wheastoen bridge and a branch of $20/29\ \Omega$ and R is parallel with this balanced bridge for maximum power



$r = R_{\text{external}}$

$$1 = \frac{1}{\frac{1}{(3+6)} + \frac{1}{(20/29+R)} + \frac{1}{(4+8)}}$$

Or $R = \frac{16}{25}\ \Omega$

Maximum power developed in the external circuit is

$$P_{\text{max}} = i^2R = \left(\frac{2}{1+1}\right)^2 \times 1 = 1\text{ W}$$

Current through the upper branch

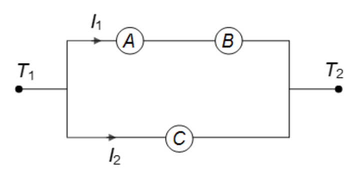
$$i_1 = i\left[\frac{\left(\frac{20}{29}+R\right)(4+8)}{9+\left(\frac{20}{29}+R\right)+12}\right]$$

$$i_2 = i\left[\frac{\left(\frac{20}{29}+R\right)(3+6)}{9+\left(\frac{20}{29}+R\right)+12}\right]$$

Therefore, i_1/i_2 is independent of R

399 **(a,b,d)**

As A and B are connected in series, hence $IA = IB$. the potential difference across both the branches will be the same



$I_AR_B + I_BR_B = I_CR_C$ or $\frac{I_B}{I_C} = \frac{R_C}{R_A+R_B}$

400 **(a,d)**

Let resistance of voltmeter be R_1, Then the equivalent resistance of circuit is

$$R_{\text{eq}} = R_2 + \frac{R_1R_V}{R_1+R_V} = \frac{R_1R_2+R_2R_V+R_VR_1}{R_1+R_V}$$

$$I = \frac{E}{R_{eq}} = \frac{E(R_1+R_V)}{R_1R_2+R_2R_V+R_VR_1}$$

On putting voltmeter across R_2, we can get current

$I' = \frac{E(R_2+R_V)}{R_1R_2+R_2R_V+R_VR_1}$ as $R_1 > R_2 \Rightarrow I > I'$

If voltmeter is ideal, then in both cases R_1 and R_2 will be in series and current in both cases will be

$I = E(R_1 + R_2)$

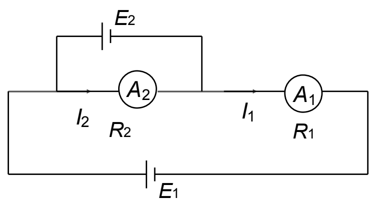
401 **(b,c)**

(Moderates) as the length is doubled, the cross-sectional area of the wire becomes half, thus the resistance of the wire $R = \rho \frac{L}{A}$ becomes four times the previous value. Hence, after the wire is elongated, the current becomes one-fourth. Electric field is potential difference per unit length and hence becomes half the initial value. The power delivered to resistance is $P = \frac{V^2}{R}$ and hence becomes one-fourth

402 **(a,b,d)**

By applying Kirchhoff's law, we can obtain

$I_2 = \frac{E_2}{R_2}$ and $I_1 = \frac{E_1 - E_2}{R_1}$



If $E_1 > E_2, I_1$ and I_2 can be the same for some value of R_1 and R_2, hence (a) is correct.

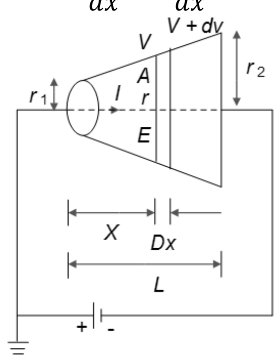
For (b) : if $E_2 > E_1$, then I_1 will be in the direction opposite to that shown in the figure and magnitude of I_1 will be $I_1 = (E_2 - E_1)/R_1$

Now I_1 and I_2 can be the same only if $R_1 < R_2$

403 **(b,c)**

$V - (V + dV) = IdR \Rightarrow -dv = IdR$

$$E = -\frac{dV}{dx} = I\frac{dR}{dx} \Rightarrow E = \frac{I\rho dx}{Adx} = \frac{I\rho}{A}$$



We can find $r = \frac{r_1 l + x(r_2 - r_1)}{l}$, $A = \pi r^2$

$E = \frac{I\rho}{A} = \frac{I\rho}{\pi r^2} = \frac{I\rho l^2}{\pi[r_1 l + x(r_2 - r_1)]^2}$; option (a) is incorrect,

Rate of heat generation in length dx

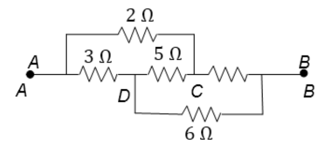
$$dQ = I^2 dR = \frac{I^2 \rho dx}{A} = \frac{dQ}{dx} = H = \frac{I^2 \rho}{A}$$

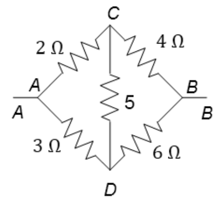
Hence, option (b) is correct.

$H = 1\left(\frac{1\rho}{A}\right) = IE$, Hence option (c) is correct

At $x = 0$, V is zero hence option (d) is incorrect

404 **(a, d)**





Rearrangement of the circuit as shown in Figure gives a balanced Wheatstone bridge, and no current flow through the 5Ω resistor. It can thus be removed from the circuit

405 **(b, c, d)**

Just after closing the switch, capacitors will act like conducting wires. Find the equivalent resistance and calculate the current.

After a long time, the switch is closed, no current flows in the circuit as the capacitors act like infinite resistance

Heat developed= $(1/2)C_{\text{eq}}V^2$

406 **(a,c)**

Resistance 4 and 6 Ω are short-circuited.

Therefore, no current will flow through these two resistances.Current passing through these two resistance. Current passing through the battery is $I = (20/2) = 10$ A.

This is also the current passing in wire AB from B to A

Power supplied by the battery is

$P = EI = (20(10) = 200$ W

Potential difference across the 4 Ω resistance = potential difference across the 6 Ω resistance $= 0$

407 **(b,d)**

Induced emf $e = -\frac{d\Phi}{dt}$. For identical rings induced emf will be same. But currents will be different.

Given $h_A > h_B$.Hence

$V_A > V_B \left(h \equiv \frac{V^2}{2g}\right)$.

If $\rho_A > \rho_B$ then $I_A < I_B$. In this case given condition can be fulfield if $m_A < m_B$. If $\rho_A < \rho_B$, then $I_A < I_B$. In this case given condition can be fulfield if $m_A \leq m_B$

408 **(a,c)**

The circuit is satisfying the condition of balance$\left(\frac{P}{Q} = \frac{R}{S}\right)$

of a Wheatstone bridge. There exists a potential difference between points B and D cell of emf 2V joined between these points. Hence $V_B - V_D = 2\text{V}$.

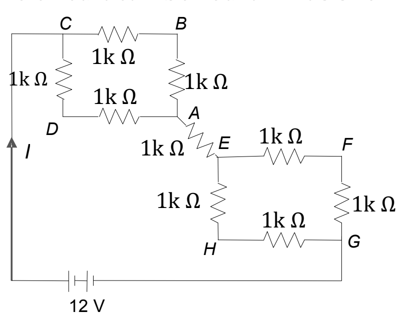
A current also flows in branch BD due to this cell of emf 2V in the direction from D to B

409 **(a, d)**
When X is joined to Y for a long time (charging), energy stored in the capacitor=heat produced in $R = H$. When X is joined to Z (discharging), the energy stored in $C(= H_1)$ reappears as heat (H_2) in R. Thus, $H_1 = H_2$

410 **(b,c)**
When switch S is open, R_1 and R_2 are short-circuited. E will be divided among V_1 and V_2 only. After closing the switch, V_1, R_1 and R_2 will be in parallel. Their effective resistance will be less than the resistance of V_1. Hence, p.d. across V_2 decreases and so across V increases

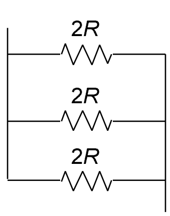
411 **(a,d)**
Equivalent resistance of the circuit = (2.5+1.5) = 4Ω
Current through battery is $I = 20/4 = 5$ A
Current through P = current through
$Q = 5/2 = 2.5$ A
$V_A - V_Q = 3 \times 2.5 = 7.5$ V
$V_A - V_Q = 2 \times 2.5 = 5$ V
From Eqs. (i) and (ii), we get $V_Q - V_P = 2.5$ V

412 **(a, b, d)**
The circuit can be redrawn as shown in the figure



$R_{eq} = 3$ kΩ, $I = \frac{12}{3\times10^3} = 4\text{mA}$
$V_E - V_G = I(1\text{k}\Omega) = 4 \times 10^{-3} \times 1 \times 10^3 = 4$ V

413 **(a)**
The equivalent circuit is represented as



Now, the resistances $2R$, $2R$ and R are connected in parallel combination. Hence, equivalent resistance is given by

$$\frac{1}{R_P} = \frac{1}{2R} + \frac{1}{2R} = \frac{1}{2R} = \frac{6}{2R} = \frac{3}{R} \Rightarrow R_P = \frac{R}{3}$$

414 **(c)**
Resistance of 40 W lamp is given by

$$R = \frac{V^2}{P} = \frac{(220)^2}{40} = 1210\Omega$$

Resistance of 100 W lamp is given by

$R = \frac{V^2}{P} = \frac{(220)^2}{100} 484\ \Omega$

Current through series combination is given by

$i = \frac{440}{(1210+484)} = 0.26$ A

Hence, potential drop across 40 W lamp

$= 1210 \times 0.26 = 314.6$ V

Hence, 40 W bulb will fuse because lamp can tolerate 220 V.

415 **(b)**
Neutral temperature is the temperature of hot junction, at which the thermos e.m.f. produced in the thermocouple becomes maximum. It is independent of cold junction and depends on the nature of materials of two metals used to form thermocouple

417 **(b)**
Both statements I and II are true. In statement I, R is varied while in Statement II, R is kept constant. Hence, both statement are independent

418 **(a)**
From the Faraday's first law

$m = zit = z\,q$

Here, z stands for electrochemical equivalent of substance.

Hence, $\frac{m_1}{m_2} = \frac{z_1}{z_2} = \frac{w_1}{w_2}$

$$\therefore \frac{0.8}{m_2} = \frac{8}{108} \Rightarrow m_2 = \frac{0.8 \times 108}{8}$$

= 10.8 g

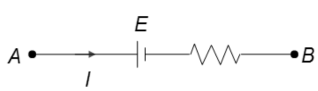
419 **(d)**
It is true that resistance of a wire is directly proportional to its length, but here when length is doubled, area of cross section decreases as the volume remains constant. Finally, resistance becomes n^2 times

420 **(b)**
Here reason is not the correct explanation of the assertion, which is correct

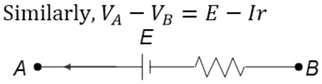
421 **(a)**
The e.m.f. of a Leclanche cell falls because of the partial polarisation due to accumulation of hydrogen gas. In case Leclanche cell is used in experiment where current is drawn after short breaks, then during each break hydrogen gas escapes and Mn_2O_3 converts into MnO_2 by taking oxygen from the atmosphere. As a result, the cell regains its original e.m.f

422 **(e)**
Voltage of dc source is constant but in ac, peak value of voltage is $\sqrt{2}$ times the rms voltage. Hence bulb will glow with more brightness when connected to an ac source of the same voltage

423 **(a)**
$V_A - E - Ir + V_B \Rightarrow V_A - V_B = E + Ir$



Similarly, $V_A - V_B = E - Ir$



424 **(a)**
Charge on capacitor $q = CE(1 - e^{-t/CR_{eq}})$

$$\therefore \quad I = \frac{dq}{dt} = \frac{E}{R_{eq}} e^{-t/CR}$$

At $t = 0,\ I = \frac{E}{R_{\text{eq}}} + \frac{E}{R+r}$

Therefore, resistance offered by the capacitor is zero.

425 **(a)**
s

426 **(d)**

$$H \propto I^2 \Rightarrow \frac{H_2}{H_1} = \left(\frac{I_2}{I_1}\right)^2 = \left(\frac{1.2I_1}{I_1}\right)^2 = 1.44$$

There is 44% increase in illumination

427 **(a)**
The potential difference across resistance R_1 is always $|E_1 - E_2|$. Hence, assertion and reason are true and the reason is the correct explanation of the assertion

428 **(b)**
On increasing temperature of wire the kinetic energy of free electrons increase and so they collide more rapidly with each other and hence their drift velocity decreases. Also when temperature increases, resistivity increases and resistivity is inversely proportional to conductivity of material

429 **(a)**
The electrical appliances with metallic body like heater, press etc. have three pin connections. Two pins are for supply line and third pin is for earth connection for safety purposes

430 **(c)**
Because there is no special attractive force that keeps a person stuck with a high power line. The actual reason is that a current of the order of 0.05 A or even less is enough to bring disorder in our nervous system. As a result of it, the affected person may lose temporarily his ability to exercise his nervous control to get himself free from the high power line

431 **(a)**
The possibility of an electric bulb fusing is higher at the time of switching ON and switching OFF because inductive effect produces a surge at the time of switching ON and OFF

432 **(d)**
If the diameter of wire AB is increased, its resistance will decrease. Hence, the potential difference between A and B due to cell C_1 will decrease. Therefore, the null point will be obtained at a higher value of x

433 **(d)**
Voltmeter gives terminal potential (V) though it can give e.m.f. if internal resistance of the cell is

zero

434 **(a)**

When a voltmeter is connected across the two poles of a call, it draws a small current from the cell. So, it measures terminal potential difference between the two poles of the cell, which is always less than the emf of the cell.

On the other hand, when a potentiometer is used for the measurement of emf of a cell it does not draw any current from the cell. Hence, it accurately measures the emf of a cell. Thus, a potentiometer is preferred over a voltmeter.

435 **(d)**

The lower the resistance of an ammeter, the higher the range

436 **(a)**

Here, $E = 2V, i = \frac{2}{2} = 1A$ and $r = 1\Omega$

Therefore, $V = E - ir = 2 - 1 \times 1 = 1V$

437 **(b)**

On increasing temperature of the wire the K.E. of electrons increase and so they collide more rapidly with each other and hence their drift velocities decrease. Resistivity also increases and resistivity is inversely proportional to conductivity of material

438 **(b)**

To start a car, a very high current is required. A car battery has very low internal resistance, so it can provide the required high current. When eight dry cells are joined in series, the internal resistance of the combination becomes very high. Due to this high internal resistance, small current will be drawn from it.

Hence, such cells cannot be used to start a car.

On a warm day, the internal resistance of car battery decreases and so large current can be drawn from the battery. But on a chilly day, the reverse process occurs.

440 **(c)**

From relation $\vec{J} = \sigma\vec{E}$, the current density $\vec{J}$ at any point in ohmic resistor is in direction of electric field $\vec{E}$ at that point. In space having non-uniform electric field, charges released from rest may not move alongEL. Hence, statement I is true while statement II is false

441 **(c)**

The equivalent circuit is represented as,

$$\frac{1}{R_{\text{AB}}} = \frac{1}{R+R} + \frac{1}{R+R}$$

Or

$$\frac{1}{R_{\text{AB}}} = \frac{1}{2R} = \frac{1}{R} \Rightarrow R_{\text{AB}} = R$$

This is balanced Wheatstone bridge hence, resistance in branch MN is not taken into consideration. Hence, the equivalent resistance between points A and B is given by

442 **(d)**

$V = E + ir$ when charging of cell takes place

443 **(a)**

Copper is a conductor and germanium is a semi-conductor

444 **(a)**

$v_d = I/neA$, If radius is doubled, A becomes four times and hence V_d becomes one- fourth

445 **(d)**

When switch S is closed, bulb C is short circuited, so voltage V distributes only in two parts $i.e.$ voltage on bulb A and B increases as compared previously. Hence illumination of bulb A and B increases

446 **(a)**

In a balanced condition, the potentiometer does not draw any current, and hence does not disturb the circuit

447 **(d)**

It is quite clear that in a battery circuit, the point of lowest potential is the negative terminal of the battery and the current flows from higher potential to lower potential

448 **(d)**

When two bulbs are connected in series then resistance of the circuit increase therefore voltage in each will decrease, so the brightness and temperature also when the temperature decrease the resistance of carbon filament slightly increases and the resistance of metal filament will decrease. Therefore, the bulb consisting of carbon filament will glow more than metallic filament bulb from relation $P = i^2 R$. Carbon is a semiconductor. It is found in IVA group of periodic table

449 **(c)**
From the relation for $V - i$ graph

$R = \tan\theta = R_0(1 + \alpha T)$

Where, θ is angle made by $V - i$ graph with i axis.

So, $R_1 = \tan\theta = R_0(1 + \alpha T_1)$...(i)

$R_2 = \tan(90° - \theta) = \cot\theta$

$= R_0(1 + aT_2)$

So,$\cot\theta - \tan\theta = R_0\alpha(T_2 - T_1)$

or $\frac{\cos\theta}{\sin\theta} - \frac{\sin\theta}{\cos\theta} = R_0\alpha(T_2 - T_1)$

$$\frac{\cos^2\theta - \sin^2\theta}{\sin\theta\cos\theta} = \frac{2\cos 2\theta}{\sin 2\theta} = R_0\,\alpha(T_2 - T_1)$$

Hence, $T_2 - T_1 \propto \cot 2\theta$

450 **(d)**
The condition for no deflection of the galvanometer is $\frac{R_1}{R_2} = \frac{R_{AC}}{R_{CB}}$

Where R_{AC} and R_{CB} are the resistances of the bridge wire of length AC andCB, respectively. If the radius of the wire AB is doubled, the ratio R_{AC}/R_{CB}will remain unchanged. Hence, the balance length will remain the same

451 **(d)**
Here, temperature of cold junction

$\theta_c = 15°C$

Neutral temperature $\theta_n = 270°C$

If θ_i is temperature of inversion, then

$$\theta_n = \frac{\theta_i + \theta_c}{2}$$

or $\theta_i = 20\theta_n - \theta_c = 2 \times 270 - 15°$

$= 540 \times 15 = 525°C$

452 **(a)**
Resistance of 50 W bulb is two times the resistance of 100 W bulb. When bulbs are connected in series, 50 W bulb will glow more as $P - i^2R$ (current remains same in series). In parallel the 100 W bulb will glow more as $P = V^2/R$ (potential difference remains same in parallel)

453 **(a)**
According to Faraday's second law of electrolysis, the masses of silver and zinc deposited will be proportional to the respective equivalent weights. We know that equivalent of silver is 108 and that of zinc is nearly 32. Hence, silver deposited is

$$\frac{z_1}{z_2} = \frac{w_1}{w_2}$$

$$\Rightarrow \frac{32}{108} = \frac{w}{w_2}$$

$$\therefore\ w_2 = \frac{108}{32}w = 3.375w = 3.5w$$

454 **(a)**
Principle of a potentiometer states that drop of potential across any segment of the potentiometer wire is directly proportional to its length. This can be satisfied if the wire of the potentiometer has a uniform area of cross section

455 **(b)**
The temperature co-efficient of resistance for metal is positive and that for semiconductor is negative.

In metals free electrons (negative charge) are charge carries while in P-type semiconductors, holes (positive charge) are majority charge carriers

456 **(a)**
The heat generated in heater coil is

$$Q_1 = \frac{V^2t}{R}$$

When half of the coil is used in heater then the resistance halved, and so the heat generated is

$$Q_2 = \frac{V^2 t}{\frac{R}{2}} = 2\frac{V^2 t}{R} = 2Q_1$$

Hence, the heat generated b half of coil will be doubled.

457 **(c)**
A laser beam is a beam of light which is light amplification by simulated emission of radiation

The energy per unit area of the laser beam is very high as compared to the torch light

458 **(a)**
Resistance of the connecting wires is much smaller than the electric appliances to which current is supplied by the wires

459 **(a)**
When lamp B or C gets fused equivalent resistance of B and C increases. In series voltage distributes in the ratio of resistance, so voltage appearing across B increases or in other words voltage across A decreases

460 **(c)**
In a conductor there are large number of free electrons. When we close the circuit, the electric field is established instantly with the speed of electromagnetic wave which causes electrons to drift at every portion of the circuit. Due to which the current is set up in the entire circuit instantly. The current which is set up does not wait for the electrons flow from one end of the conductor to the another end. It is due to this reason, the electric bulb glows immediately when switch is on

461 **(a)**
The resistance, $R = \frac{V^2}{P} \Rightarrow R \propto 1/P$

$i.e.$, higher the wattage of a bulb, lesser is the resistance and so it will glow bright

462 **(a)**
If either the e.m.f. of the driver cell or potential difference across the whole potentiometer wire is lesser than the e.m.f. of the experimental cell, then balance point will not obtained

463 **(a)**
If resistance of a voltmeter is not infinite, it will draw some current from the circuit and finally the reading will be less than actual

464 **(b)**
Let R $_1$, R $_2$ be two resistances. Suppose R $_2$ >R $_1$ then if they are connected in series combination, the equivalent resistance R $_1$ is,

$$R_s = R_1 = R_2$$

Hence, it is obvious that R_s will be larger than highest resistance R_2

Again when the resistances are connected in parallel the equivalent resistance is,

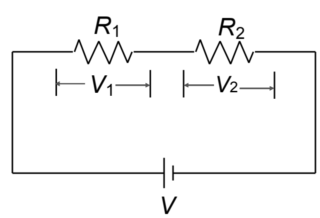
$$\frac{1}{R_p} = \frac{1}{R_1} = \frac{1}{R_2}$$

$$R_p = \frac{R_1 R_2}{R_1 + R_2}$$

It is also clear that R_p will be smaller than the smallest resistance R_1.

465 **(a)**
In series, current in both resistances will be the same. For the same current, the more is the resistance, the more is the potential drop

466 **(a)**
If a series combination of two resistance R_1 and $R_2 (> R_1)$ is connected across a cell then current in both resistances will be same.



$\therefore I$ =constant

or $\frac{V}{R}$ =constant

$$\therefore \frac{V_1}{V_2} = \frac{R_1}{R_2}$$

As $R_1 < R_2$ or $\frac{R_1}{R_2} < 1$

$$\therefore \frac{V_1}{V_2} < 1 \text{ or } V_1 < V_2$$

Hence, on larger resistance, the potential drop will be maximum

467 **(a)**

Heat produced per second in an electrical appliance is given by

$$H = \frac{V^2}{R} \text{ or } H \propto \frac{1}{R}.$$

As toaster has less resistance than that of bulb hence, it is clear that more heat will be produced in comparison with a bulb, when it connected in parallel with the bulb.

468 **(d)**

As the length of the wire is doubled, the cross-sectional area of the wire becomes half. Therefore, resistance of the wire becomes four times and the current becomes one-fourth of the initial value

Also, $V_d = \frac{I}{neA}$

Since current becomes one-fourth and cross-sectional area of the wire becomes half, therefore, from the above equation the drift velocity of electron becomes half. Hence, statement I is false

469 **(a)**

It is clear that electrons move in all directions haphazardly in metals. When an electric field is applied, each free electron acquire a drift velocity. There is a net flow of charge, which constitute current. In the absence of electric field this is impossible and hence, there is no current

470 **(c)**

The resistance of a galvanometer is fixed. In metre bridge experiments, to protect the galvanometer from a high current, high resistance is connected to the galvanometer in order to protect it from any damage

471 **(a)**

If either the e.m.f. of the driver cell or the potential difference across the whole potentiometer wire is lesser than the e.m.f. of the experimental cell, the balance point will not be obtained

472 **(d)**

In a simple battery circuit, the point at the lowest potential is the negative terminal of battery. The current flows in the circuit from positive terminal to negative terminal

473 **(c)**

The electrons suffer a large number of collisions with the positive ions of the conductor. Although the electric filed accelerates an electron between two collisions, it is decelerated by collision. The net acceleration averages out to zero and the electron acquires a constant average speed. The gain in speed between collisions is lost in the next collision

474 **(b)**

Both the statements are correct, but independent of each other

475 **(d)**

The electrons are in motion which constitute electric current in a conductor but numbers of positive and negative charges are same.

476 **(d)**

Power used $= i^2 R$

Hence, power is consumed, not the current

477 **(c)**

On increasing the temperature of metals, the resistance of metal increases. Therefore, the temperature coefficient of resistance of metals is positive.

On increasing the temperature of the insulators, the resistance decreases. Therefore, the temperature coefficient of the resistance of insulators is negative

478 **(c)**

The smaller is the resistance, the more is the current in parallel

479 **(a)**

When current flow through a conductor it always remains uncharged. Hence, no electric field is produced outside it.

480 **(a)**

Resistance wire $R = \rho \frac{l}{A}$, where ρ is resistivity of material which does not depend on the geometry of wire. Since when wire is bent resistivity, length and area of cross-section do not change, therefore resistance of wire also remain same

481 **(d)**

Internal resistance is drawn in series with battery

482 **(a)**

As filament of bulb and line wire are in series, hence current through both is same. Because $H = \frac{i^2Rt}{4.2}$ and resistance of the filament of the bulb is much higher than that of line wires, hence heat produced in the filament is much higher than that of line wires

483 **(a)**

here$E = 2$ V, $I = \frac{2}{2}$1A and $r = 1\Omega$

$V = E - ir = 2 - (1)(1) = 1$V

484 **(c)**

The resistance of the galvanometer is fixed. In meter bridge experiments, to protect the galvanometer from a high current, high resistance is connected to the galvanometer in order to protect it from damage

485 **(a)**

Voltmeter measures current indirectly in terms of mass of ions deposited and electrochemical equivalent of the substance $\left(I = \frac{m}{Zt}\right)$. Since value of m and Z are measured to 3rd decimal place and 5th decimal place respectively. The relative error in the measurement of current by voltmeter will be very small as compared to that when measured by ammeter directly

486 **(b)**

The electric power of a heater is more than that of a bulb As $P \propto \frac{1}{R}$, the resistance of heater is less than that of the electric bulb, when a heater connected in parallel to the bulb switched on, it draws more current due to its lesser resistance, consequently, the current through the bulb decreases and so it becomes dim.

When the heat coil becomes sufficiency hot, its resistance becomes more and then it draws a little lesser current. Consequently, the current through the electric bulbs recovers

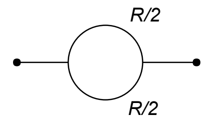
Hence, dimness of the bulb decreases

487 **(d)**

Resistance of metallic wire increase with rise of temperature

488 **(a)**

resistance is $R/4$



490 **(a)**

$V = IR \Rightarrow V = neAv_d\frac{\rho l}{A} \Rightarrow v_d = \frac{v}{ne\rho l} \Rightarrow v_d \propto \frac{1}{l}$

491 **(c)**

Drift velocity is directly proportional to electric field. If there is no electric field, then there is no drifting of electrons in a particular direction, hence no current in the conductor

492 **(c)**

Thomson e.m.f. in lead is practically zero

494 **(d)**

Here assertion and reason are not correct

495 **(b)**

From the formula

$P = \frac{V^2}{R}$ ...(i)

But $R = \frac{\rho l}{A}$ ...(ii)

Now, from Eqs. (i) and (ii) , we have

$$P = \frac{V^2}{\frac{\rho l}{A}} = \frac{V^2A}{\rho l}$$

$$\Rightarrow P \propto \frac{1}{\rho} \Rightarrow P \propto \rho^{-1}$$

496 **(a)**

Drift velocity of free electrons is given by

$$V_d = \frac{eE}{m}\tau$$

Here, $E = \frac{V}{l}$

$$\therefore v_d = \frac{eV}{ml}\tau$$

or $v_d \propto \frac{1}{l}$ $\left(\frac{eV}{m} = \tau \text{ is constant}\right)$

497 **(a)**

The maximum current that can be tolerated by a fuse wire in independent of its length. So, length is immaterial for fuse wire.

A safely fuse is basically a piece of wire having a suitable high resistivity and low melting point so that it breaks if the current in it exceeds the safe limit

498 **(a)**
s

500 **(a)**
Sensitivity $\propto \frac{1}{\text{Potential gradient}}$
$\propto$ (Length of wire)

501 **(c)**
Assertion is true but reason is false. Fuse wire must have high resistance because in series current remains same, therefore according to Joule's law $H = \frac{i^2Rt}{4.2}$, heat produced is high if R is high. The melting point must be slow so that wire may melt with increase in temperature. As the current equal to maximum safe value flows through the fuse wire, it heats up, melts and breaks the circuit

502 **(b)**
Heater wire must have high resistance than connecting wires so that most of the potential drops across the heater wire. Because in series the more the resistances, the more the potential difference. Obviously, it should have high melting point

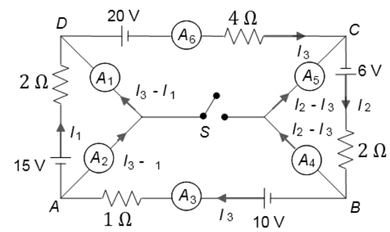
503 **(d)**
Direction of flow of current is from higher potential to lower potential

504 **(b)**
Here assertion and reason both are correct but the reason is not the correct explanation of assertion

505 **(c)**
The metallic body of the electrical appliances is connected to the third pin which is connected to the earth. This is actually a safety precaution and avoids eventual electric shock. In this process, the extra charge flowing through the body is passed to earth.

The three pin connections do not affect on heading of connecting wires

506 **(d)**
When S is open:



$I_1 = \frac{15}{2} = 7.5\text{A}$

$I_2 = \frac{6}{2} = 3\text{A}$

Loop $ADCBA$:

15-20+6+10=$2I_1 + 4I_3 + 2I_2 + 1I_3$

$I_3 = -2\text{A}$

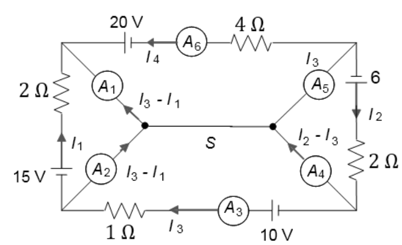
Current in A_1 and A_2:

$I_3 - I_1 = -2 - 7.5 = -9.5$ A

Current in A_4 and A_5:

$I_2 - I_3 = 3 - (-2)$ =5 A

After closing S:



$I_1 = \frac{15}{2} = 7.5\text{A}$

$I_2 = \frac{6}{2} = 3\text{A}$

$I_3 = \frac{10}{1} = 10\text{A}$

$I_4 = \frac{20}{4} = 5$ A

Current in A_1:

$I_1 + I_4 = 7.5 - 7.5 = 12.5$ A

Current in A_2:

$I_3 - I_1 = 10 - 7.5 = 2.5\text{A}$

Current in A_4:

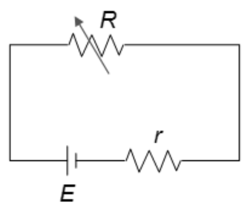
$I_2 - I_3 = 3 - 10 = -7\text{A}$

Current in A_5:

$I_4 - I_2 = 5 + 3 = 8\text{ A}$

507 **(a)**

a. we know that power developed by R is maximum for $R = r$

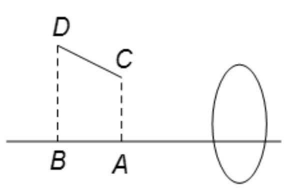


b. initially, angle between area vector of loop and magnetic field is 90°, it becomes zero and then again after 90° after 180° rotation

$\emptyset = BA\cos\theta$

$e = \frac{d\phi}{dt} = BA\sin\theta\left(\frac{d\phi}{dt}\right) = BA\,\omega\sin\theta$

c. AB is the angle of the rod before the lens is displaced. CD is the image of the rod after displacing the lens perpendicular to the principle axis



d. $Z = \sqrt{R_2 + X_C^2} = \sqrt{R^2 + \left(\frac{1}{\omega C}\right)^2}$

As ω is increased, z is decreased, so current through bulb will increase thus increasing the brightness

508 **(a)**

Charging rate means current $\left(\frac{dq}{dt} = I\right)$. So, if charging rate is maximum, then current is also maximum. Hence, ii →a,d

Charge on the capacitor is maximum in steady state. In steady state current becomes zero. Hence, ii→ c

Power supplied by the battery is maximum initially because current is maximum initially. At this time, charge on the capacitor is zero. Hence, iii.→c

Difference in the power supplied by battery and power consumed in R is $EI - I^2R = EI - I(IR) = EI - IE = 0$

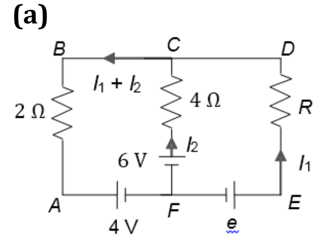
Hence iv.→ c

509 **(b)**

When the switch is closed, equivalent resistance is$R$. After opening the switch, the equivalent resistance becomes 2 R. hence, equivalent resistance increases.

Also current through battery decreases, hence ammeter reading decrease. Current though left R also decrease. So voltmeter reading decreases and power dissipated through left R also decreases

510 **(a)**



Loop $FEDCF$: $e - 6 = RI_1 - 4I_2$ ...(i)

Loop $AFCBA$: $6 - 4 = 4I_2 + 2(I_1 + I_2)$

2$= 2I_1 + 6I_2$

Solving them we get:

$I_1 = \frac{3e - 14}{4 + 3R}, I_2 = \frac{R + 6 - e}{4 + 3R}$

i. $I_2 = 0 \Rightarrow e = R + 6$

e>6V ($\therefore R \neq 0$)

ii. For current from F to C direction

$I_2 > 0 \Rightarrow R + 6 > e \Rightarrow e < R + 6$

Possible for any finite value of e, because R is finite.

iii. For current from C to F direction.

$I_2 < 0 \Rightarrow e > R + 6$

iv. For current in 2 Ω from B to A direction

$$I_1 + I_2 = \frac{R - 8 + 2e}{4 + 3R} > 0$$

$$R - 8 + 2e > 0 \Rightarrow e > 4 - \frac{R}{2}$$

Depending upon the value of R, e can take any value from zero to infinity

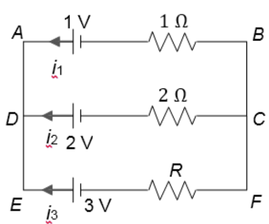
511 **(c)**
Current through any cross section should remain the same

$I = neAv_d$, as area increases, drift velocity decrease

E is directly proportional to v_d, so E also decreases

If E decreases, then p.d. across a segment of fixed length also decreases

512 **(d)**
Let current through various branches is as shown in the figure.



$i_1 + i_2 + i_3 = 0$ ...(i)

$V_A - V_B = V_D - V_C = V_E - V_F$

$1\text{-}1i_1 = 2 - 2i_2 = 3 - Ri_3$ ...(ii)

From Eqs. (i) and (ii), we get

$$i_1 + \frac{2 - 1 + i_1}{2} + \frac{3 - 1 + i_1}{R} = 0 \Rightarrow i_1 = \frac{-(R+4)}{3R+2}$$

Again from Eqs. (i) and (ii), we get

$$\frac{2i_2 - 1}{1} + i_2 + \frac{1 + 2i_2}{R} = 0 \Rightarrow i_2 = \frac{R-1}{3R+2}$$

Now $i_3 = -i_1 - i_2 = \frac{5}{3R+2}$

i. Current i_3 cannot be zero

ii. Current i_1 cannot be zero

iii. $i_2 = 0 \Rightarrow R = 1\Omega$

iv. $i_3 = \frac{5}{8} \Rightarrow \frac{5}{3R+2} = \frac{5}{8} \Rightarrow R = 2\Omega$

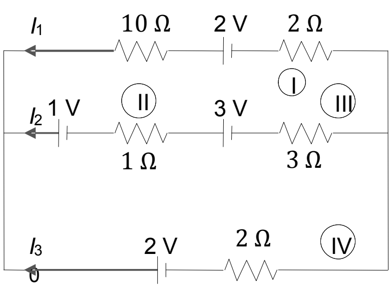
513 **(c)**
We have $I_1 = -\frac{1}{20}$ A, $I_2 = \frac{7}{20}$ A, $I_3 = -\frac{6}{20}$ A

In each cell, thermal energy will be dissipated due to internal resistance whether the chemical energy of the cell is increasing or decreasing

i. Cell I is getting charged, hence its chemical energy increases

ii. Cells II and III both are getting discharged, hence their chemical energies are decreasing. So, work done by both of them is positive

iv. cell IV is getting charged, hence its chemical energy increases

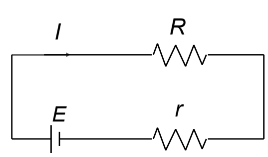


514 **(b)**
When the switch is closed, the equivalent resistance is R. After opening the switch, the equivalent resistance becomes $2R$. Hence, the equivalent resistance increases.

Also, current through the battery decreases, hence ammeter reading decreases. Current through the left R also decreases. So voltmeter reading decreases and power dissipated through the left R also decreases

515 **(d)**

$$I = \frac{E}{R + R}$$



Terminal potential difference across the cell is

$V = E - Ir$

This is maximum if $I = 0$, and this is possible if $R = \infty$. hence, i→ c

Power transferred to R is maximum if $R = r$. In all other cases it will be somewhat less. Hence, ii.→a,b,c,d

Power dissipated in cell = EI. This is maximum if I is maximum, for this $R = 0$. Hence, iii→d

Also if I is maximum, there will be the fastest drift of ions in electrolyte in the cell. Hence, iv→d

516 **(a)**
From relation $J = \sigma\phi$

Multiplying both sides by cross-sectional area of rod A, we get $JA = \sigma EA$ or $i = \sigma\phi$

$\frac{\phi}{i} = \frac{1}{\sigma}$ = resistivity of the rod

$\frac{E}{J} = \frac{1}{\sigma}$ = resistivity of the rod

$\sigma V = iV$ = power delivered to the rod

$\frac{V}{\sigma\phi} = \frac{V}{i}$ = resistance of the rod

517 **(a)**
a. since current in both rods is the same,

$\therefore \quad n_1 e v_1 A_1 = n_2 e v_2 A_2$

$\therefore \quad \frac{v_1}{v_2} = \frac{n_2 A_2}{n_1 A_1} = \frac{1}{2} \times \frac{2}{1} = 1$

b. $\therefore \; E = \rho J = \rho \frac{1}{A}$

$\therefore \; \frac{E_1}{E_2} = \frac{\rho_2}{\rho_1} = \frac{A_2}{A_1} = \frac{2}{1} \times \frac{2}{1} = 4$

c. $\frac{\text{p.d.across rod I}}{\text{p.d.across rod II}} = \frac{E_1 \times AB}{E_2 \times BC} = 4$

d. $\frac{\text{Average time taken by free electron}}{\text{Average time taken by free electron}}$

$\frac{\text{to move from A toB}}{\text{to move from B to C}}$

$= \frac{AB}{V_1} \times \frac{V_2}{BC} = 1$

518 **(a)**
i. Electrical conductivity of a conductor depends on temperature of the material. It decreases with the increase in temperature. It also depends upon the nature of material

ii. Conductance (the reciprocal of resistance) also depends upon dimensions of material apart from temperature and nature of material

iii. $J = \sigma E$, so current density depends upon electric field. For a given conductor, σ is fixed

iv. Current will depend upon resistance which depends upon dimension, temperature and nature of material

519 **(a)**
For 2 V range: $I_g(R_G + R_1) = 2$ V

$\Rightarrow \; R_1 = \frac{2}{10^{-3}} - 40 = 1960\ \Omega = 1.96\ \text{k}\ \Omega$

For 10 V range : $I_G(R_G + R_1 + R_2)$= 10 V

$\Rightarrow \; R_2 = \frac{10}{1 \times 10^{-3}} - 40 - 1960 = 8000\Omega = 8\text{k}\Omega$

For 100 V range: $I_G(R_G + R_1 + R_2 + R_3) = 100$ V

$\Rightarrow R_3 = \frac{100}{10^{-3}} - 40 - 1960 - 8000 = 90000\Omega$
$= 90\text{k}\Omega$

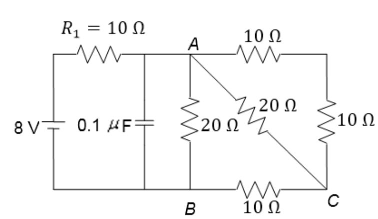
The overall resistance of the meter on 100 V range is

$R_G + R_1 + R_2 + R_3 = 100\ \text{k}\Omega$

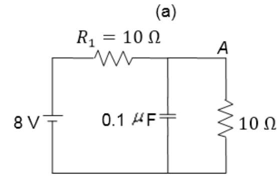
The overall resistance of the meter on 2 V range is

$R_G + R_1 = 2\ \text{k}\Omega$

520 **(c)**
The equivalent circuit is as shown in figure.(b)



(a)



(b)

The current through $R_1 = \frac{8}{20} = 0.4\text{A}$

In the steady state, the potential difference across AB is 4 V

Charge on capacitor in steady state is

$q = CV = 0.4\mu\text{C}$

Current through resistor R is $I = \frac{V}{R} = \frac{4}{20} = 0.2$ A

521 **(a)**

a. it is possible that small length of potentiometer wire is used for positive terminal of e. m. f. to be measured may not be connected at extreme end of the potentiometer wire

b. Sensitivity of the potentiometer decreases

c. sensitivity of the potentiometer decreases

d. Accuracy of the potentiometer increases

522 **(c)**

i. If deflection in a galvanometer is in the same direction for the position of jockey on one side of the null point, then for the position of jockey on the other side of the null point, the deflection in the galvanometer should be in the opposite direction. But if e.m.f. of the battery in the primary circuit is less than the e.m.f. of the cell to be measured, then for all positions of jockey on wire, deflection in the galvanometer will be in one direction only

ii. Due to protective resistance, the galvanometer will show les deflection when away from the null point. Hence, uncertainty in the location of the null point increases

iii. For a short potentiometer wire, accuracy is less

iv. For a long potentiometer wire, accuracy is more

524 **(c)**

a. For $P_{\max} = R = 2r$

$$P_{\max} = \left(\frac{2E}{R+2r}\right)^2 R = \frac{E^2}{2r}$$

b. For $P_{\max}$: $R = \frac{r}{2}$

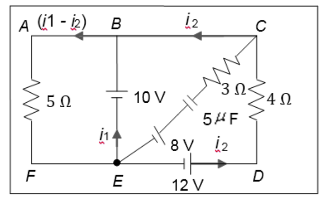
$$P_{\max} = \left(\frac{E}{R+R/2}\right) R = \frac{E^2}{2r}$$

c. $P = \left(\frac{2E}{r+2r}\right)^2 \; r = \frac{4E^2}{9r}$

d. $P = \left(\frac{2E}{r+r/2}\right) \; r = \frac{4E^2}{9r}$

525 **(b)**

When a steady state is reached, no current passes through the capacitor or the branch CE.



Considering the loop $ABEFA$.

$5\times(i_1 + i_2) = 10$ or $i_1 + i_2 = 2\text{A}$ ...(i)

Considering the loop $BCDEB$

$4i_2 = 12 - 10 = 2 \Rightarrow i_2 = 0.5$ A

So, $i_1 = 2 - 0.5 - 1.5$ A

To find the charge on capacitors, we must know potential difference across the plates.

Consider the loop $CEDC$:

$-12 + 4i_2 + 3 \times 0 - V_c + 8 = 0$

Or $V_c = -2$ V. So charge on capacitor
$Q = CV = 10\mu\text{C}$

526 **(a)**

$$1250 = 14\theta + \frac{1}{2}(-0.04)\theta^2$$

or $0.02\theta^2 - 14\theta + 1250 = 0$
On solving, we get,
$\theta = 105$°C or 595°C

527 **(b)**

If P is the power of the kettle, then
$P \times t = mc(\theta_2 - \theta_1) \times J$

$$\therefore P = \frac{2000 \times 1 \times (100-20) \times 4.2}{2 \times 60}$$

$= 5600\text{W} = 5.6$ kW.

528 **(a)**

$$E = \frac{V}{L} = \frac{3.0\text{V}}{0.6\text{ m}} = 5\text{Vm}^{-1}$$

$\therefore v_d = \frac{e\tau}{m}E = \frac{1.6 \times 10^{-19} \times 2.5 \times 10^{-14} \times 5}{9.11 \times 10^{31}}$

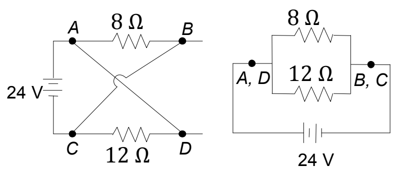
$= 2.2 \times 10^{-2} \text{ms}^{-1}$

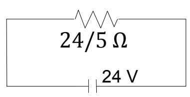
529 **(a)**

With only 30V battery, as shown win figure, total current will be= $\frac{30\text{V}}{7.5\Omega} = 4\text{A}$ (Since resistance of network= 7.5 Ω

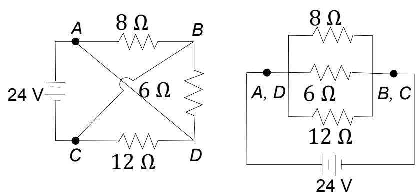
530 **(d)**

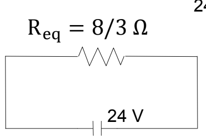
The current are as shown



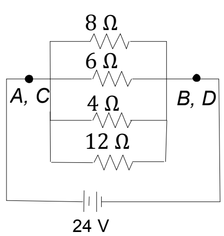


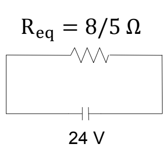
$I = \frac{24}{24/5} = 5\text{A}$





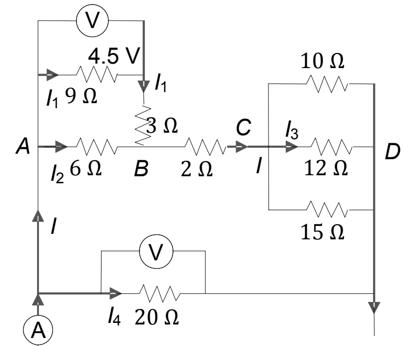
$\frac{1}{R_{\text{eq}}} = \frac{1}{8} + \frac{1}{6} + \frac{1}{12} \Rightarrow R_{\text{eq}} = \frac{8}{3}\Omega \; I = \frac{24}{8/3} = 9 \text{ A}$





$\frac{1}{R_{\text{eq}}} = \frac{1}{8} + \frac{1}{6} + \frac{1}{4} + \frac{1}{12} \Rightarrow R_{\text{eq}} = \frac{8}{5}\Omega, I = \frac{24}{8/5} 15\text{A}$

531 **(c)**



$I_1 = \frac{4.5}{9} - \frac{1}{2}\text{A}$

Potential difference across AB:

$4.5 + 3I_1 = 6I_2 \Rightarrow I_2 = 1 \text{ A}, I = I_1 + I_2 = 1.5 \text{ A}$

Equivalent resistance between C and D: $R_1 = 4\Omega$

Potential difference across $CD = R_1 I = 4 \times 1.5 = 6 \text{ V}$

Current through 12Ω, $I_3 = \frac{6}{12} = \frac{1}{2}\text{A}$

Potential difference across AD is

$6I_2 + 2I + 12I_3 = 6 \times 1 + 2 \times 1.5 + 12 \times 0.5 = 15\text{V}$

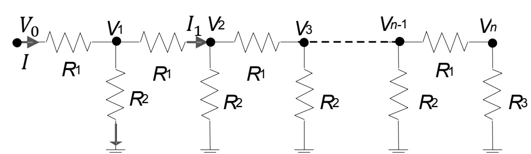
This will be equal to the reading of voltmeter across 20 Ω

$I_4 = \frac{15}{20} = 0.75\text{A}$

Reading of the ammeter $= I + I_4 = 1.5 + 0.75 = 2.25\text{A}$

532 **(d)**

Given $V_1 = \frac{V_0}{k}, V_2 = \frac{V_1}{k}, V_3 = \frac{V_2}{k},\; I = I_1 + I_2$



$\frac{V_0 - V_1}{R_1} = \frac{V_1 - V_2}{R_1} + \frac{V_1 - 0}{R_2}$

$\frac{V_0 - V_0/k}{R_1} = \frac{V_0/k - V_0/k^2}{R_1} + \frac{V_0/k}{R_2}$

$\frac{R_1}{R_2} = \frac{(k-1)^2}{k}$

Current in R_1 and R_3 will be the same: $\frac{V_{n-1} - V_n}{R_1} = \frac{V_n}{R_3}$

$\frac{V_{n-1} - \frac{V_{n-1}}{k}}{R_1} = \frac{V_{n-1}}{kR_3}$

$\Rightarrow R_1 = R_3(k-1)$

Put the value of R_1 in the above expression, we get:

$\frac{R_2}{R_3} = \frac{k}{k-1}$

Current in R_2 nearest to V_0:

$$I_2 = \frac{V_1}{R_2} = \frac{V_0/k}{R_3\left(\frac{k}{k-1}\right)} = \left(\frac{k-1}{k^2}\right)\frac{V_0}{R_3}$$

533 **(a)**

$q = \int i dt =$ area of given curve $= \frac{1}{2} i_0 t_0$

$$\frac{i}{i_0} + \frac{t}{t_0} = 1 \Rightarrow i = i_0\left(1 - \frac{t}{t_0}\right)$$

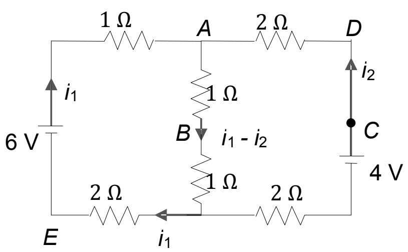
$$\text{Heat} = \int i^2 R dt = \int_0^{t_0} i_0 R \left(1 - \frac{t}{t_0}\right)^2 dt$$

$$H = \left.\frac{i_0^2 R\left(1 - \frac{t}{t_0}\right)^3}{3\left(-\frac{1}{t_0}\right)}\right]_0^{t_0} \Rightarrow H = \frac{R t_0 i_0^2}{3}$$

534 **(b)**

In the steady state, there will be no current in capacitor branch.

Loop $EABE$: $6 = i_1 + (1+1)(i_1 + i_2) + 2i_1 \Rightarrow$
$5i_1 + 2i_2 = 6 \quad \ldots$ (i)



Loop $ADCBA$: $4 = 2i_2 + (1+1)(i_1 + i_2) + 2i_2$
$\Rightarrow 6i_2 + 2i_1 = 4 \quad \ldots$(ii)

Solving Eqs. (i) and (ii), $i_1 = 14/13$ A, $i_2 = 4/13$ A

Given $V_E = 0, V_E + 6 - 1i_1 - 1(i_1 + i_2) = V_B$

$\Rightarrow V_B = 6 = 2i_1 - i_2 = 6 - 2 \times \frac{14}{13} - \frac{4}{13} = \frac{46}{13}$ V

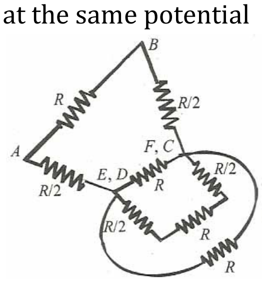
Now along $BADC$: $V_B + 1(i_1 + i_2) + 2i_2 = V_C$

$$V_C - V_B = i_1 + 3i_2 = \frac{14}{13} + 3 \times \frac{4}{13} = 2\text{V}$$

Charge on capacitor: q= $C(V_C - V_B) = 4 \times 2 = 8\mu$C

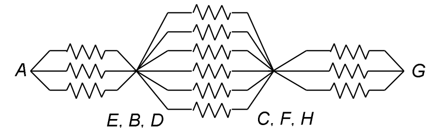
535 **(c)**

If we connect a battery across A and B, then E and D will be at the same potential and F and C will be at the same potential



Find $R_{\text{eq}(AB)} = \frac{7R}{12}$

If we connect the battery across $A$and G, then B, E and D will be at the same potential. C, F and H will be at the same potential



$$R_{\text{eq}} = \frac{5R}{6}$$

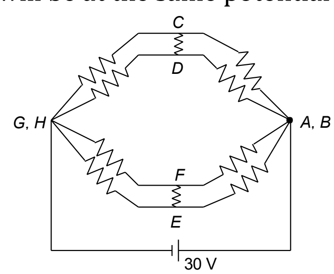
If we connect the battery across A and C, then no current will flow in the resistances between B and F and between H and D. So they can be removed

Now get $R_{\text{eq}} = \frac{3R}{4}$

536 **(d)**

D, B and E are symmetrical to A, hence potential at these points is same. Similarly, C, F and H are symmetrically to G. So potential at these point is the same.

Resulting diagram will be as shown: C, D, F and E will be at the same potential



P.d. between C and G will be half of the applied potential, i.e.,

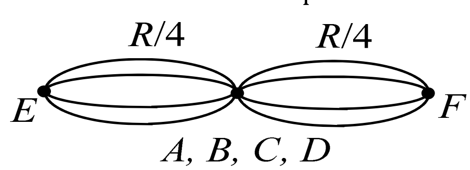
$V_{CG} = 30/2$=15 V

537 **(a)**

If we connect battery between E and F, then A, B, C and D will be all at the same potential

$$R_{\text{eq}} = \frac{R}{4} + \frac{R}{4} = \frac{R}{2}$$

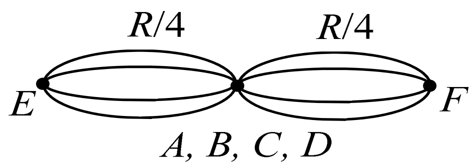
If we connect battery between A and C, then E and F will be at the same potential



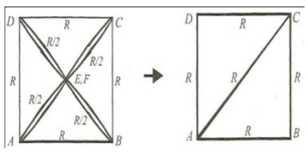
Now resistances between DE and EB will be useless:

$\Rightarrow R_{\text{eq}} = R/2$

Let us remove the resistance between A and B, then E and F will be at the same potential, we can draw the remaining as:



M is the midpoint of DC, M will be at the same pot as E and F



Now find $R_{AB} = 5/7R$. The resistance which we had removed will be in parallel to it so

$R_{\text{eq}} = \frac{R_{AB}R}{R_{AB}+R} = \frac{(5/7)RR}{(5/7)R+R} = \frac{5}{12}R$

538 **(d)**

$r = \frac{l_1 - l_2}{l_2}R = \frac{84-70}{70} \times 5 = 1\Omega$

$1 = \frac{l_1 - l_3}{l_3} \times 4$, put $l_1 = 84$ cm and get $l_3 = 67.2$ cm

539 **(a)**

Let R_1 and R_2 be the resistances of the ammeter and the voltmeter, respectively. Let the external resistance be denoted by R and the internal resistance of battery be r.

The equivalent resistance of the parallel combination of R and R_2 is given by

$R' = \frac{RR_2}{R+R_2}$

The total resistance RT of circuit then becomes

$RT = R_1 + r + \frac{RR_2}{R+R_2}$

The current in the circuit is given by

$I = \frac{E}{R_1 + r + \frac{RR_2}{R+R_2}}$

This must be equal to 0.04 A, the reading indicated by the ammeter

$\frac{3.4}{2+3+\frac{100R_2}{100+R_2}} = 0.04 \Rightarrow R_2 = 400\ \Omega$

In case of an ideal voltmeter, no current flows through it. In that case, current in the circuit is

$I' = \frac{3.4}{2+3+100} = \frac{3.4}{105} = 0.0324$ A

Potential drop across the resistance R would be $100\times 0.0324 = 3.24$ V. This should be the reading indicated by an ideal voltmeter

540 **(c)**

Just after closing, capacitor behave as a short circuit and all current flows through it, hence ammeter reads zero.

After a long time, capacitor behaves like an open circuit and no current flows through it

Therefore, $i = \frac{V_0}{R_1+R_2} = \frac{30}{10+5} = 2$ mA

Just after reopening, potential difference across R_2 remains the same as charge on the capacitor does not change initially, hence current remains the same.

541 **(a)**

$\frac{e}{1.02} = \frac{88}{66} \Rightarrow e = 1.36$ V

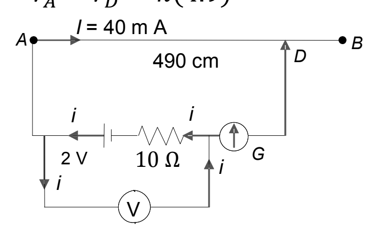
4 V is greater than applied e.m.f. 2 V, hence no balance point is obtained.

On connecting the resistance across e, current will flow in e due to which terminal potential difference will be less than e.m.f. and the balancing length will decrease.

542 **(b)**

Since 2 V is balanced across a length of 500 cm = 5 m. So the potential gradient is $k = 2/5$ V/m

Reading of voltmeter = p.d. across voltmeter $= V_A - V_D = k(4.9)$



$\Rightarrow$ Reading of the voltmeter $= \frac{2}{5} \times 4.9 = 1.96$ V

543 **(d)**

$k = \frac{E_1}{100} = \frac{2}{100} 0.02$V/cm

$E_2 = k(75) = 0.02 \times 75 = 1.5$ V

544 **(b)**

As section AB consumes 50 W at 1 A and $P = VI$,

$V = V_A - V_B = \frac{P}{I} = \frac{50}{1}\frac{W}{A} = 50$ V

As R and C are in series

$V = V_R + V_C$, i.e., $V_C = V - V_R$

But here $V = 50$ V and $V_R = IR = 1 \times 2 = 2$ V

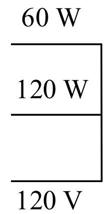
So, $V_c = 50 - 2 = 48$ V

Now as the element C absorbs energy and has no resistance, it is a source of e.m.f. with zero internal resistance (i.e., ideal battery)

So e.m.f., $E = V + Ir = 48 + 1 \times 0 = 48$ V

And as in charging, positive and negative terminals of the charger are connected to the positive and negative terminals of the battery, respectively, B is connected to the negative terminal of element C

60 W bulb will be of higher resistance. If only witch '1' is closed, 120 W bulb will glow. If only switch '2' is closed, 60 W bulb will glow. If both the switches are closed, both bulbs will glow with total illumination of 180 W



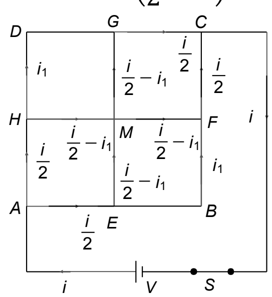
When the filament of higher resistance (of 60 W bulb) burns out, then for two settings (either '1' is closed or both are closed) power dissipated will be 120 W

546 **(c)**

In loop $EBFME$:

$$V_E - ri_1 - ri_1 + r\left(\frac{i}{2} - i_1\right) + r\left(\frac{i}{2} - i_1\right) = V_E$$

$$\Rightarrow \ 2i_1 = 2\left(\frac{i}{2} - i_1\right) \ \Rightarrow \ i_1 = \frac{i}{4}$$



Loop $AEBCSA$: $V_A - r\frac{i}{2} - ri_1 - ri_1 - r\frac{i}{2} + V = V_A$

$$\Rightarrow \ V = ri + 2ri_1 \ \Rightarrow V = ri + 2r\frac{i}{4}$$

$$\Rightarrow \ V = \frac{3ri}{2}, \qquad R_{\text{eq}} = \frac{V}{i} = \frac{3r}{2}$$

$$\frac{P_1}{P_2} = \frac{\left(\frac{i}{2}\right)^2 r}{\left(\frac{i}{2} - i_1\right)^2 r} = \frac{i^2}{(i - 2i_1)^2} = 4$$

Let ℓ be the balancing length, then

$k\ell = V_H - V_C$

$$\Rightarrow k\ell = \left(\frac{i}{2} - i_1\right)r + \left(\frac{i}{2} - i_1\right)r + \frac{i}{2}r$$

$$\Rightarrow k\ell = \left(\frac{3i}{2} - 2i_1\right)r \ \ \Rightarrow k\ell = ir$$

$$\Rightarrow \ \ \ell = \frac{2V}{3k} \ \ \Rightarrow \ell = \frac{2V}{3k}$$

547 **(d)**

Initially, when all the capacitors are uncharged, they will act as conducting wires. Hence, all the resistances (except 5 Ω) will be short-circuited. So, no resistance occurs between A and F. So, current through the 5 Ω resistor will be (10/5) A=2 A

In steady state, distribution of current is shown.

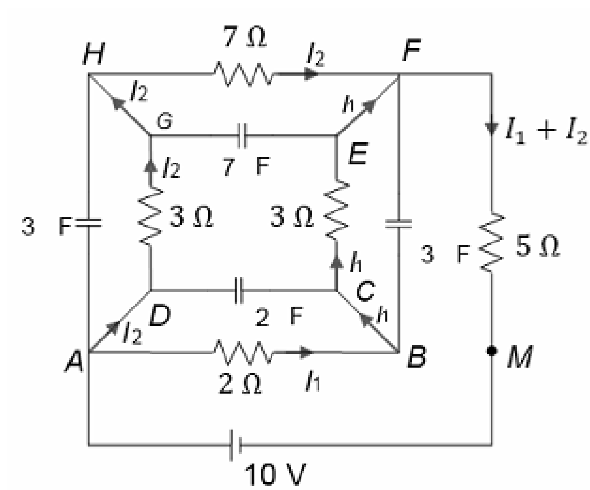
Loop $ABCEFMA$: $10 = 2I_1 + 3I_1 + 5(I_1 + I_2)$

Or $10I_1 + 5I_2 = 10$ (i)

Loop $ADGHFMA$: $10 = 3I_2 + 7I_2 + 5(I_2 + I_2)$

Or $5I_1 + 15I_2 = 10$

From Eqs. (i) and (ii), $I_1 = \frac{4}{5}$ A, $I_2 = \frac{2}{5}$ A



Hence, current through the 5 Ω resistor is $I_2 + I_2 = (6/5)$ A

Potential difference across the 2 μF capacitor is

$$2I_1 = 2 \times \frac{4}{5} = \frac{8}{5} \text{ V}$$

Energy in it is given by $U_1 = \frac{1}{2} \times 2\left(\frac{8}{5}\right)^2$=(64/25)μJ

Potential difference across the 3 μF capacitor is

$$3I_1 = 3 \times \frac{4}{5} = \frac{12}{5} \text{ V}$$

Energy in it is given by $U_2 = \frac{1}{2} \times 3\left(\frac{12}{5}\right)^2 =$ (216/25) μJ

Potential difference across the 3 μF capacitor is

$$3I_2 = 3 \times \frac{2}{5} = \frac{6}{5} \text{ V}$$

Energy in it is given by $U_3 = \frac{1}{2} \times 3\left(\frac{6}{5}\right)^2 = (54/25)$

μJ

Potential difference across the 7 μF capacitor is

$$7I_2 = 7 \times \frac{2}{5} = \frac{14}{5}\text{ V}$$

Energy in it is given by $U_4 = \frac{1}{2} \times 7\left(\frac{14}{5}\right)^2 =$ (686/25)μJ

This whole of the energy stored in all capacitors will be dissipated after the switch is opened. So the energy dissipated is $U_1 + U_2 + U_3 + U_4$=40.8 μJ

548 **(b)**

$i_2 = i_3 = I_b$, $V_1 = (V_2 + V_3) = V$, and $P_2 = P_3$

$\Rightarrow$ $R_2 = R_3$ and $V_2 = V_3 = V/2$

$P_1 = P_2 = P_3 = P_4$ (given)

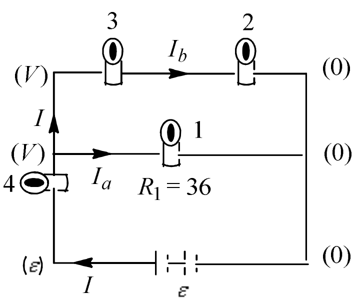
$$P_1 = \frac{V^2}{36}; \quad P_3 = \frac{(V/2)^2}{R_3}$$

As $P_1 = P_3$, so $R_1 = 9\ \Omega$

Also $R_3 = R_2 = 9\ \Omega$

$I_a = \frac{I}{3}$ and $I_4 = I, P_1 = P_4 = 4$ W

$$\left(\frac{I}{3}\right)^2 R_1 = (I)^2 R_4 = 4\text{ W} \Rightarrow \frac{R_1}{9} = R_4 \Rightarrow R_4 \Rightarrow 4\ \Omega$$



Also $I = 1$A

$R_{eq} = 16\ \Omega$ and $I = 1$ A, ε = 16 V

549 **(b)**

$$\eta = \frac{0.4 \times 4200(\theta - \theta_1)}{420 \times 4.8(\theta - \theta_1)} \times 100 = \frac{250}{3} = 83.34\%$$

550 **(c)**

$V = E + ir$ (during charging) = 14 V

551 **(b)**

As per the figure, $V_{bc} = 0.10 \times 2 = 0.2$ V

So actual drop = 12 – 0.2 = 11.8 V

Then $R = \frac{11.8}{0.1} = 118\Omega$

552 **(a)**

$I \propto r^{3/2}$

$$\frac{I_1}{I_2} = \frac{(4r)^{3/2}}{r^{3/2}} = \frac{8}{1}$$

553 **(c)**

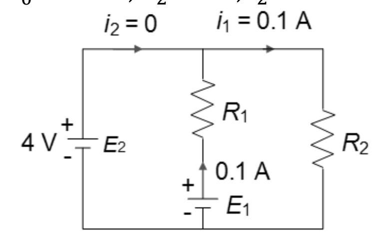
Just after closing, capacitor behaves as short circuit and all current flows through it; hence ammeter reads zero

554 **(a)**

$$R_A = R_A = \frac{R \times R_V}{R + R_V} < R$$

555 **(b)**

$i_0 = 0.1$ A, $E_2 = 4$V, $i_2 = 0$



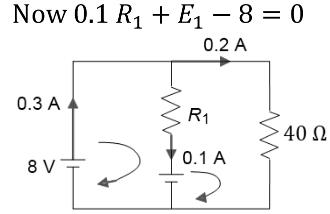
As 0.1 R_1 + 0.1 $R_2 - E_1 = 0$

0.1 R_2 − 4 V =0

R_2 =40Ω

Now, $i_2 = 0.3$ A, $i_1 = 0.1$A, E_2 =8A

Now 0.1 $R_1 + E_1 - 8 = 0$



$0.1 + 4 - E_1 = 0$

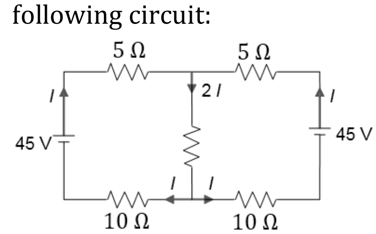
$0.2R_1 - 4 = 0$

$$R_1 = \frac{4}{0.2} = 20\ \Omega$$

0.2 E_1 = 2 + 4 = 6 V

556 **(d)**

A steady state, the circuit will be simplified to the following circuit:



Using Kirchhoff's law, we can calculate $I = 1$ A

Further using Kirchhoff's law in original circuit, we can calculate charges on difference capacitors

557 **(c)**

8 Ω and 4Ω will be in parallel : $R_{eq} = \frac{8 \times 4}{8+4} = \frac{8}{3}\Omega$

558 **(b)**

$$E = \rho j\ ; j = \frac{I}{2\pi r^2} \Rightarrow E = \frac{\rho I}{2\pi r^2}$$

559 **(a)**

As the magnetic field is grater, the critical temperature is lower and as B_2 is larger than B_1. Graph (a) is correct

560 **(6)**

$150 = \frac{15\times15}{R_{eq}}$ or $R_{\text{eq}} = \frac{15\times15}{150}\ \Omega = \frac{3}{2}\ \Omega$

Now, $\frac{2R}{2+R} = \frac{3}{2} \Rightarrow R = 6\ \Omega$

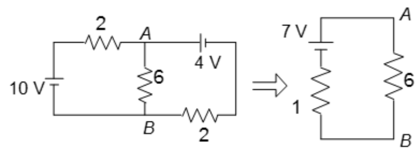
561 **(5)**

$$\varepsilon = \frac{\frac{E_1}{r_1}+\frac{E_2}{r_2}}{\frac{1}{r_1}+\frac{1}{r_2}} = \frac{\frac{6}{1}+\frac{3}{2}}{\frac{1}{1}+\frac{1}{2}} = \frac{15}{3} = 5 \text{ volt}$$

562 **(6)**

9 V and 16 Ω can be ignored because potential difference between $A$and $C$is fixed which is 4 V.

The circuit can be drawn as shown below



Equivalent e.m.f.: $e = \frac{\Sigma(E/r)}{\Sigma(1/r)} = \frac{10/2+4/2}{1/2+1/2} = 7\text{ V}$

Equivalent internal resistance: $r_0 = \frac{1}{\Sigma(1/r)} = \frac{1}{1/2+1/2} = 1\Omega$

Now $V_{AB} = \frac{7}{(6+1)} \times 6 = 6\text{ V}$

563 **(7)**

This means you will not get the balancing point.

$$i = \frac{2}{1+15} = \frac{1}{8}, E_P = \frac{1}{8}\times 3 \times \frac{7}{2} = \frac{21}{16}$$

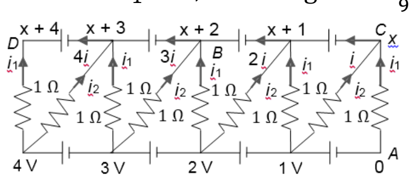
$\frac{21}{16} = i \times 3 \times \frac{9}{2} \Rightarrow i = \frac{7}{72}\text{A}$, now $\frac{7}{72} = \frac{2}{16+R} \Rightarrow R = \frac{32}{7}\Omega$

564 **(9)**

At junction C: $i_1 + i_2 = i$,

Where $i_1 = \frac{0-x}{1}, i_2 = \frac{1-x}{1}$

At D: $4i + i_1 = 0$, solve to get $x = \frac{4}{9}$



Now $V_A - i_1 + 1 + 1 = V_B \Rightarrow V_A - V_B = -\left(2+\frac{4}{9}\right) = -\frac{22}{9}\text{ V}$

565 **(6)**

$i = 2\text{ A}, R = 25\text{ W}, t = 1\text{ min} = 60\text{ sec}$

Heat developed $= i^2Rt = (2\times2\times25\times60) = 100\times60\text{J}$

$= 6000\text{ J}$

566 **(9)**

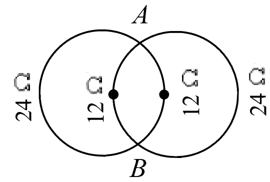
For three identical resistors in series, $P_s = V^2/3R$

If they are now in parallel over the same voltage,

$$P_p = \frac{V^2}{R_{\text{eq}}} = \frac{V^2}{R/3} = \frac{9V^2}{3R} = 9P_s = 9 \times (27\text{ W})$$

567 **(1)**

The resistance of four sections are shown in the figure



Hence, the equivalent resistance R across AB is

$\frac{1}{R} = \frac{1}{24} + \frac{1}{12} + \frac{1}{12} + \frac{1}{24} \Rightarrow R = 4\ \Omega$

Power $= V^2/R = 20^2/4 = 100$ W

568 **(2)**

If the wire connected as such across the battery, then current in wire,

$$i = \frac{V}{R} = \frac{200}{80} = 2.5\text{ A}$$

and power obtained,

$$P = \frac{V^2}{R} = \frac{200\times200}{80} = 500\text{ W}$$

The wire can carry maximum current of 5 A. therefore to double the current, the resistance should be halved. Thus if we divide the wire in two parts and the two parts are connected in parallel across 200 V mains supply, then the resistance of each part = 40 W; therefore, current in each wire = 200/40 = 5 A

Not resistance, $R' = \frac{R_1R_1}{R_1+R_2} = \frac{40\times40}{40+40} = 20\ \Omega$

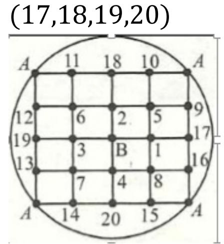
and new power obtained is

$$P_{\max} = \frac{V^2}{R} = \frac{200\times200}{20} = 2000\text{ watts}$$

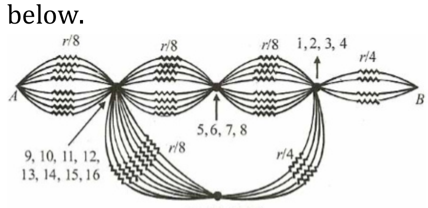
Thus, the maximum power is 2000 W and this is obtained when wire is cut in two halves and they are connected in parallel across the given supply

569 **(6)**

If we connect battery between A and B, then different points will be at the same potentials (1,2,3,4); (5,6,7,8); (9,10,11,12,13,14,15,16) and (17,18,19,20)



The resulting circuit can be drawn as shown below.



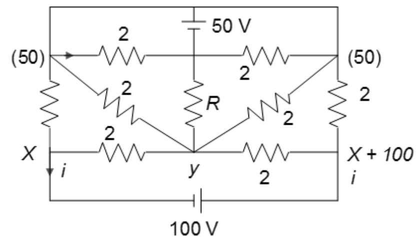
Solve to get $R_{AB} = \frac{21}{40}r \Rightarrow R_{AB} = \frac{21}{40}\times\frac{80}{7} = 6\Omega$

570 **(2)**

At y according to Kirchhoff's junction law,

$$\frac{y-x}{r}+\frac{y-x-100}{r}+\frac{y-50}{r}+\frac{y}{r}+\frac{y-50}{r}=0$$

$5y-2x=200$ (i)



Similarly at x,

$$i=\frac{50-x}{r}+\frac{y-x}{r}$$

At $x+100$ (ii)

$i=\frac{x+100-50}{r}+\frac{x+100-y}{r}$ (iii)

From Eqs. (ii) ad (iii), we get $y-2x=50$

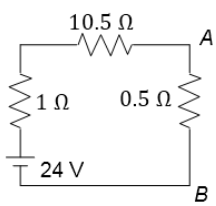
From Eqs. (i) and (iv), $y=37.5$ V (iv)

So, current through R is $37.5/18.75 = 2$ A

571 **(1)**

Current through the battery will be minimum when all the three switches are open. The resulting circuit is shown in Figure.

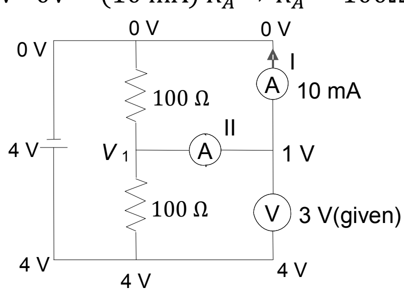
Hence, $V_{AB} = (0.5)V_{AB}\times\frac{24}{12} = 1\text{V}$



572 **(1)**

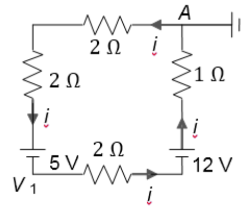
R_A =resistance of ammeter

1 V−0V = (10 mA) $R_A \Rightarrow R_A = 100\Omega$



573 **(9)**

The resulting circuit can be drawn as shown No current will flow into the earth.



$i = (12-5)/7$=1 A, $V_A - 2i - 2i - 5 = V_1$ but $V_A = 0$

$\Rightarrow V_1 = -9$V

574 **(3)**

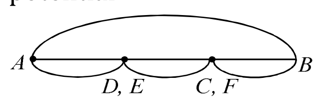
$$\frac{4-V_1}{100}=\frac{V_1-1}{100}+\frac{V_1-0}{100}\Rightarrow V_1=\frac{5}{3}\text{ V}$$

Current in ammeter (II)=$\frac{V_1-1}{R_A} = \frac{(5/3)-1}{200} = \frac{2}{300}$

A $= \frac{20}{3}$ mA

575 **(3)**

By symmetry, points D and E have the same potential. Similarly points $C$and F have the same potential.



$$r_{eq}\frac{\frac{(3r)}{2}r}{\frac{3r}{2}+r}=\frac{3r}{5}=\frac{3}{r}\times 5=3\Omega$$

576 **(3)**

$$R=\frac{6}{0.5}=12\ \Omega$$

$H = I^2Rt = (0.5)^2\times 12\times 1 = 3$ J

577 **(2)**

$$x=\frac{(2R_x)R}{3R+x}$$

$3Rx + x^2 = 2R^2 + Rx$

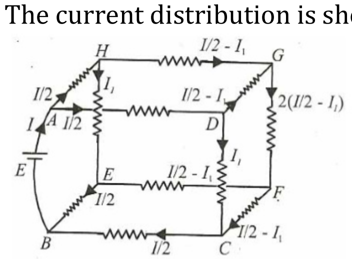
$x^2 + 2Rx - 2R^2 = 0$

$$x=\frac{-2R\pm\sqrt{4R^2+8R^2}}{2}=R\sqrt{3-1}$$

$= (\sqrt{3+1})(\sqrt{3}-1) = 3-1 = 2\Omega$

578 **(3)**

Let a battery of e.m.f. E is applied between points A and B. Let a current I enter through point A. The current distribution is shown in the figure



If R_{AB} is a equivalent resistance between points A and B, then from Ohm's law

$R_{AB}I = E$ ...(i)

Applying Kirchhoff's second law to mesh $DGFC$, we get

$\left(\frac{I}{2} - I_1\right)R + (1/2I_1)R + \left(\frac{I}{2} - I_1\right)R - I_1R = 0 \Rightarrow$

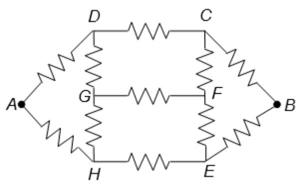
$I_1 = \frac{2}{5}I$ ...(ii)

Applying Kirchhoff's second law to external circuit $AHEBA$, we get

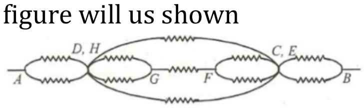
$E = \frac{1}{2}R + I_1R + \frac{1}{2}R$ ... (iii)

Solving Eqs. (i), (ii), (iii), we get $R_{AB} = \frac{7}{5}R = \frac{7}{5} \times \frac{15}{7} = 3\Omega$

Alternative Method: The figure can be redrawn a shown below.



If we connect a battery between A and B, then D and H will be at the same potential; similarly C and E will be at the same potential. Resulting figure will us shown



Now simplify to get $R_{AB} = \frac{7}{5}R$

579 **(4)**

Let resistance of heating coil be R, then

$$100 = \frac{220^2}{R} \Rightarrow R = \frac{(220)^2}{100}\ \Omega$$

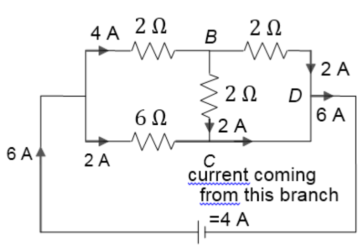
Resistance of each cut part $= R/2$

Now, power dissipated $= P = 2\left(\frac{(220)^2}{R/2}\right)$

$$\Rightarrow P = 4\frac{(220)^2}{R} = 4 \times 100 = 400\text{ W}$$

580 **(4)**

R_{eq}=2 Ω; $i = 12/2 = 6$ A



Current through branch $CD = 4$ A

581 **(8)**

Due to symmetry, the line of resistors passing through b will be uselss.

$$r_{eq} = 2r + \frac{2rr_{eq}}{2r + r_{eq}} \Rightarrow r_{eq} = (1 + \sqrt{5})r$$

$=(\sqrt{5} + 1)2(\sqrt{5} - 1) = 8\Omega$

582 **(3)**

Let R be the combined resistance of galvanometer and an unknown resistance and r the internal resistance of each battery. When the batteries, each of e.m.f. E are connected in series, the net e.m.f. $=2E$ and net internal resistnce $= 2r$

Current $i_1 = \frac{2E}{R+2r} \Rightarrow 1.0 = \frac{2\times1.5}{R+2r}$

$\Rightarrow R + 2r = 3$ ...(i)

When the batteries are connected in parallel, the e.m.f. remains E and net internal resistance become $r/2$. Therefore,

Current is $i_2 = \frac{E}{R+\frac{r}{2}} = \frac{2E}{2R+r}$

$\Rightarrow 2R + r = \frac{2E}{i_2} = \frac{2\times1.5}{0.6}$ =5.0 ...(ii)

Solving Eqs. (i) and (ii), we get $r = \frac{1}{3}\Omega$

583 **(5)**

Potential gradient, $k = \frac{IR_P}{L} = \frac{ER_P}{(R+R_P+r)L}$ (where R_P is resistance of the wire)

$$\Rightarrow 50 \times 10^{-3} = \frac{2.5 \times 30}{(R + 30 + 5) \times 10} \Rightarrow R = 115\ \Omega$$

584 **(1)**

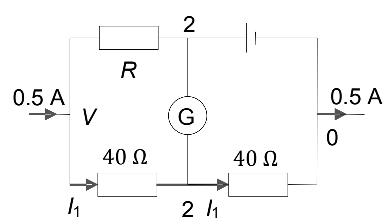
$I_G = 10$ mA, $G = 10\Omega$

$S(I - I_G) = I_G G$ where S is shunt in parallel, solve to get

$S = 0.1\ \Omega$

585 **(9)**

$$\frac{V-2}{40} = \frac{2-0}{40} \Rightarrow V = 4$$



$$I = \frac{2}{40} = 0.05\text{ A}$$

$$\therefore \frac{V-2}{R} = 0.45$$

$$R = \frac{4-2}{0.45} = \frac{2}{0.45} = \frac{40}{9}\Omega$$

586 **(4)**

Let the voltmeter reading when the voltmeter has zero error be$V$.

$$\frac{l_1R}{l_2R} = \frac{V_1}{V_2} \Rightarrow \frac{1.75}{2.75} = \frac{14.4 - V}{22.4 - V} \Rightarrow \frac{7}{11} = \frac{14.4 - V}{22.4 - V}$$

$\Rightarrow 7 \times (22.4 - V) = 11(14.4 - V)$

$\Rightarrow 156.8 - 7V = 158.4 - 11V \Rightarrow V = 0.4$V

587 **(8)**

Equivalent resistance of the ammeter is

$$\frac{(480\ \Omega)(20\Omega)}{480\Omega + 20\Omega} = 19.2\ \Omega$$

The equivalent resistance of the circuit is 140.8 Ω +19.2 Ω =160 Ω. Therefore, current, $i = 20$ V/160 Ω $= (1/8)$A

588 **(2)**

Here all the resistances will be in parallel

Current through 12 Ω: $I_1 = 24/12 = 2$ A

Hence, reading of $A_1 = I_1 = 2$ A

589 **(0)**

Potential difference across each of the resistors will be zero; hence, no current in any resistor