Single Correct Answer Type

1. Two friends A and B are waiting for another friend for tea. A took the tea in a cup and mixed the cold milk and then waits. B took the tea in the cup and then mixed the cold milk when the friend comes. Then the tea will be hotter in the cup of

a) A b) B
c) Tea will be equally hot in both cups d) Friend's cup

2. The temperature of a metal block is increased from $27°C$ to $84°C$. The rate of the radiated energy from the block will increase approximately
a) 2 times b) 4 times c) 8 times d) 16 times

3. If the initial temperatures of metallic sphere and disc, of the same mass, radius and nature are equal, then the ratio of their rate of cooling in same environment will be
a) 1 : 4 b) 4 : 1 c) 1 : 2 d) 2 : 1

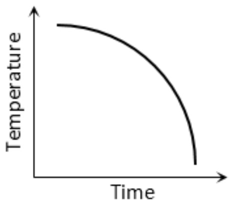
4. What should be the lengths of a steel and copper rod at $0°C$ so that the length of the steel rod is 5 cm longer than the copper rod at any temperature?
α(Steel) = $1.1 \times 10^{-5} °C^{-1}$
α ¿Copper)= $1.7 \times 10^{-5} °C^{-1}$
a) 14.17 cm; 9.17 cm b) 9.17 cm, 14.17 cm
c) 28.34 cm; 18.34 cm d) 14.17 cm, 18.34 cm

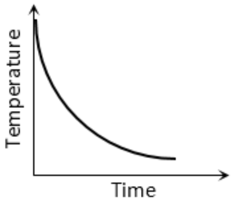
5. Pick out the statement which is not true
a) IR radiations are used for long distance photography
b) IR radiations arise due to inner electron transitions in atoms
c) IR radiations are detected by using a bolometer
d) Sun is the natural source of IR radiation

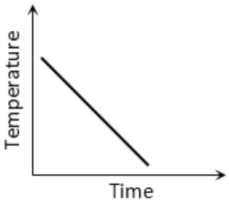
6. If the ratio of coefficient of thermal conductivity of silver and copper is 10 : 9, then the ratio of the lengths upto which wax will melt in Ingen Hauz experiment will be
a) 6 : 10 b) $\sqrt{10}:3$ c) 100 : 81 d) 81 : 100

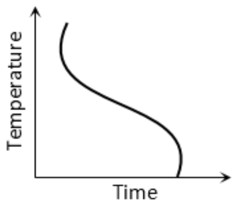
7. A black body at a temperature of $1640\ K$ has the wavelength corresponding to maximum emission equal to $1.75\ \mu$. Assuming the moon to be a perfectly black body, the temperature of the moon, if the wavelength corresponding to maximum emission is $14.35\ \mu$ is
a) $100\ K$ b) $150\ K$ c) $200\ K$ d) $250\ K$

8. A block of metal is heated to a temperature much higher than the room temperature and allowed to cool in a room free from air currents. Which of the following curves correctly represents the rate of cooling

a) 

b) 

c) 

d) 

9. Newton's law of cooling is a special case of

a) Stefan's law b) Kirchhoff's law c) Wien's law d) Planck's law

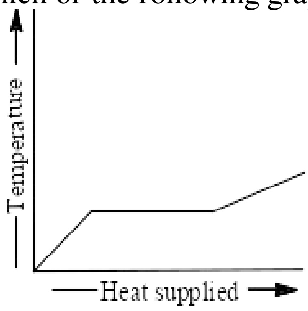
10. The radiant energy from the sun incident normally at the surface of earth is $20\, kcal/m^2\, min$. What would have been the radiant energy incident normally on the earth, if the sun had a temperature twice of the present one

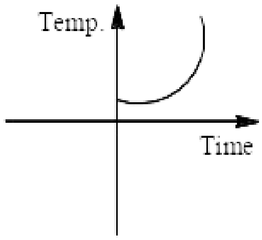
a) $160\, kcal/m^2\, min$ b) $40\, kcal/m^2\, min$ c) $320\, kcal/m^2\, min$ d) $80\, kcal/m^2\, min$

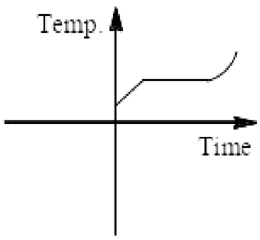
11. The spectrum from a black body radiation is a

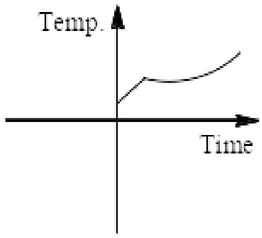
a) Line spectrum
b) Band spectrum
c) Continuous spectrum
d) Line and band spectrum both

12. Liquid oxygen at 50 K is heated to 300 K at constant pressure of 1 atm. The rate of heating is constant. Which of the following graphs represents the variations of temperature with time?

a) 

b) 

c) 

d) 

13. Of two masses of $5\, kg$ each falling from height of $10\, m$, by which $2\, kg$ water is stirred. The rise in temperature of water

a) $2.6\, ℃$ b) $1.2\, ℃$ c) $0.32\, ℃$ d) $0.12\, ℃$

14. The ratio of thermal conductivity of two rods of different material is 5:4. The two rods of same area of cross-section and same thermal resistance will have the lengths in the ratio

a) 4 : 5 b) 9 : 1 c) 1 : 9 d) 5 : 4

15. The coefficient of volumetric expansion of mercury is $18 \times 10^{-5}/℃$. A thermometer bulbs has a volume $10^{-6}\, m^3$ and cross section of stem is $0.004\, cm^2$. Assuming that bulb is filled with mercury at $0\, ℃$ then the length of the mercury column at $100\, ℃$ is

a) $18.8\, mm$ b) $9.2\, mm$ c) $7.4\, cm$ d) $4.5\, cm$

16. "Good emitters are good absorbers" is a statement concluded from

a) Newton's law of cooling
b) Stefan's law of radiation
c) Provost's theory
d) Kirchhoff's law

17. Water falls from a height 500 m. The rise in temperature of water at bottom if whole of energy remains

in water, will be (specific heat of water is c=4.2 kJ kg^{-1})

a) $0.23℃$ b) $1.16℃$ c) $0.96℃$ d) $1.02℃$

18. A metallic solid sphere is routing about its diameter as axis of rotation. If the temperature is increased by $200℃$, the percentage in its moment of inertia is (Coefficient of linear expansion of the metal=10^{-5} $℃^{-1}$)

a) 0.1% b) 0.2% c) 0.3% d) 0.4%

19. The wavelength of maximum intensity of radiation emitted by a star is $289.8\,nm$. The radiation intensity for the star is : (Stefan's constant $5.67\times10^{-8} W\,m^{-2}\,K^{-4}$, constant $b=2898\,\mu mK$¿

a) $5.67\times10^{8} W/m^2$ b) $5.67\times10^{12} W/m^2$ c) $10.67\times10^{7} W/m^2$ d) $10.67\times10^{14} W/m^2$

20. When vapour condenses into liquid

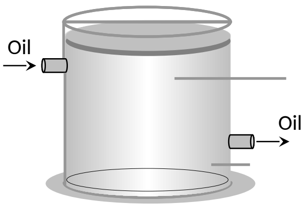
a) It absorbs heat b) It liberates heat

c) Its temperature increases d) Its temperature decreases

21. A hot body will radiate heat most rapidly if its surface is

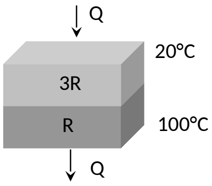
a) White & polished b) White & rough c) Black & polished d) Black & rough

22. The top of insulated cylindrical container is covered by a disc having emissivity 0.6 and thickness $1\,cm$. The temperature is maintained by circulating oil as shown in figure. If temperature of upper surface of disc is $127\,℃$ and temperature of surrounding is $27\,℃$, then the radiation loss to the surroundings will be (Take $\sigma=\frac{17}{3}\times10^{-8} W/m^2K^4$)



a) $595\,J/m^2\times s$ b) $595\,cal/m^2\times s$ c) $991.0\,J/m^2\times s$ d) $440\,J/m^2\times s$

23. In the following figure, two insulating sheets with thermal resistances R and $3R$ as shown in figure. The temperature θ is



a) $20\,℃$ b) $60\,℃$ c) $75\,℃$ d) $80\,℃$

24. Four rods of different radii r and length l are used to connect two reservoirs of heat at different temperatures. Which one will conduct heat fastest?

a) r= 2 cm, l 0.5 m b) r = 1 cm, l= 0.5 m c) r = 2 cm, l=¿2 m d) r = 1 cm, l= 1 m

25. Two spheres of radii in the ratio 1:2 and densities in the ratio 2:1 and of same specific heat, are heated to same temperature and left in the same surrounding. Their rate of cooling will be in the ratio

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

26. The value of Stefan's constant is

a) $5.67\times10^{-8} W/m^2\text{-}K^4$ b) $5.67\times10^{-5} W/m^2\text{-}K^4$

c) $5.67\times10^{-11} W/m^2\text{-}K^4$ d) None of these

27. An experiment takes 10 min to raise temperature of water from $0℃$ and $100℃$ and another 55 min to convert it totally into steam by a stabilized heater. The latent heat of vaporization comes out to be

a) $530\,cal g^{-1}$ b) $540\,cal g^{-1}$ c) $550\,cal g^{-1}$ d) $560\,cal g^{-1}$

28. Flash light equipped with a new set of batteries, produces bright white light. As the batteries were out

a) The light intensity gets reduced with no change in its colour

b) Light colour changes first to yellow and then red with no change in intensity

c) It stops working suddenly while giving white light

d) Colour changes to red and also intensity gets reduced

29. The temperature of a piece of iron is $27\,℃$ and it is radiating energy at the rate of $Q\,kW\,m^{-2}$. If its temperature is raised to $151\,℃$, the rate of radiation of energy will become approximately

a) $2\,Q\,kW\,m^{-2}$ b) $4\,Q\,kW\,m^{-2}$ c) $6\,Q\,kW\,m^{-2}$ d) $8\,Q\,kW\,m^{-2}$

30. The temperature of a thin uniform circular disc, of one metre diameter is increased by $10℃$. The percentage increase in moment of inertia of the disc about an axis passing through its centre and perpendicular to the circular face (linear coefficient of expansion=$11\times10^{-6}\,℃^{-1}$)

a) 0.0055 b) 0.011 c) 0.022 d) 0.044

31. Surface of the lake is at $2\,℃$. Find the temperature of the bottom of the lake

a) $2\,℃$ b) $3\,℃$ c) $4\,℃$ d) $1\,℃$

32. The rate of radiation of a black body at $0\,℃$ is $E\,J/s$. The rate of radiation of this black body at $273\,℃$ will be

a) $16\,E$ b) $8\,E$ c) $4\,E$ d) E

33. A bimetallic is made of two strips $A \wedge B$ having coefficients of linear expansion $\alpha_A \wedge \alpha_B$. If $\alpha_A < \alpha_B$, then on heating, the strip will

a) Bend with A on outer side b) Bend with B on outer side

c) Not bend at all d) None of the above

34. The end A of a rod AB of length 1 m is maintained at $100℃$ and the end Bat $10℃$. The temperature at a distance of 60 cm from the end $B$is

a) $64℃$ b) $36℃$ c) $46℃$ d) $72℃$

35. A body initially at $80℃$ cools to $64℃$ in 5 min and to $52℃$ in 10 min. the temperature of the surrounding is

a) $26℃$ b) $16℃$ c) $36℃$ d) $40℃$

36. For a perfectly black body, its absorptive power is

a) 1 b) 0.5 c) 0 d) Infinity

37. In a steady state of thermal conduction, temperature of the ends A and B of a $20\,cm$ long rod are $100\,℃$ and $0\,℃$ respectively. What will be the temperature of the rod at a point at a distance of $6\,cm$ from the end A of the rod

a) $-30\,℃$ b) $70\,℃$ c) $5\,℃$ d) None of the above

38. A hot and a cold body are kept in vacuum separated from each other. Which of the following cause decrease in temperature of the hot body

a) Radiation b) Convection

c) Conduction d) Temperature remains unchanged

39. A *litre* of alcohol weighs

a) Less in winter than in summer
b) Less in summer than in winter
c) Same both in summer and winter
d) None of the above

40. A solid sphere and a hollow sphere of the same material and size are heated to the same temperature and allowed to cool in the same surroundings. If the temperature difference between each sphere and its surroundings is T, then

a) The hollow sphere will cool at a faster rate for all values of T
b) The solid sphere will cool at a faster rate for all values of T
c) Both spheres will cool at the same rate for all values of T
d) Both spheres will cool at the same rate only for small values of T

41. On the Celsius scale the absolute zero of temperature is at

a) $0\,°C$
b) $-32\,°C$
c) $100\,°C$
d) $-273.15\,°C$

42. A composite rod made of copper ($\alpha = 1.8 \times 10^{-5}\,K^{-1}$) and steel ($\alpha = 1.2 \times 10^{-5}\,K^{-1}$) is heated. Then

a) It bends with steel on concave side
b) It bends with copper on concave side
c) It does not expand
d) Data is insufficient

43. Ratio among linear expansion coefficient (α), areal expansion coefficient (β) and volume expansion coefficient (γ) is

a) $1:2:3$
b) $3:2:1$
c) $4:3:2$
d) None of these

44. Which of the following statements is true/correct

a) During clear nights, the temperature rises steadily upward near the ground level
b) Newton's law of cooling, an appropriate form of Stefan's law, is valid only for natural convection
c) The total energy emitted by a black body per unit time per unit area is proportional to the square of its temperature in the Kelvin scale
d) Two spheres of the same material have radii $1\,m$ and $4\,m$ and temperatures $4000\,K$ and $2000\,K$ respectively. The energy radiated per second by the first sphere is greater than that radiated per second by the second sphere

45. Two temperature scales A and B are related by $\frac{A-42}{110} = \frac{B-72}{220}$. At which temperature two scales have the same reading?

a) -42°C
b) -72°C
c) 12°C
d) 40°C

46. The thermal capacity of a body is $80\,cal$, then its water equivalent is

a) $80\,cal/g$
b) $8\,g$
c) $80\,g$
d) $80\,kg$

47. The thermal capacity of $40\,g$ of aluminium (specific heat ¿$0.2\,cal/g/°C$) is

a) $40\,cal/°C$
b) $160\,cal/°C$
c) $200\,cal/°C$
d) $8\,cal/°C$

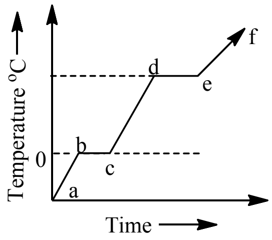
48. The earth radiates in the infra-red region of the spectrum. The spectrum is correctly given by

a) Wien's law
b) Rayleigh Jeans law
c) Planck's law of radiation
d) Stefan's law of radiation

49. Which of the following law states that "good absorbers of heat are good emitters"

a) Stefan's law b) Kirchhoff's law c) Planck's law d) Wien's law

50. The following figure represents the temperature *versus* time plot for a given amount of a substance when heat energy is supplied to it at a fixed rate and at a constant pressure.

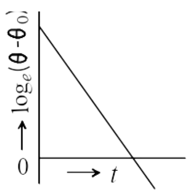


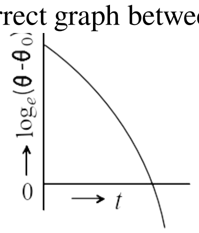
Which parts of the above plot represents a phase change?

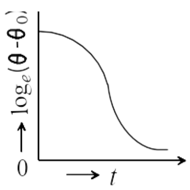
a) a to b and e to f b) b to c and c to d

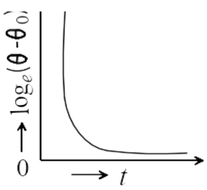
c) d to e and e to f d) b to c and d to e

51. A liquid in a beaker has temperature $\theta(t)$ at time t and θ_0 is temperature of surroundings, then according to Newton's law of cooling the correct graph between $\log_e(\theta-\theta_0)$ and t is

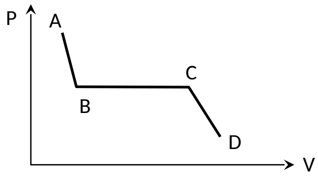
a) 

b) 

c) 

d) 

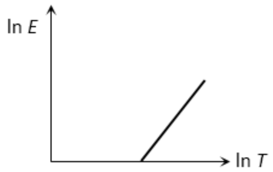
52. The portion AB of the indicator diagram representing the state of matter denotes

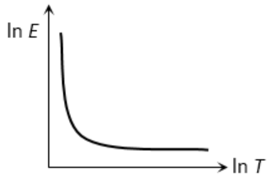


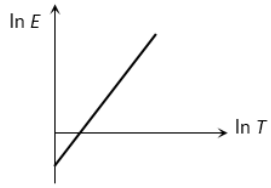
a) The liquid state of matter b) Gaseous state of matter

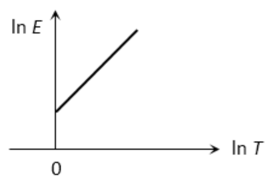
c) Change from liquid to gaseous state d) Change from gaseous state to liquid state

53. Which of the following graphs correctly represents the relation between $\ln E$ and $\ln T$ where E is the amount of radiation emitted per unit time from unit area of a body and T is the absolute temperature

a) 

b) 

c) 

d) 

54. $0.93\, watt-hour$ of energy is supplied to a block of ice weighing $10\, g$. It is found that

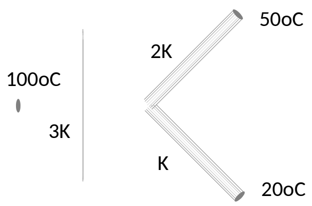
a) Half of the block melts

b) The entire block melts and the water attains a temperature of $4\ ℃$

c) The entire block just melts

d) The block remains unchanged

55. Three rods of the same dimension have thermal conductivities $3K$, $2K$ and K. They are arranged as shown in fig. Given below, with their ends at $100\ ℃$, $50\ ℃$ and $20\ ℃$. The temperature of their junction is



a) 60 ℃ b) 70 ℃ c) 50 ℃ d) 35 ℃

56. Melting point of ice

a) Increases with increasing pressure
b) Decreases with increasing pressure
c) Is independent of pressure
d) Is proportional to pressure

57. The surface temperature of the stars is determined using

a) Planck's law
b) Wien's displacement law
c) Rayleigh-Jeans law
d) Kirchhoff's law

58. The total energy radiated from a black body source is collected for 1 min and is used to heat a quantity of water. The temperature of water is found to increase from 20℃ to 20.5℃ . If the absolute temperature of the black body is doubles and the experiment is repeated with the same quantity of water at 20℃, the temperature of water will be

a) 21℃ b) 22℃ c) 24℃ d) 28℃

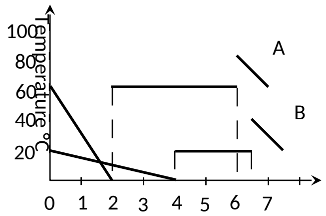
59. It is hotter for the same distance over the top of a fire than it is in the side of it, mainly because

a) Air conducts heat upwards
b) Heat is radiated upwards
c) Convection takes more heat upwards
d) Convection, conduction and radiation all contribute significantly transferring heat upwards

60. A black body has maximum wavelength λ_m at temperature $2000\,K$. Its corresponding wavelength at temperature $3000\,K$ will be

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

61. Two substances A and B of equal mass m are heated at uniform rate of $6\,cal\,s^{-1}$ under similar conditions. A graph between temperature and time is shown in figure. Ratio of heat absorbed H_A/H_B by them for complete fusion is

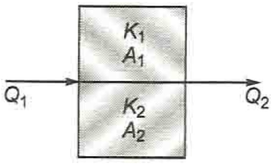


a) 9/4 b) 4/9 c) 8/5 d) 5/8

62. A black body radiates energy at the rate of $E\,W\,m^{-2}$ at a high temperature $T\,K$. When the temperature is reduced to $\left(\frac{T}{2}\right)$ K, the radiant energy is

a) $\frac{E}{2}$ b) $2E$ c) $\frac{E}{4}$ d) $\frac{E}{16}$

63. Two plates of same thickness, of coefficients of thermal conductivity $K_1 \wedge K_2$ and areas of cross section $A_1 \wedge A_2$ are connected as shown in figure. The common coefficient of thermal conductivity K will be



a) $K_1A_1+K_2A_2$ b) $\frac{K_1A_1}{K_2A_2}$ c) $\frac{K_1A_1+K_2A_2}{A_1+A_2}$ d) $\frac{K_1A_2+K_2A_1}{K_1+K_2}$

64. A black body at a temperature of $227°C$ radiates heat at the rate of 20 $cal\,m^{-2}s^{-1}$. When its temperature rises to $727°C$, the rate of heat radiated will be

a) $40\,cal\,m^{-2}s^{-1}$ b) $160\,cal\,m^{-2}s^{-1}$ c) $320\,cal\,m^{-2}s^{-1}$ d) $640\,cal\,m^{-2}s^{-1}$

65. Wien's constant is 2892×10^{-6} MKS unit and the value of λ_m from moon is 14.46 microns. What is the surface temperature of moon

a) $100\,K$ b) $300\,K$ c) $400\,K$ d) $200\,K$

66. Ice starts forming in a lake with water at $0°C$,when the atmospheric temperature is $-10\,°C$ .If time taken for 1 cm of ice to be formed is 7 h, the time taken for the thickness of ice to increase from 1 cm to 2 cm is

a) 7 h b) Less than 7 h

c) More than 7 h but less than 14 h d) More than 14 h

67. The tungsten filament of an electric lamp has a surface area A and a power rating P. If the emissivity of the filament is ε and σ is Stefan's constant, the steady temperature of the filament will be

a) $T=\left(\frac{P}{A\varepsilon\sigma}\right)^4$ b) $T=\left(\frac{P}{A\varepsilon\sigma}\right)$ c) $T=\left(\frac{A\varepsilon\sigma}{P}\right)^{\frac{1}{4}}$ d) $T=\left(\frac{P}{A\varepsilon\sigma}\right)^{\frac{1}{4}}$

68. When a copper ball is heated, the largest percentage increase will occur in its

a) Diameter b) Area c) Volume d) Density

69. Suppose the sun expands so that its radius becomes 100 times its present radius and its surface temperature becomes half of its present value. The total energy emitted by it then will increase by a factor of

a) 10^4 b) 625 c) 256 d) 16

70. Two spheres P and Q, of same colour having radii 8 cm and 2 cm are maintained at temperatures $127°C$ and $527°C$ respectively. The energy radiated by P and Q is

a) 0.054 b) 0.0034 c) 1 d) 2

71. A steel scale measures the length of copper wire as $80.0\,cm$, when both are at $20\,°C$ (the calibration temperature for scale). What would be the scale read for the length of the wire when both are at $40\,°C$? (Given $\alpha_{steel}=11\times10^{-6}\,per\,°C \wedge \alpha_{copper}=17\times10^{-6}\,per\,°C$)

a) $80.0096\,cm$ b) $80.0272\,cm$ c) $1\,cm$ d) $25.2\,cm$

72. Two rods of the same length and diameter having thermal conductivities K_1 and K_2 are joined in parallel. The equivalent thermal conductivity of the combination is

a) $\frac{K_1K_2}{K_1+K_2}$ b) K_1+K_2 c) $\frac{K_1K_2}{2}$ d) $\sqrt{K_1}K_2$

73. The temperature of equal masses of three different liquids A, B and C are $12°C$, $19°C$ and $28°C$ respectively. The temperature when A and B are mixed is $16°C$ and when B and C are mixed is $23°C$. The temperature when A and C are mixed is

a) $18.2°C$ b) $22°C$ c) $20.2\,°C$ d) $24.2°C$

74. A block of mass $100\,gm$ slides on a rough horizontal surface. If the speed of the block decreases from $10\,m/s$ to $5\,m/s$, the thermal energy developed in the process is

a) $3.75\,J$ b) $37.5\,J$ c) $0.375\,J$ d) $0.75\,J$

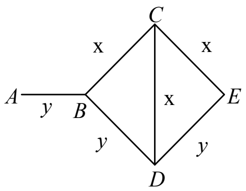
75. Absorption co-efficient of an open window is

a) Zero b) 0.5 c) 1 d) 0.25

76. Temperature of water at the surface of lake is $-20\,°C$. Then temperature of water just below the lower surface of ice layer is

a) $-4\,°C$ b) $0\,°C$ c) $4\,°C$ d) $-20\,°C$

77. Three rods of material X and three rods of material Y are connected as shown in figure. All are identical in length and cross sectional area. If end A is maintained at 60°C, end E at 10°C, thermal conductivity of X is 0.92 cal $s^{-1}cm^{-1}°C^{-1}$ and that Y is 0.46 cal$s^{-1}cm^{-1}°C^{-1}$, then find the temperature of junctions B, C, D.



a) $20\,°C, 30\,°C, 20\,°C$ b) $30°C, 20\,°C, 20\,°C$ c) $20°C, 20\,°C, 30\,°C$ d) $20°C, 20°C, 20\,°C$

78. The Fahrenheit and Kelvin scales of temperature will give the same reading at

a) -40 b) 313 c) 574.25 d) 732.75

79. Boiling water is changing into steam. At this stage then specific heat of water is

a) ¿1 b) ∞ c) 1 d) 0

80. An ideal black body at room temperature is thrown into a furnance. It is observed that

a) It is the darkest body at all times

b) It cannot be distinguished at all times

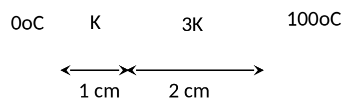
c) Initially it is the darkest body and later it becomes brightest

d) Initially it is the darkest body and later it cannot be distinguished

81. A spherical black body with a radius of $12\,cm$ radiates $440\,W$ power at $500\,K$. If the radius were halved and the temperature doubled, the power radiated in watt would be

a) 225 b) 450 c) 900 d) 1800

82. Two bars of thermal conductivities K and $3K$ and lengths $1\,cm$ and $2\,cm$ respectively have equal cross-sectional area, they are joined lengths wise as shown in the figure. If the temperature at the ends of this composite bar is $0\,°C$ and $100\,°C$ respectively (see figure), then the temperature ϕ of the interface is



a) $50\,°C$ b) $\frac{100}{3}\,°C$ c) $60\,°C$ d) $\frac{200}{3}\,°C$

83. A metal rod of Young's modulus γ and coefficient of thermal expansion α is held at its two ends such that its length remains invariant. If its temperature is raised by $t\,°C$, the linear stress developed in it is

a) $\frac{\alpha t}{\gamma}$ b) $\frac{\gamma}{\alpha E}$ c) $\gamma \alpha t$ d) $\frac{I}{\gamma \alpha t}$

84. Two beakers A and B are filled to the brim with water at $4\,°C$. When A is heated and B is cooled, the water

a) Level in B decreases b) Will overflow in A only

c) Will overflow in B only d) Will overflow in both A and B

85. The real coefficient of volume expansion of glycerine is $0.000597\ per\,°C$ and linear coefficient of expansion of glass is $0.000009\ per\,°C$. Then the apparent volume coefficient of expansion of glycerine is

a) $0.000558\ per\,°C$ b) $0.00057\ per\,°C$ c) $0.00027\ per\,°C$ d) $0.00066\ per\,°C$

86. Two identical conducting rods are first connected independently to two vessels, one containing water at $100°C$ and the other containing ice at $0°C$. In the second case, the rods are joined end to end and connected to the same vessels. Let q_1 and $q_2\ g s^{-1}$ be the rate of melting of ice in the two cases respectively. The ratio $\frac{q_1}{q_2}$ is

a) $\frac{1}{2}$ b) $\frac{2}{1}$ c) $\frac{4}{1}$ d) $\frac{1}{4}$

87. Which of the following statements is correct

a) A good absorber is a bad emitter

b) Every body absorbs and emits radiations at every temperature

c) The energy of radiations emitted from a black body is same for all wavelengths

d) The law showing the relation of temperatures with the wavelength of maximum emission from an ideal black body is Plank's law

88. A metal rod having linear expansion coefficient $2 \times 10^{-5}\,°C^{-1}$ has a length of 1 m at $20°C$. The temperature at which it is shortened by 1 mm is

a) $-20\,°C$ b) $-15\,°C$ c) $-30\,°C$ d) $-25\,°C$

89. Thermoelectric thermometer is based on

a) Photoelectric effect b) Seebeck effect c) Compton effect d) Joule effect

90. If mass-energy equivalence is taken into account, when water is cooled to form ice, the mass of water should

a) Increase b) Remain unchanged

c) Decrease d) First increase then decrease

91. A black body is heated from $27\,°C$ to $127\,°C$. The ratio of their energies of radiations emitted will be

a) 3 : 4 b) 9 : 16 c) 27 : 64 d) 81 : 256

92. Two metallic spheres S_1 and S_2 are made of the same material and have identical surface finish. The mass of S_1 is three times that of S_2. Both the spheres are heated to the same high temperature and placed in the same room having lower temperature but are thermally insulated from each other. The ratio of the initial rate of cooling of S_1 to that of S_2 is

a) $1/3$ b) $(1/3)^{1/3}$ c) $1/\sqrt{3}$ d) $\sqrt{3}/1$

93. In a radiation spectrum obtained from a furnace of 2600 K has maximum intensity at 12000 $Å$ wavelength. If the maximum intensity in spectrum of a star is at 5000 A. the temperature of the outer surface of star is

a) 7800 K b) 6240 K c) 5240 K d) 3640 K

94. A lead bullet strikes against a steel plate with a velocity 200 m/s. If the impact is perfectly inelastic and the heat produced is equally shared between the bullet and the target, then the rise in temperature of the bullet is (specific heat capacity of lead=$125\,Jkg^{-1}\,K^{-1}$)

a) 80°C b) 60°C c) 40°C d) 120°C

95. A constant volume gas thermometer shows pressure reading of 50 cm and 90 cm of mercury at $0\,°C$ and $100°C$

respectively. When the pressure reading is 60 cm of mercury, the temperature is

a) $25℃$ b) $40℃$ c) $12℃$ d) $12.5℃$

96. Hot water cools from $60℃$ to $50℃$ in the first 10 min and to $42℃$ in the first 10 min and to $42℃$ in the next 10 min. Then the temperature of the surroundings is

a) $20℃$ b) $30℃$ c) $15℃$ d) $10℃$

97. There is a black spot on a body. If the body is heated and carried in dark room then it glows more. This can be explained on the basis of

a) Newton's law of cooling b) Wien's law

c) Kirchhoff's law d) Stefan's

98. If l is length A is the area of cross section and K is thermal conductivity, then the thermal resistance of the block is given by

a) KlA b) $1/KlA$ c) $l+KA$ d) l/KA

99. The absolute temperatures of two black bodies are $2000\,K$ and $3000\,K$ respectively. The ratio of wavelengths corresponding to maximum emission of radiation by them will be

a) 2 : 3 b) 3 : 2 c) 9 : 4 d) 4 : 9

100. A clock which keeps correct time at $20℃$, is subjected to $40℃$. If coefficient of linear expansion of the pendulum is $12\times10^{-6}℃^{-1}$. How much will it gain or lose time?

a) $10.3\,s\,day^{-1}$ b) $20.6\,s\,day^{-1}$ c) $5\,s\,day^{-1}$ d) $20\,min\,day^{-1}$

101. In a pressure cooker, cooking is faster because the increase of vapour pressure

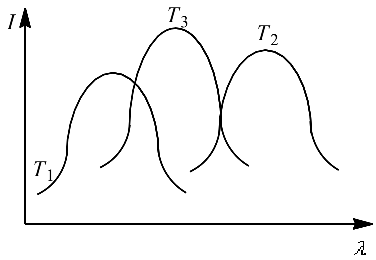
a) Increases specific heat b) Decreases specific heat

c) Decreases the boiling point d) Increases the boiling point

102. The heat is flowing through a rod of length $50\,cm$ and area of cross-section $5\,cm^2$. Its ends are respectively at $25\,℃$ and $125\,℃$. The coefficient of thermal conductivity of the material of the rod is $0.092\,kcal/m\times s\times℃$. The temperature gradient in the rod is

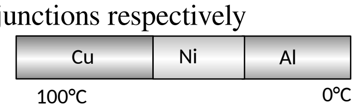
a) $2\,℃/cm$ b) $2\,℃/m$ c) $20\,℃/cm$ d) $20\,℃/m$

103. The plots of intensity of radiation *versus*wavelength of three black bodies at temperatures $T_1, T_2 \wedge T_3$ are shown. Then,



a) $T_3>T_2>T_1$ b) $T_1>T_2>T_3$ c) $T_2>T_3>T_1$ d) $T_1>T_3>T_2$

104. A composite metal bar of uniform section is made up of length $25\,cm$ of copper, $10\,cm$ of nickel and $15\,cm$ of aluminium. Each part being in perfect thermal contact with the adjoining part. The copper end of the composite rod is maintained at $100\,℃$ and the aluminium end at $0\,℃$. The whole rod is covered with belt so that no heat loss occurs at the sides. If $K_{Cu}=2K_{Al}$ and $K_{Al}=3K_{¿}$, then what will be the temperatures of $Cu-¿$ and $¿-Al$ junctions respectively



a) $23.33\,℃$ and $78.8\,℃$ b) $83.33\,℃$ and $20\,℃$ c) $50\,℃$ and $30\,℃$ d) $30\,℃$ and $50\,℃$

105. Mercury boils at 367°C.However,mercury thermometers are made such that they can measure

temperature are made such that they can measure temperature upto 500°C.This is done by

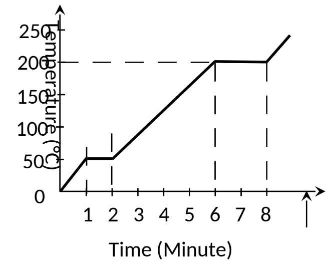
a) Maintaining vacuum above mercury column in the stem of the thermometer

b) Filling nitrogen gas at high pressure above the mercury column

c) Filling oxygen gas at high pressure above the mercury column

d) Filling nitrogen gas at low pressure above the mercury column

106. A student takes $50\, gm$ wax (specific heat ¿$0.6\, kcal/kg\, °C$) and heats it till it boils. The graph between temperature and time is as follows. Heat supplied to the wax per minute and boiling point are respectively



a) $500\, cal, 50\, °C$ b) $1000\, cal, 100\, °C$ c) $1500\, cal, 200\, °C$ d) $1000\, cal, 200\, °C$

107. Dry ice is

a) Ice cube b) Sodium chloride c) Liquid nitrogen d) Solid carbon dioxide

108. A partition wall has two layers A and B in contanct, each made of a different material. They have the same thickness but the thermal conductivity of layer A is twice that of layer B. If the steady state temperature difference across the wall is $60\, K$, then the corresponding difference across the layer A is

a) $10\, K$ b) $20\, K$ c) $30\, K$ d) $40\, K$

109. A closed bottle containing water at $30\, °C$ is carried to the moon in a space-ship. If it is placed on the surface of the moon, what will happen to the water as soon as the lid is opened

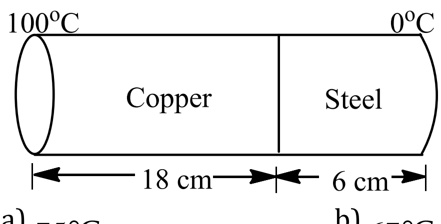
a) Water will boil

b) Water will freeze

c) Nothing will happen on it

d) It will decompose into H_2 and O_2

110. The coefficient of thermal conductivity of copper is 9 times that of steel. In the composite cylindrical bar shown in the figure, what will be the temperature at the junction of copper and steel?



a) 75°C b) 67°C c) 25°C d) 33°C

111. Three discs, A, B and Chaving radii 2 m, 4 m and 6 m respectively are coated with carbon black on their outer surfaces. The wavelengths corresponding to maximum intensitios are 300 nm, 400 nm and 500 nm respectively. The power radiated by them are $Q_A, Q_B$and Q_C respectively

a) $Q_A\, is\, maximum$ b) $Q_B\, is\, maximum$ c) $Q_c\, is\, maximum$ d) $Q_A = Q_B = Q_C$

112. Two rods of different materials having coefficient of thermal expansions α_1 and α_2 and Young's moduli Y_1 and Y_2 respectively are fixed between two rigid walls. The rods are heated, such that they undergo the same increase in temperature. There is no bending of rods. If α_1/α_2=2/3 and stresses developed in the two rods are equal, then $\frac{Y1}{Y2}$ is

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

113. Four identical rods of same material are joined end to end to form a square. If the temperature difference between the ends of a diagonal is $100\ ℃$, then the temperature difference between the ends of other diagonal will be

a) $0\ ℃$
b) $\frac{100}{l}\ ℃$; where l is the length of each rod
c) $\frac{100}{2l}\ ℃$
d) $100\ ℃$

114. On investigation of light from three different stars A, B and C, it was found that in the spectrum of A the intensity of red colour is maximum, in B the intensity of blue colour is maximum and in C the intensity of yellow colour is maximum. From these observations it can be concluded that

a) The temperatures of A is maximum, B is minimum and C is intermediate
b) The temperatures of A is maximum, C is minimum and B is intermediate
c) The temperatures of B is maximum, A is minimum and C is intermediate
d) The temperatures of C is maximum, B is minimum and A is intermediate

115. In a room where the temperature is $30℃$, a body cools form $61℃$ to $59℃$ in 4 min. The time (in minutes) taken by the body to cool from $51℃$ to $49℃$ will be

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

116. When red glass is heated in dark room it will seen

a) Green
b) Purple
c) Black
d) Yellow

117. Which of the following cylindrical rods will conduct most heat, when their ends are maintained at the same steady temperature

a) Length $1\ m$; radius $1\ cm$
b) Length $2\ m$; radius $1\ cm$
c) Length $2\ m$; radius $2\ cm$
d) Length $1\ m$; radius $2\ cm$

118. A sphere, a cube and a thin circular plate, all made of the same material and having the same mass are initially heated to a temperature of $1000\ ℃$. Which one of these will cool first

a) Plate
b) Sphere
c) Cube
d) None of these

119. A steel meter scale is to be ruled so that millimeter intervals are accurate within about $5 \times 10^{-5}\ mm$ at a certain temperature. The maximum temperature variation allowable during the ruling is (Coefficient of linear expansion of steel ¿ $10 \times 10^{-6}\ K^{-1}$)

a) $2\ ℃$
b) $5\ ℃$
c) $7\ ℃$
d) $10\ ℃$

120. Colour of shinning bright star is an indication of its

a) Distance from the earth
b) Size
c) Temperature
d) Mass

121. A metal ball of surface area $200\ c\ m^2$ and temperature $527\ ℃$ is surrounded by a vessel at $27\ ℃$. If the emissivity of the metal is 0.4, then the rate of loss of heat from the ball is $(\sigma = 5.67 \times 10^{-8}\ J/m^2 - s - K^4)$

a) 108 joules approx
b) 168 joules approx
c) 182 joules approx
d) 192 joules approx

122. Two vessels of different materials are similar in size in every respect. The same quantity of ice filled in them gets melted in 20 minutes and 30 minutes. The ratio of their thermal conductivities will be

a) 1.5
b) 1
c) $2/3$
d) 4

123. Solar radiation emitted by sun correspond to that emitted by black body at a temperature of 6000 K. Maximum intensity is emitted at wavelength of $4800\ Å$. If the sun was to cool down from 6000 K to 3000 K, then the peak intensity of emitted radiation would occur at a wavelength

a) $4800Å$ b) $9600Å$ c) $2400Å$ d) $19200Å$

124. Hot water cools from $60℃$ to $50℃$ in the first 10 min and to $42℃$ in the next 10 min. The temperature of the surroundings is

a) $10℃$ b) $5℃$ c) $15℃$ d) $20℃$

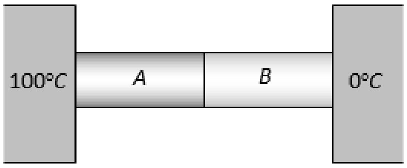
125. Water of volume 2 L in a container is heated with a coil of 1 kW at $27℃$. The lid of the container is open and energy dissipates at rate of $160 Js^{-1}$. In how much time temperature will rise from $27℃$ to 77 $℃$ [Given specific heat of water is 4.2 kJ kg^{-1}]

a) 8 min 20 s b) 6 min 2 s c) 7 min d) 14 min

126. A lead ball moving with a velocity V strikes a wall and stops. If 50% of its energy is converted into heat, then what will be the increase in temperature (Specific heat of lead is S)

a) $\frac{2V^2}{JS}$ b) $\frac{V^2}{4\,JS}$ c) $\frac{V^2}{J}$ d) $\frac{V^2 S}{2J}$

127. Two metal cubes A and B of same size are arranged as shown in the figure. The extreme ends of the combination are maintained at the indicated temperatures. The arrangement is thermally insulated. The coefficients of thermal conductivity of A and B are $300\, W/m℃$ and $200\, W/m℃$, respectively. After steady state is reached, the temperature of the interface will be



a) $45\,℃$ b) $90\,℃$ c) $30\,℃$ d) $60\,℃$

128. The surface temperature of the sun is

a) $2900\,K$ b) $4000\,K$ c) $5800\,K$ d) $9000\,K$

129. The mechanical equivalent of heat J is

a) A constant b) A physical quantity c) A conversion factor d) None of the above

130. On a hilly region, water boils at 95°C.The temperature expressed in Fahrenheit is

a) 100°F b) 20.3 °F c) 150°F d) $203℉$

131. At a certain temperature for given wave length, the ratio of emissive power of a body to emissive power of black body in same circumstances is known as

a) Relative emissivity b) Emissivity

c) Absorption coefficient d) Coefficient of reflection

132. Recently, the phenomenon of superconductivity has been observed at $95\,K$. This temperature is nearly equal to

a) $-288^o\,F$ b) $-146^o\,F$ c) $-368^o\,F$ d) $+178^o\,F$

133. The maximum wavelength of radiation emitted at $2000\,K$ is $4\,\mu m$. What will be the maximum wavelength of radiation emitted at $2400\,K$

a) $3.33\,\mu m$ b) $0.66\,\mu m$ c) $1\,\mu m$ d) $1\,m$

134. For proper ventilation of building, windows must be open near the bottom and top of the walls so as to let pass

a) In more air

b) In cool air near the bottom and hot air out near the roof

c) In hot air near the roof and cool air out near the bottom

d) Out hot air near the roof

135. A gas in an airtight container is heated from $25\,℃$ to $90\,℃$. The density of the gas will

a) Increase slightly
b) Increase considerably
c) Remain the same
d) Decrease slightly

136. At NTP water boils at $100\,℃$. Deep down the mine, water will boil at a temperature

a) $100\,℃$
b) ¿$100\,℃$
c) ¿$100\,℃$
d) Will not boil at all

137. Calorie is defined as the amount of heat required to raise temperature of 1 g of water by 1 ℃ and it is defined under which of the following conditions?

a) From 14.5℃ to 15.5℃ at 760 mm of Hg
b) From 98.5℃ to 99.5℃ at 760 mm of Hg
c) From 13.5℃ to 14.5℃ at 76 mm of Hg
d) From 3.5℃ to 4.5℃ at 76 mm of Hg

138. According to the experiment of Ingen Hausz the relation between the thermal conductivity of a metal rod is K and the length of the rod whenever the wax melts is

a) $K/l=$¿ constant
b) $K^2/l=$¿ constant
c) $K/l^2=$¿ constant
d) $Kl=$¿ constant

139. Two solid spheres of the same material have the same radius but one is hollow while the other is solid. Both spheres are heated to same temperature. Then

a) The solid sphere expands more
b) The hollow sphere expands more
c) Expansion is same for both
d) Nothing can be said about their relative expansion if their masses are not given

140. Three very large plates of same area are kept parallel and close to each other. They are considered as ideal black surfaces and have very high thermal conductivity. The first and third plates are maintained at temperatures $2T$ and $3T$ respectively. The temperature of the middle (i.e. second) plate under steady state condition is

a) $\left(\frac{65}{2}\right)^{\frac{1}{4}}T$
b) $\left(\frac{97}{4}\right)^{\frac{1}{4}}T$
c) $\left(\frac{97}{2}\right)^{\frac{1}{4}}T$
d) $(97)^{\frac{1}{4}}T$

141. The coefficient of volume expansion of a liquid is $49\times10^{-5}K^{-1}$. Calculate the fractional change in its density when the temperature is raised by $30℃$.

a) 7.5×10^{-3}
b) 3.0×10^{-3}
c) 1.5×10^{-2}
d) 1.1×10^{-3}

142. A body takes $5\,minutes$ to cool from $90\,℃$ to $60\,℃$. If the temperature of the surroundings is $20\,℃$, the time taken by it to cool from $60\,℃$ to $30\,℃$ will be

a) $5\,min$
b) $8\,min$
c) $11\,min$
d) $12\,min$

143. Four pieces of iron heated in a furnace to different temperatures show different colours listed below. Which one has the highest temperature

a) White
b) Yellow
c) Orange
d) Red

144. No other thermometer is as suitable as a platinum resistance thermometer to measure temperature in the entire range of

a) $0\,℃$¿$100\,℃$
b) $100\,℃$¿$1500\,℃$
c) $-50\,℃$¿$+350\,℃$
d) $-200\,℃$¿$600\,℃$

145. Which of the following is the correct device for the detection of thermal radiation

a) Constant volume thermometer
b) Liquid-in-glass thermometer

c) Six's maximum and minimum thermometer
d) Thermopile

146. The cause of Fraunhoffer lines is

a) Reflection of radiations by chromosphere
b) Absorption of radiations by chromosphere
c) Emission of radiations by chromosphere
d) Transmission of radiations by chromosphere

147. While measuring the thermal conductivity of a liquid, we keep the upper part hot and lower part cool, so that

a) Convection may be stopped
b) Radiation may be stopped
c) Heat conduction is easier downwards
d) It is easier and more convenient to do so

148. One gram of ice is mixed with one gram of steam. At thermal equilibrium the temperature of mixture is

a) $0°C$
b) $100°C$
c) $55°C$
d) $80°C$

149. The dimensions of thermal resistance are

a) $M^{-1}L^{-2}T^3K$
b) $ML^2T^{-2}K^{-1}$
c) $ML^2T^{-3}K$
d) $ML^2T^{-2}K^{-2}$

150. Two rectangular blocks A and B of different metals have same length and same area of cross-section. They are kept in such a way that their cross-sectional area touch each other. The temperature at one end of A is $100\ °C$ and that of B at the other end is $0\ °C$. If the ratio of their thermal conductivity is 1 : 3, then under steady state, the temperature of the junction in contact will be

a) $25\ °C$
b) $50\ °C$
c) $75\ °C$
d) $100\ °C$

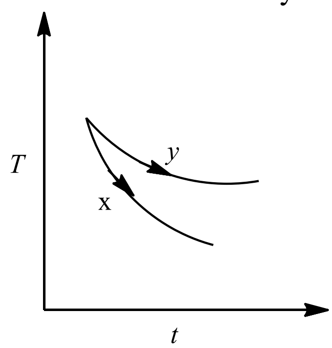
151. Two identical metal balls at temperature $200\ °C$ and $400\ °C$ kept in air at $27\ °C$. The ratio of net heat loss by these bodies is

a) 1/4
b) 1/2
c) 1/16
d) $\frac{473^4 - 300^4}{673^4 - 300^4}$

152. Water is used to cool radiators of engines, because

a) Of its lower density
b) It is easily available
c) It is cheap
d) It has high specific heat

153. The graph, shown in the adjacent diagram, represents the variation of temperature (T) of two bodies, x and y having same surface area, with time (t) due to the emission of radiation. Find the correct relation between the emissivity and absorptivity power of the two bodies.



a) $E_x > E_y \wedge a_x < a_y$
b) $E_x < E_x \wedge a_x > a_y$
c) $E_x > E_x \wedge a_x > a_y$
d) $E_x < E_x \wedge a_x < a_y$

154. Two black metallic spheres of radius $4\ m$, at $2000\ K$ and $1\ m$ at $4000\ K$ will have ratio of energy radiation as

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

155. Which one of the following processes depends on gravity?

a) Conduction b) Convection c) Radiation d) None of these

156. A body has same temperature as that of the surrounding. Then

a) It radiates same heat as it absorbs b) It absorbs more, radiates less heat

c) It radiates more, absorbs less heat d) It never radiates heat

157. If at temperature $T_1 = 1000\,K$, the wavelength is $1.4 \times 10^{-6}\,m$, then at temperature the wavelength will be $2.8 \times 10^{-6}\,m$

a) $2000\,K$ b) $500\,K$ c) $250\,K$ d) None of these

158. Temperature of a black body increases from $327\,°C$ to $927\,°C$, the initial energy possessed is $2\,KJ$, what is its final energy

a) $32\,KJ$ b) $320\,KJ$ c) $1200\,KJ$ d) None of these

159. Two vessels of different materials are similar in size in every respect. The same quantity of ice filled in them gets melted in $20\,minutes$ and $40\,minutes$ respectively. The ratio of thermal conductivities of the materials is

a) 5 : 6 b) 6 : 5 c) 3 : 1 d) 2 : 1

160. The weight of a person is $60\,kg$. If he gets 10^5 calories heat through food and the efficiency of his body is 28%, then upto how much height he can climb (approximately)

a) $100\,m$ b) $200\,m$ c) $400\,m$ d) $1000\,m$

161. A body of length $1\,m$ having cross sectional area $0.75\,m^2$ has heat flow through it at the rate of $6000\,Joule/s$. Then find the temperature difference if $K = 200\,J\,m^{-1}\,K^{-1}$

a) $20\,°C$ b) $40\,°C$ c) $80\,°C$ d) $100\,°C$

162. In Searle's method for finding conductivity of metals, the temperature gradient along the bar

a) Is greater nearer the hot end b) Is greater nearer to the cold end

c) Is the same at all points along the bar d) Increases as we go from hot end to cold end

163. Which of the following is the unit of specific heat

a) $J\,kg\,°C^{-1}$ b) $J/kg\,°C$ c) $kg\,°C/J$ d) $J/kg\,°C^{-2}$

164. A black body radiates at the rate of W watts at a temperature T. If the temperature of the body is reduced to $T/3$, it will radiate at the rate of (in $Watts$)

a) $\frac{W}{81}$ b) $\frac{W}{27}$ c) $\frac{W}{9}$ d) $\frac{W}{3}$

165. The intensity of radiation emitted by the sun has its maximum value at a wavelength of 510 nm and that emitted by the north star has the maximum value at wavelength of 350 nm. If these stars behave like black bodies, then the ratio of surface temperatures of the sun and north star is

a) 1.46 b) 0.69 c) 1.21 d) 0.83

166. An electric kettle takes $4\,A$ current at $220\,V$. How much time will it take to boil 1 kg of water from temperature $20\,°C$? The temperature of boiling water is $100\,°C$

a) $12.6\,min$ b) 4.2 min c) 6.3 min d) 8.4 min

167. Expansion during heating

a) Occurs only in solids b) Increases the weight of a material

c) Decreases the density of a material d) Occurs at the same rate for all liquids and solids

168. If the ratio of densities of two substances is $5:6$ and that of the specific heats is $3:5$. Then the ratio between heat capacities per unit volume is

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

169. One end of a metal rod of length 1.0 m and area of cross-section $100 cm^2$ is maintained at $100\ ℃$. If the other end of the rod is maintained at $0 ℃$, the quantity of heat transmitted through the rod per minute is (coefficient of thermal conductivity of material of rod =100W/m-K)

a) 3×10^3 J b) 6×10^3 J c) 9×10^3 J d) 12×10^3 J

170. The freezer in a refrigerator is located at the top section so that

a) The entire of the refrigerator is cooled quickly due to convection

b) The motor is not heated

c) The heat gained from the environment is high

d) The heat gained from the environment is low

171. If there are no heat losses, the heat released by the condensation of $x\,g$ of steam at $100\ ℃$ into water at $100\ ℃$ can be used to convert $y\,gm$ of ice at $0\ ℃$ into water at $100\ ℃$. Then the ratio $y : x$ is nearly

a) $1:1$ b) $2.5:1$ c) $2:1$ d) $3:1$

172. The thermal conductivity of a material in CGS system is 0.4. In steady state, the rate of flow of heat is $10\ cal/s$-$c\,m^2$, then the thermal gradient will be

a) $10\ ℃/cm$ b) $12\ ℃/cm$ c) $25\ ℃/cm$ d) $20\ ℃/cm$

173. In MKS system, Stefan's constant is denoted by σ. In CGS system multiplying factor of σ will be

a) 1 b) 10^3 c) 10^5 d) 10^2

174. A body cools from $60\ ℃$ to $50℃$ in 10 min. if the room temperature is $25℃$ and assuming Newton's law of cooling to hold good, the temperature of the body at the end of the next 10 min will be

a) $45℃$ b) $42.85℃$ c) $40℃$ d) $38.5℃$

175. The temperature at which a black body ceases to radiate energy, is

a) Zero b) 273 K c) 30 K d) 100 K

176. One quality of a thermometer is that its heat capacity should be small. If P is a mercury thermometer, Q is a resistance thermometer and R thermocouple type then

a) P is best, R worst b) R is best, P worst c) R is best, Q worst d) P is best, Q worst

177. An ice box made of Styrofoam (Thermal conductivity=$0.01\ Jm^{-1}s^{-1}K^{-1}$) is used to keep liquids cool. It has a total wall area including lid of $0.8 m^2$ and wall thickness of 0.2 cm. A bottle of water is placed in the box and filled with ice. If the outside temperature is $30℃$ the rate flow of heat into the box is (in Js^{-1})

a) 16 b) 14 c) 12 d) 10

178. In heat transfer, which method is based on gravitation

a) Natural convection b) Conduction c) Radiation d) Stirring of liquids

179. The temperature at which the vapour pressure of a liquid becomes equals to the external (atmospheric) pressure is its

a) Melting point b) Sublimation point c) Critical temperature d) Boiling point

180. Newton's law of cooling holds good only, if the temperature difference between the body and the surroundings is

a) Less than $10℃$ b) More than $10℃$ c) Less than $100℃$ d) More than $100℃$

181. A black body at a high temperature T radiates energy at the rate of U (in Wm^{-2}). When the temperature falls to half ($ie, \frac{T}{2}$), the radiated energy (in Wm^{-2}) will be

a) $\frac{U}{8}$ b) $\frac{U}{16}$ c) $\frac{U}{4}$ d) $\frac{U}{2}$

182. If two metallic plates of equal thicknesses and thermal conductivities K_1 and K_2 are put together face to face and a common plate is constructed, then the equivalent thermal conductivity of this plate will be

K1 K2

a) $\frac{K_1 K_2}{K_1+K_2}$ b) $\frac{2K_1 K_2}{K_1+K_2}$ c) $\frac{(K_1^2+K_2^2)^{3/2}}{K_1 K_2}$ d) $\frac{(K_1^2+K_2^2)^{3/2}}{2K_1 K_2}$

183. If the temperature of the sun were to increase from T to $2T$ and its radius from R to $2R$, when the ratio of radiant energy received on earth to what it was previously, will be

a) 4 b) 16 c) 32 d) 64

184. The gas thermometers are more sensitive than liquid thermometers because

a) Gases expand more than liquids b) Gases are easily obtained

c) Gases are much lighter d) Gases do not easily change their states

185. $1g$ of a steam at $100\,°C$ melts how much ice at $0\,°C$? (Latent heat of ice ¿ $80\,cal/gm$ and latent heat of steam ¿ $540\,cal/gm$)

a) $1\,gm$ b) $2\,gm$ c) $4\,gm$ d) $8\,gm$

186. A body radiates energy $5\,W$ at a temperature of $127\,°C$. If the temperature is increased to $927\,°C$, then it radiates energy at the rate of

a) $410\,W$ b) $81\,W$ c) $405\,W$ d) $200\,W$

187. According to 'Newton's Law of cooling', the rate of cooling of a body is proportional to the

a) Temperature of the body

b) Temperature of the surrounding

c) Fourth power of the temperature of the body

d) Difference of the temperature of the body and the surroundings

188. The heat is flowing through two cylindrical rods of same material. The diameters of the rods are in the ratio 1:2 and their lengths are in the ratio 2:1. If the temperature difference between their ends is the same, the ratio of rate of flow of heat through them will be

a) 1 : 1 b) 2 : 1 c) 1 : 4 d) 1 : 8

189. The quantities of heat required to raise the temperatures of two copper spheres of radii $r_1 \wedge r_2 (r_1 = 1.5 r_2)$ through 1 K are in the ratio of

a) 1 b) $\frac{3}{2}$ c) $\frac{9}{4}$ d) $\frac{27}{8}$

190. 'Stem Correction' in platinum resistance thermometers are eliminated by the use of

a) Cells b) Electrodes c) Compensating leads d) None of the above

191. Two walls of thicknesses d_1 and d_2 and thermal conductivities k_1 and k_2 are in contact. In the steady state, if the temperatures at the outer surfaces are T_1 and T_2, the temperature at the common wall is

a) $\frac{k_1 T_1 d_2 + k_2 T_2 d_1}{k_1 d_2 + k_2 d_1}$ b) $\frac{k_1 T_1 + k_2 d_2}{d_1 + d_2}$ c) $\left(\frac{k_1 d_1 + k_2 d_2}{T_1 + T_2}\right) T_1 T_2$ d) $\frac{k_1 d_1 T_1 + k_2 d_2 T_2}{k_1 d_1 + k_2 d_2}$

192. The coefficient of thermal conductivity of a rod depends on

a) Area
b) Length
c) Material of rod
d) Temperature difference

193. Two thermometers are used to record the temperature of a room. If the bulb of one is wrapped in wet hanky

a) The temperature recorded by both will be same
b) The temperature recorded by wet-bulb thermometer will be greater than that recorded by the other
c) The temperature recorded by dry-bulb thermometer will be greater than that recorded by the other
d) None of the above

194. A $5\,cm$ thick ice block is there on the surface of water in a lake. The temperature of air is $-10\,℃$; how much time it will take to double the thickness of the block
¿-k, $d_{ice}=0.92\,g\,cm^{-3}$¿

a) $1\,hour$
b) $191\,hours$
c) $19.1\,hours$
d) $1.91\,hours$

195. $80\,gm$ of water at $30\,℃$ are poured on a large block of ice at $0\,℃$. The mass of ice that melts is

a) $30\,gm$
b) $80\,gm$
c) $1600\,gm$
d) $150\,gm$

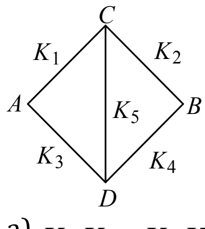
196. It is known that wax contracts on solidification. If molten wax is taken in a large vessel and it is allowed to cool slowly, then

a) It will start solidifying from the top to downward
b) It will start solidifying from the bottom to upward
c) It will start solidifying from the middle, upward and downward at equal rates
d) The whole mass will solidify simultaneously

197. A black body is heated from $27℃$ to $927℃$. The ratio of radiation emitted will be

a) 1:4
b) 1:8
c) 1:16
d) 1:256

198. Five rods of same dimensions are arranged as shown in figure. They have thermal conductivities $K_1, K_2, K_3, K_4 \wedge K_5$. When points $A \wedge B$ are maintained at different temperature, no heat would flow through central rod, if



a) $K_1 K_4 = K_2 K_3$
b) $K_1 = K_4 \wedge K_2 = K_3$
c) $\frac{K_1}{K_4} = \frac{K_2}{K_3}$
d) $K_1 K_2 = K_3 K_4$.

199. The thermal conductivity of a rod is 2. What is its thermal resistivity?

a) 0.5
b) 1
c) 0.25
d) 2

200. When two ends of a rod wrapped with cotton are maintained at different temperatures and after same time every point of the rod attains a constant temperature, then

a) Conduction of heat at different points of the rod stops because the temperature is not increasing

b) Rod is bad conductor of heat

c) Heat is being radiated from each point of the rod

d) Each point of the rod is giving heat to its neighbour at the same rate at which it is receiving heat

201. The temperature at which a black body of unit area loses its energy at the rate of $1\ joule/second$ is

a) $-65\,°C$ b) $65\,°C$ c) $65\,K$ d) None of these

202. The densities of a liquid at $0°C$ and $100°C$ are respectively 1.0127 and 1. A specific gravity bottle is filled with 300 g of the liquid at $0°C$ upto the brim and it is heated to $100°C$. Then the mass of the liquid expelled in grams is (Coefficient of linear expansion of glass=$9\times10^{-6}\,°C^{-1}$)

a) $\frac{3}{10.1}$ b) $\frac{3}{1.01}$ c) $\frac{3.81}{1.0127}$ d) $\frac{3.81}{0.0127}$

203. A clock with an iron pendulum keeps correct time at $15°C$. What will be the error, in second per day, if the room temperature is $20°C$?
(The coefficient of linear expansion of iron is $0.000012°C^{-1}.¿$

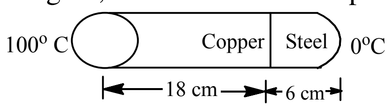
a) 2.6 s b) 6.2 s c) 1.3 s d) 3.1 s

204. Can we boil water inside the earth satellite by convection

a) Yes b) No

c) Nothing can be said d) In complete information is given

205. The coefficient of thermal conductivity of copper is nine times that of steel. In the composite cylindrical bar show in figure, what will be the temperature at the junction of copper ad steel?



a) $75°C$ b) $67°C$ c) $33°C$ d) $25°C$

206. If the temperature of the sun becomes twice its present temperature, then

a) Radiated energy would be predominantly in infrared

b) Radiated energy would be predominantly in ultraviolet

c) Radiated energy would be predominantly in X-ray region

d) Radiated energy would become twice the present radiated energy

207. A black body of surface area $10\,cm^2$ is heated to $127\,°C$ and is suspended in a room at temperature $27\,°C$. The initial rate of loss of heat from the body at the room temperature will be

a) $2.99\,W$ b) $1.89\,W$ c) $1.18\,W$ d) $0.99\,W$

208. A body of area $1\,cm^2$ is heated to a temperature $1000\,K$. The amount of energy radiated by the body in $1\,s$ is
(Stefan's constant $\sigma=5.67\times10^{-8}\,W\,m^{-2}\,K^{-4}¿$

a) 5.67 joule b) 0.567 joule c) 56.7 joule d) 567 joule

209. Heat current is maximum in which of the following (rods are of identical dimension)?

a) [Cu] b) [Steel | Cu]

c) [Cu | Steel] d) [Steel]

210. Two spheres made of same material have radii in the ratio 1:2. Both are at same temperature. Ratio of heat radiation energy emitted per second by them is

a) 1 : 2 b) 1 : 8 c) 1 : 4 d) 1 : 16

211. A body, which emits radiations of all possible wavelengths, is known as

a) Good conductor b) Partial radiator c) Absorber of photons d) Perfectly black-body

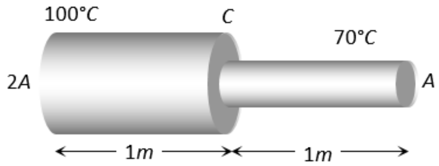
212. The temperature of hot and cold end of a $20\,cm$ long rod in thermal steady state are at $100\,℃$ and $20\,℃$ respectively. Temperature at the centre of the rod is

a) $50\,℃$ b) $60\,℃$ c) $40\,℃$ d) $30\,℃$

213. The ends of two rods of different materials with their thermal conductivities, radii of cross-sections and lengths all are in the ratio 1:2 are maintained at the same temperature difference. If the rate of flow of heat in the larger rod is $4\,cal/s$, that in the shorter rod in cal/s will be

a) 1 b) 2 c) 8 d) 16

214. A metal rod of length $2\,m$ has cross sectional areas $2A$ and A as shown in figure. The ends are maintained at temperatures $100\,℃$ and $70\,℃$. The temperature at middle point C is



a) $80\,℃$ b) $85\,℃$ c) $90\,℃$ d) $95\,℃$

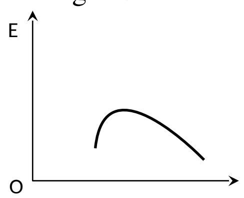
215. Good absorbers of heat are

a) Poor emitters b) Non-emitters c) Good emitters d) Highly polished

216. A black body at a temperature of $227℃$ radiates heat at the rate of 5 cal$cm^{-2}s^{-1}$. At a temperature of $727℃$ the rate of heat radiated per unit area in cal$cm^{-2}s^{-1}$ is

a) 400 b) 80 c) 40 d) 15

217. The energy distribution E with the wavelength (λ) for the black body radiation at temperature $T\,kelvin$ is shown in the figure. As the temperature is increased the maxima will



a) Shift towards left and become higher b) Rise high but will not shift

c) Shift towards right and become higher d) Shift towards left and the curve will become broader

218. The wavelength of the radiation emitted by a body depends upon

a) The nature of the surface b) The area of the surface

c) The temperature of the surface d) All of the above factors

219. There is a rough black spot on a polished metallic plate. It is heated upto $1400\,K$ approximately and then at once taken in a dark room. Which of the following statements is true

a) In comparison with the plate, the spot will shine more

b) In comparison with the plate, the spot will appear more black

c) The spot and the plate will be equally bright

d) The plate and the black spot can not be seen in the dark room

220. In which of the following process convection does not take place primarily

a) Sea and land breeze
b) Boiling of water
c) Warming of glass of bulb due to filament
d) Heating air around a furnace

221. Work done in converting one gram of ice at -10$℃$ into steam at 100$℃$ is

a) 3045 J
b) 6056 J
c) 721 J
d) 616 J

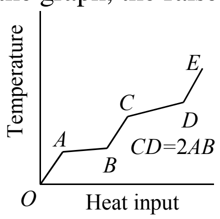
222. There is some change in length when a 33000 N tensile force is applied on a steel rod of area of cross-section$10^{-3} m^2$. The change of temperature required to produce the same elongation, if the steel rod is heated, is (The modulus of elasticity is $3 \times 10^{11} Nm^{-2}$ and the coefficient of linear expansion of steel is $1.1 \times 10^{-5} ℃^{-1}$.

a) $20℃$
b) $15 ℃$
c) $10 ℃$
d) $0 ℃$

223. If a graph is plotted taking the temperature in Fahrenheit along Y-axis and the corresponding temperature in Celsius along the X-axis, it will be a straight line

a) Having $a + ve$ intercept on Y-axis
b) Having $a + ve$ intercept on X-axis
c) Passing through the origin
d) Having $a - ve$ intercepts on both the axis

224. A solid material is supplied with heat at constant rate and the temperature of the material changes as shown. From the graph, the false conclusion drawn is



a) AB and CD of the graph represent phase changes

b) AB represents the change of state from solid to liquid

c) Latent heat of fusion is twice the latent heat of vaporization

d) CD represents change of state from liquid to vapour

225. A lead bulled strikes at target with a velocity of 480 ms^{-1}. If the bullet falls dead, the rise in temperature of bullet (c = 0.03), assuming that heat produced is equally shared between the bullet and target is

a) $557℃$
b) $457℃$
c) $857℃$
d) $754℃$

226. The absolute zero is the temperature at which

a) Water freezes
b) All substances exist in solid state
c) Molecular motion ceases
d) None of the above

227. In a water-fall the water falls from a height of $100 m$. If the entire $K.E.$ of water is converted into heat, the rise in temperature of water will be

a) $0.23 ℃$
b) $0.46 ℃$
c) $2.3 ℃$
d) $0.023 ℃$

228. The thermal radiation from a hot body travels with a velocity of

a) $330 m s^{-1}$
b) $2 \times 10^8 m s^{-1}$
c) $1200 m s^{-1}$
d) $3 \times 10^8 m s^{-1}$

229. One end of a copper rod of length $1.0\,m$ and area of cross-section $10^{-3}\,m^2$ is immersed in boiling water and the other end in ice. If the coefficient of thermal conductivity of copper is $92\,cal/m\text{-}s\text{-}°C$ and the latent heat of ice is $8\times10^4\,cal/kg$, then the amount of ice which will melt in one minute is

a) $9.2\times10^{-3}\,kg$ b) $8\times10^{-3}\,kg$ c) $6.9\times10^{-3}\,kg$ d) $5.4\times10^{-3}\,kg$

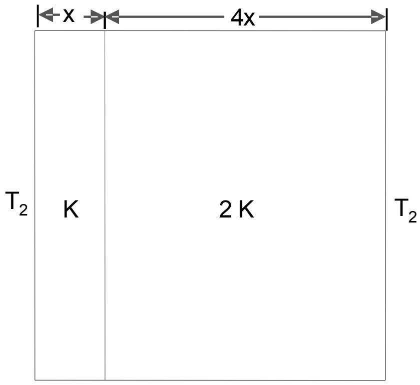
230. Triple point of water is

a) $273.16^o\,F$ b) $273.16\,K$ c) $273.16\,°C$ d) $273.16\,R$

231. Let there be four articles having colours blue, red, black and white. When they are heated together and allowed to cool, which article cool at the earliest

a) Blue b) Red c) Black d) White

232. The temperature of the two outer surfaces of a composite slab, consisting of two materials having coefficients of thermal conductivity K and $2K$ and thickness x and $4x$, respectively are T_2 and T_1 $(T_2 > T_1)$. The rate of heat transfer through the slab, in a steady state is $\left(\frac{A(T_2-T_1)K}{x}\right)f$, with f equals to



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

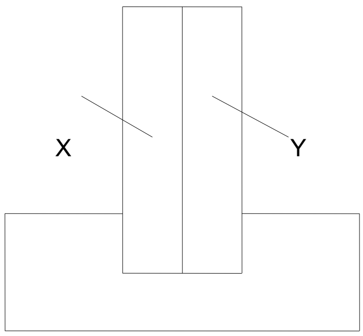
233. Temperatures of two stars are in ratio 3:2. If wavelength of maximum intensity of first body is $4000\,Å$, what is corresponding wavelength second body?

a) $9000\,Å$ b) $6000\,Å$ c) $2000\,Å$ d) $8000\,Å$

234. During constant temperature, we feel colder on a day when the relative humidity will be

a) 25% b) 12.5% c) 50% d) 75%

235. A bimetallic strip consists of metals X and Y. It is mounted rigidly at the base as shown. The metal X has a higher coefficient of expansion compared to that for metal Y. when bimetallic strip is placed in a cold bath



a) It will bend towards the right b) It will bend towards the left

c) It will not bend but shrink d) It will neither bend nor shrink

236. A faulty thermometer has its lower fixed point marked as $-10\,°C$ and upper fixed point marked as 110^o. If the temperature of the body shown in this scale is 62^o, the temperature shown on the Celsius scale is

a) $72\,°C$ b) $82\,°C$ c) $60\,°C$ d) $42\,°C$

237. Which of the prism is used to see infra-red spectrum of light

a) Rock-salt b) Nicol c) Flint d) Crown

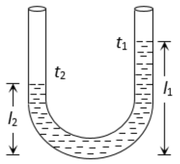
238. The two ends of a rod of length L and a uniform cross-sectional area A are kept at two temperature T_1 and T_2 $(T_1 > T_2)$. The rate of heat transfer, $\frac{dQ}{dt}$, through the rod in a steady state is given by

a) $\frac{dQ}{dt}=\frac{kL(T_1-T_2)}{A}$ b) $\frac{dQ}{dt}=\frac{k(T_1-T_2)}{LA}$ c) $\frac{dQ}{dt}=kLA(T_1-T_2)$ d) $\frac{dQ}{dt}=\frac{kA(T_1-T_2)}{L}$

239. The temperatures of two bodies A and B are respectively $727\,°C$ and $327\,°C$. The ratio $H_A : H_B$ of the rates of heat radiated by them is

a) 727 : 327 b) 5 : 3 c) 25 : 9 d) 625 : 81

240. In a vertical U-tube containing a liquid, the two arms are maintained at different temperatures t_1 and t_2. The liquid columns in the two arms have heights l_1 and l_2 respectively. The coefficient of volume expansion of the liquid is equal to

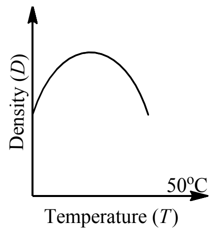
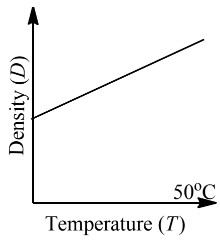
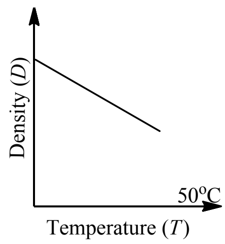
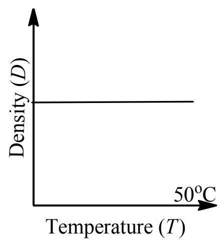


a) $\frac{l_1-l_2}{l_2 t_1 - l_1 t_2}$ b) $\frac{l_1-l_2}{l_1 t_1 - l_2 t_2}$ c) $\frac{l_1+l_2}{l_2 t_1 + l_1 t_2}$ d) $\frac{l_1+l_2}{l_1 t_1 + l_2 t_2}$

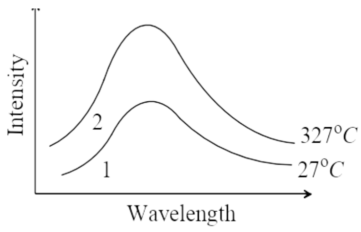
241. A lead bullet of $10\,g$ travelling at $300\,m/s$ strikes against a block of wood and comes to rest. Assuming 50% of heat is absorbed by the bullet, the increase in its temperature is
(specific heat of lead ¿ $150\,J/kg, K$)

a) $100\,°C$ b) $125\,°C$ c) $150\,°C$ d) $200\,°C$

242. Which one of the figure gives the temperature dependence of density water correctly?

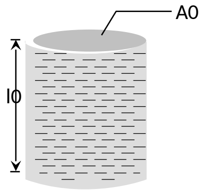
a) 
b) 
c) 
d) 

243. The spectrum of a black body at two temperatures $27\,°C$ and $327\,°C$ is shown in the figure. Let A_1 and A_2 be the areas under the two curves respectively. The value of $\frac{A_2}{A_1}$ is



a) 1 : 16 b) 4 : 1 c) 2 : 1 d) 16 : 1

244. The figure shows a glass tube (linear co-efficient of expansion is α) completely filled with a liquid of volume expansion co-efficient γ. On heating length of the liquid column does not change. Choose the correct relation between γ and α



a) $\gamma=\alpha$ b) $\gamma=2\alpha$ c) $\gamma=3\alpha$ d) $\gamma=\frac{\alpha}{3}$

245. Which of the following statements is wrong

a) Rough surfaces are better radiators than smooth surface

b) Highly polished mirror like surfaces are very good radiators

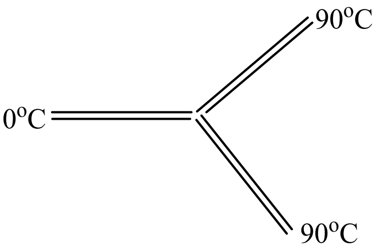
c) Black surfaces are better absorbers than white ones

d) Black surfaces are better radiators than white

246. Two rods of same length and cross section are joined along the length. Thermal conductivities of first and second rod are K_1 and K_2. The temperature of the free ends of the first and second rods are maintained at θ_1 and θ_2 respectively. The temperature of the common junction is

a) $\frac{\theta_1+\theta_2}{2}$ b) $\frac{K_2 K_1}{K_1+K_2}(\theta_1+\theta_2)$ c) $\frac{K_1\theta_1+K_2\theta_2}{K_1+K_2}$ d) $\frac{K_2\theta_1+K_1\theta_2}{K_1+K_2}$

247. Three rods made of same material and having same cross-section are joined as shown in the figure. Each rod is of same length. The temperature at the junction of the three rods is



a) $45°C$ b) $90°C$ c) $30°C$ d) $60°C$

248. If the temperature of the sun (black body) is doubled, the rate of energy received on earth will be increased by a factor of

a) 2 b) 4 c) 8 d) 16

249. If a liquid is heated in weightlessness, the heat is transmitted through

a) Conduction

b) Convection

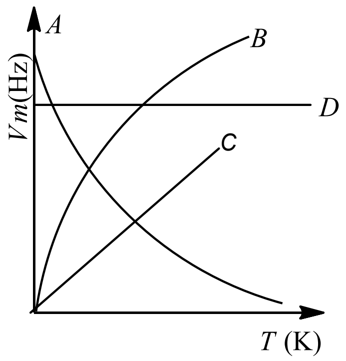
c) Radiation

d) Neither, because the liquid cannot be heated in weightlessness

250. The luminosity of the Rigel star is 17000 times that of the sun. Assume both to be perfectly black bodies. If the surface temperature of the sun is 6000 K, then the temperature of the star is

a) 68400 K b) 1.02×10^8K c) 12000 K d) $68400°C$

251. Which one of the following is v_m-T graph for perfectly black body? v_m is the frequency of radiation with maximum intensity, T is the absolute temperature.



a) D b) C c) B d) A

252. Which of the following circular rods. (given radius r and length l) each made of the same material as whose ends are maintained at the same temperature will conduct most heat?
a) $r=2r_0; l=2l_0$ b) $r=2r_0; l=l_0$ c) $r=r_0; l=l_0$ d) $r=r_0; l=2l_0$

253. When a rod is heated but prevented from expanding, the stress developed is independent of
a) Material of the rod b) Rise in temperature c) Length of rod d) None of above

254. 2 g of water condenses when passed through 40 g of water initially at 25°C. The condensation of steam raises the temperature of water to 54.3°C. What is the latent heat of steam?
a) $540\,cal g^{-1}$ b) $536\,cal g^{-1}$ c) $270\,cal g^{-1}$ d) $480\,cal g^{-1}$

255. A sphere at temperature $600\,K$ is placed in an environment of temperature is $200\,K$. Its cooling rate is H. If its temperature reduced to $400\,K$ then cooling rate in same environment will become
a) $(3/16)H$ b) $(16/3)H$ c) $(9/27)H$ d) $(1/16)H$

256. $10\,g$ of ice at $0\,°C$ is mixed with $100\,g$ of water at $50\,°C$. What is the resultant temperature of mixture
a) $31.2\,°C$ b) $32.8\,°C$ c) $36.7\,°C$ d) $38.2\,°C$

257. A rod of length $20\,cm$ is made of metal. It expands by $0.075\,cm$ when its temperature is raised from $0\,°C$ to $100\,°C$. Another rod of a different metal B having the same length expands by $0.045\,cm$ for the same change in temperature. A third rod of the same length is composed of two parts, one of metal A and the other of metal B. This rod expands by $0.060\,cm$ for the same change in temperature. The portion made of metal A has the length
a) $20\,cm$ b) $10\,cm$ c) $15\,cm$ d) $18\,cm$

258. A wall is made up of two layers A and B. The thickness of the two layers is the same, but materials are different. The thermal conductivity of A is double than that of B. In thermal equilibrium the temperature difference between the two ends is $36\,°C$. Then the difference of temperature at the two surfaces of A will be
a) $6\,°C$ b) $12\,°C$ c) $18\,°C$ d) $24\,°C$

259. A metal ball immersed in alcohol weighs W_1 at $0\,°C$ and W_2 at $59\,°C$. The coefficient of cubical expansion of the metal is less than that of alcohol. Assuming that the density of metal is large compared to that of alcohol, it can be shown that
a) $W_1 > W_2$ b) $W_1 = W_2$ c) $W_1 < W_2$ d) $W_2 = (W_1/2)$

260. Which of the following has maximum specific heat
a) Water b) Alcohol c) Glycerine d) Oil

261. A piece of glass is heated to a high temperature and then allowed to cool. If it cracks, a probable reason for this is the following property of glass
a) Low thermal conductivity b) High thermal conductivity

c) High specific heat

d) High melting point

262. A metallic ball and highly stretched spring are made of the same material and have the same mass. They are heated so that they melt, the latent heat required

a) Are the same for both

b) Is greater for the ball

c) Is greater for the spring

d) For the two may or may not be the same depending upon the metal

263. The maximum energy in the thermal radiation from a hot source occurs at a wavelength of $11 \times 10^{-5} cm$. According to Wien's law, the temperature of the source (on Kelvin scale) will be n times the temperature of another source (on Kelvin scale) for which the wavelength at maximum energy is $5.5 \times 10^{-5} cm$. The value n is

a) 2 b) 4 c) $\frac{1}{2}$ d) 1

264. Calculate the amount of heat (in calories) required to convert $5 g$ of ice at $0 ℃$ to steam at $100 ℃$

a) $3100 cal$ b) $3200 cal$ c) $3600 cal$ d) $4200 cal$

265. Which of the following is more close to a black body?

a) Black board paint b) Green leaves c) Black holes d) Red roses

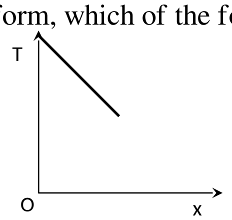
266. The initial temperature of a body is $80 ℃$. If its temperature falls to $64 ℃$ in $5 minutes$ and in $10 minutes$ to $52 ℃$ then the temperature of surrounding will be

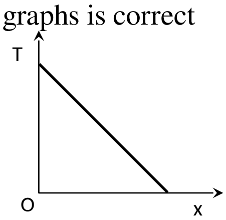
a) $26 ℃$ b) $49 ℃$ c) $35 ℃$ d) $42 ℃$

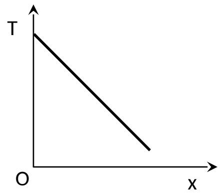
267. The temperature, at which Centigrade and Fahrenheit scales give the same reading is

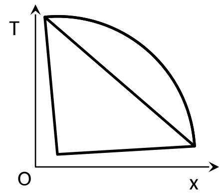
a) -40° b) 40° c) -30° d) 30°

268. Heat is flowing through a conductor of length l from $x=0$ to $x=l$. If its thermal resistance per unit length is uniform, which of the following graphs is correct

a) 

b) 

c) 

d) 

269. A wire 3 m in length and 1 mm in diameter at 30℃ is kept in a low temperature at $-170 ℃$ and is stretched by hanging a weight of 10 kg at one end. The change in length of the wise is ($Y=2 \times 10^{11} Nm^{-2}$, g=$10 ms^{-2}$ and $\alpha=1.2 \times 10^{-5} ℃^{-1}$)

a) 5.2 mm b) 2.5 mm c) 52 mm d) 25 mm

270. The Wien's displacement law express relation between

a) Frequency and temperature

b) Temperature and amplitude

c) Wavelength and radiating power of black body

d) Wavelength corresponding to maximum energy and temperature

271. In the Ingen Hauz's experiment the wax melts up to lengths 10 and $25 cm$ on two identical rods of different materials. The ratio of thermal conductivities of the two material is

a) 1 : 6.25 b) 6.25 : 1 c) $1:\sqrt{2.5}$ d) 1 : 2.5

272. A metal rod AB of length $10\,x$ has its one end A in ice at $0\,°C$ and the other end B in water at $100\,°C$. If a point P on the rod is maintained at $400\,°C$, then it is found that equal amounts of water and ice evaporate and melt per unit time. The latent heat of evaporation of water is $540\,cal/g$ latent heat of melting of ice is $80\,cal/g$. If the point P is at a distance of λx from the ice end A, find the value of λ. [Neglect any heat loss to the surrounding]

a) 9 b) 2 c) 6 d) 1

273. The freezing point of the liquid decreases when pressure is increased, if the liquid

a) Expands while freezing b) Contracts while freezing

c) Does not change in volume while freezing d) None of these

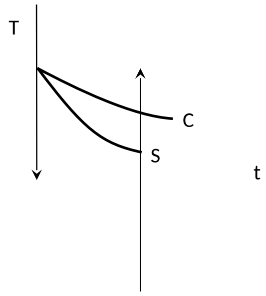
274. If the temperature difference on the two sides of a wall increases from $100\,°C$ to $200\,°C$, its thermal conductivity

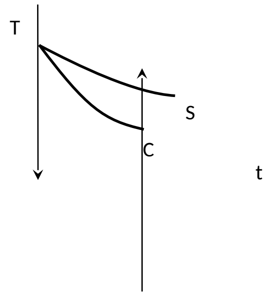
a) Remains unchanged b) Is doubled c) Is halved d) Becomes four times

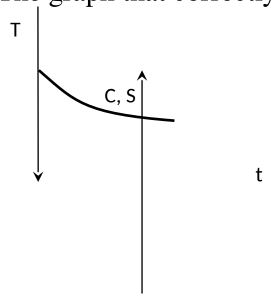
275. The coefficient of apparent expansion of a liquid when determined using two different vessels A and B are γ_1 and γ_2 respectively. If the coefficient of linear expansion of the vessel A is α, the coefficient of linear expansion of the vessel B is

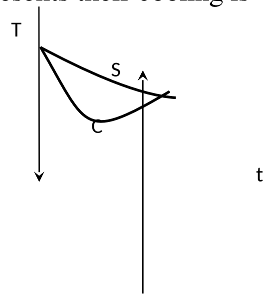
a) $\frac{\alpha\gamma_1\gamma_2}{\gamma_1+\gamma_2}$ b) $\frac{\gamma_1-\gamma_2}{2\alpha}$ c) $\frac{\gamma_1-\gamma_2+\alpha}{3}$ d) $\frac{\gamma_1-\gamma_2}{3}+\alpha$

276. A hollow copper sphere S and a hollow copper cube C, both of negligible thin walls of same area, are filled with water at $90\,°C$ and allowed to cool in the same environment. The graph that correctly represents their cooling is

a) 

b) 

c) 

d) 

277. A pendulum clock keeps correct time at $0\,°C$. Its mean coefficient of linear expansions is $\alpha/°C$, then the loss in seconds per day by the clock if the temperature rises by $t\,°C$ is

a) $\frac{\frac{1}{2}\alpha t\times 864000}{1-\frac{\alpha t}{2}}$ b) $\frac{1}{2}\alpha t\times 86400$ c) $\frac{\frac{1}{2}\alpha t\times 86400}{\left(1-\frac{\alpha t}{2}\right)^2}$ d) $\frac{\frac{1}{2}\alpha t\times 86400}{1+\frac{\alpha t}{2}}$

278. In which case the thermal conductivity increases from left to right

a) Al, Cu, Ag b) Ag, Cu, Al c) Cu, Ag, Al d) Al, Ag, Cu

279. A slab consists of two parallel layers of copper and brass of the same thickness and having thermal conductivities in the ratio 1:4. If the free face of brass is at $100\,°C$ and that of copper at $0\,°C$, the temperature of interface is

a) $80\,°C$ b) $20\,°C$ c) $60\,°C$ d) $40\,°C$

280. The volume of a metal sphere increases by 0.24% when its temperature is raised by 40°C . The coefficient of linear expansion of the metal is …¿ °C.

a) 2×10^{-5} b) 6×10^{-5} c) 18×10^{-5} d) 1.2×10^{-5}

281. The original temperature of a black body is $727\,°C$. The temperature at which this black body must be raised so as to double the total radiant energy, is

a) $971\,K$ b) $1190\,K$ c) $2001\,K$ d) $1458\,K$

282. Three objects coloured black, gray and white can with stand hostile conditions at 2800°C. These objects are thrown into furnace where each of them attains a temperature of 2000°C. Which object will glow brightest?

a) The white object b) The black object

c) All glow with equal brightness d) Gray object

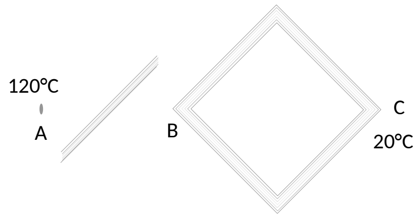
283. Mercury thermometers can be used to measure temperatures upto

a) 100 ℃ b) 212 ℃ c) 360 ℃ d) 500 ℃

284. Two spheres of radii 8 cm and 2 cm are cooling. Their temperatures are 127℃ and 527℃ respectively. Find the ratio of energy radiated by them in the same time

a) 0.06 b) 0.5 c) 1 d) 2

285. Five identical rods are joined as shown in figure. Point A and C are maintained at temperature 120 ℃ and 20 ℃ respectively. The temperature of junction B will be



a) 100 ℃ b) 80 ℃ c) 70 ℃ d) 0 ℃

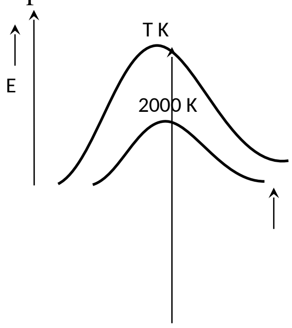
286. The saturation vapour pressure of water at 100 ℃ is

a) 739 mm of mercury b) 750 mm of mercury c) 760 mm of mercury d) 712 mm of mercury

287. Two spheres made of same substance have diameters in the ratio $1:2$. Their thermal capacities are in the ratio of

a) $1:2$ b) $1:8$ c) $1:4$ d) $2:1$

288. The adjoining diagram shows the spectral energy density distribution E_λ of a black body at two different temperatures. If the areas under the curves are in the ratio 16 : 1, the value of temperature T is



a) 32,000 K b) 16,000 K c) 8,000 K d) 4,000 K

289. A constant pressure air thermometer gave a reading of 47.5 units of volume when immersed in ice cold water, and 67 units in a boiling liquids. The boiling point of the liquid will be

a) 135 ℃ b) 125 ℃ c) 112 ℃ d) 100 ℃

290. A hammer of mass 1 kg having speed of 50 m/s, hit a iron nail of mass 200 gm. If specific heat of iron is 0.105 cal/gm℃ and half the energy is converted into heat, the raise in temperature of nail is

a) 7.1 ℃ b) 9.2 ℃ c) 10.5 ℃ d) 12.1 ℃

291. If a black body emits 0.5 J of energy per second when it is at 27℃, then the amount of energy emitted by it when it is at 627℃ will be

a) 40.5 J b) 162 J c) 13.5 J d) 135 J

292. A calorimeter of mass 0.2 kg and specific heat 900 J/kg-K. Containing 0.5 kg of a liquid of specific heat 2400 J/kg-K. Its temperature falls from 60 ℃ to 55 ℃ in one minute. The rate of cooling is

a) 5 J/s b) 15 J/s c) 100 J/s d) 115 J/s

293. It is difficult to cook rice in an open vessel by boiling it a high altitudes because of

a) Low boiling point and high pressure
b) High boiling point and low pressure
c) Low boiling point and low pressure
d) High boiling point and high pressure

294. A vessel contains 110 g of water. The heat capacity of the vessel is equal to 10 g of water. The initial temperature of water in vessel in $10℃$. If 220 g of hot water at $70℃$ is poured in the vessel, the final temperature neglecting radiation loss will be

a) $70℃$ b) $80℃$ c) $60℃$ d) $50℃$

295. A black body at $227℃$ radiates heat at the rate of $7\, Cal/cm^2 s$. At a temperature of $727℃$, the rate of heat radiated in the same units will be

a) 60 b) 50 c) 112 d) 80

296. A cane is taken out from a refrigerator at $0℃$. The atmospheric temperature is $25℃$. If t_1 is the time taken to heat from $0℃$ to $5℃$ and t_2 is the time taken from $10℃$ to $15℃$, then

a) $t_1 > t_2$ b) $t_1 < t_2$ c) $t_1 = t_2$ d) There is no relation

297. Equal masses of two liquids are filled in two similar calorimeters. The rate of cooling will

a) Depend on the nature heats of liquids
b) Depend on the specific heats of liquids
c) Be same for both the liquids
d) Depend on the mass of the liquids

298. Absolute zero $(0\,K)$ is that temperature at which

a) Matter ceases to exist
b) Ice melts and water freezes
c) Volume and pressure of a gas becomes zero
d) None of these

299. A wall has two layers A and B made of different materials. The thickness of both the layers is the same. The thermal conductivity of A and B are K_A and K_B such that $K_A = 3K_B$. The temperature across the wall is $20℃$. In thermal equilibrium

a) The temperature difference across $A = 15℃$
b) The temperature difference across $A = 5℃$
c) The temperature difference across A is $10℃$
d) The rate of transfer of heat through A is more than that through B

300. The apparent coefficient of expansion of a liquid when heated in a copper vessel is C and when heated in a silver vessel is S. If A is the linear coefficient of expansion of copper, then the linear coefficient of expansion of silver is

a) $\frac{C+S-3A}{3}$ b) $\frac{C+3A-S}{3}$ c) $\frac{S+3A-C}{3}$ d) $\frac{C+S+3A}{3}$

301. Two identical plates of different metals are joined to form a single plate whose thickness is double the thickness of each plate. If the coefficients of conductivity of each plate are 2 and 3 respectively, then the conductivity of composite plate will be

a) 5 b) 2.4 c) 1.5 d) 1.2

302. A body cools from $62℃$ to $50℃$ in 10 min and to $42℃$ in the next 10 min. The temperature of the surrounding is

a) $16℃$ b) $26℃$ c) $36℃$ d) $21℃$

303. Water has maximum density at

a) $0\,°C$ b) $32^o\,F$ c) $-4\,°C$ d) $4\,°C$

304. For an opaque body coefficient of transmission is

a) Zero b) 1 c) 0.5 d) ∞

305. The temperature of a substance increases by $27\,°C$. On the Kelvin scale this increase is equal to

a) $300\,K$ b) $2.46\,K$ c) $27\,K$ d) $7\,K$

306. On heating a liquid of coefficient of cubical expansion γ in a container having coefficient of linear expansion $\gamma/3$, the level of liquid in the container will

a) Rise
b) Fall
c) Will remain almost stationary
d) It is difficult to say

307. Hailstone at $0\,°C$ falls from a height of $1\,km$ on an insulating surface converting whole of its kinetic energy into heat. What part of it will melt $(g=10\,m/s^2)$

a) $\frac{1}{33}$ b) $\frac{1}{8}$ c) $\frac{1}{33}\times 10^{-4}$ d) All of it will melt

308. A particular star (assuming it as a black body) has a surface temperature of about $5\times 10^4\,K$. The wavelength in nanometers at which its radiation becomes maximum is $(b=0.0029\,mK)$

a) 48 b) 58 c) 60 d) 70

309. If the sun's surface radiates heat at $6.3\times 10^7\,W\,m^{-2}$. Calculate the temperature of the sun assuming it to be a black body $(\sigma=5.7\times 10^{-8}\,W\,m^{-2}\,K^{-4})$

a) $5.8\times 10^3\,K$ b) $8.5\times 10^3\,K$ c) $3.5\times 10^8\,K$ d) $5.3\times 10^8\,K$

310. If the radius of a star is R and it acts as a black body, what would be the temperature of the star, in which the rate of energy production is Q

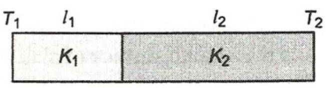
a) $Q/4\pi R^2\sigma$
b) $(Q/4\pi R^2\sigma)^{-1/2}$
c) $(4\pi R^2 Q/\sigma)^{1/4}$
d) $(Q/4\pi R^2\sigma)^{1/4}$

(σ stands for stefan's constant)

311. Maximum density of H_2O is at the temperature

a) $32^o\,F$ b) $39.2^o\,F$ c) $42^o\,F$ d) $4^o\,F$

312. One end of a thermally insulated rod is kept at a temperature T_1 and other at T_2. The rod is composed of two sections of lengths l_1 and l_2 and thermal conductivities K_1 and K_2 respectively. The temperature at the interface of the two sections is

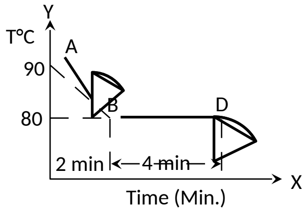


a) $(K\text{¿¿}2 l_2 T_1 + K_1 l_1 T_2)/(K_1 l_1 + K_2 l_2)\text{¿}$
b) $(K\text{¿¿}2 l_1 T_1 + K_1 l_2 T_2)/(K_2 l_1 + K_1 l_2)\text{¿}$
c) $(K\text{¿¿}1 l_2 T_1 + K_2 l_1 T_2)/(K_1 l_2 + K_2 l_1)\text{¿}$
d) $(K\text{¿¿}1 l_1 T_1 + K_2 l_2 T_2)/(K_1 l_1 + K_2 l_2)\text{¿}$

313. At temperature T, the power radiated by a body is $Q\,watts$. At the temperature $3T$ the power radiated by it will be

a) $3Q$ b) $9Q$ c) $27Q$ d) $81Q$

314. The figure given below shows the cooling curve of pure wax material after heating. It cools from A to B and solidifies along BD. If L and C are respective values of latent heat and the specific heat of the liquid wax, the ratio L/C is



a) 40 b) 80 c) 100 d) 20

315. A metal plate $4\ mm$ thick has a temperature difference of $32\ ℃$ between its faces. It transmits $200\ kcal/h$ through an area of $5\ cm^2$. Thermal conductivity of the material is

a) $58.33\ W/m\text{-}℃$ b) $33.58\ W/m\text{-}℃$ c) $5\times10^{-4}\ W/m\text{-}℃$ d) None of these

316. We have seen that a gamma-ray does of $3\ Gy$ is lethal to half the people exposed to it. If the equivalent energy were absorbed as heat, what rise in body temperature would result

a) $300\ \mu K$ b) $700\ \mu K$ c) $455\ \mu K$ d) $390\ \mu K$

317. A perfect black body is one whose emissive power is

a) Maximum b) Zero c) Unity d) Minimum

318. Heat travels through vacuum by

a) Radiation b) Conduction c) Convection d) None of these

319. A solid copper sphere (density ρ and specific heat capacity c) of radius r at an initial temperature $200\ K$ is suspended inside a chamber whose walls are at almost $0\ K$. The time required (in μs) for the temperature of the sphere to drop to $100\ K$ is

a) $\frac{72}{2}\frac{r\rho c}{\sigma}$ b) $\frac{7}{72}\frac{r\rho c}{\sigma}$ c) $\frac{27}{7}\frac{r\rho c}{\sigma}$ d) $\frac{7}{27}\frac{r\rho c}{\sigma}$

320. Wires A and B have identical lengths and have circular cross-section. The radius of A is twice the radius of $B\ i.e.\ r_A=2r_B$. For a given temperature difference between the two ends, both wires conduct heat at the same rate. The relation between the thermal conductivities is given by

a) $K_A=4K_B$ b) $K_A=2K_B$ c) $K_A=K_B/2$ d) $K_A=K_B/4$

321. Density of substance at 0℃ is $10\ g/cc$ and at 100℃, its density is 9.7 g/cc. The coefficient of linear expansion of the substance is

a) 1.03×10^{-4} b) 3×10^{-4} c) 19.7×10^{-3} d) 10^{-3}

322. The volume of a gas at $20\ ℃$ is $100\ cm^3$ at normal pressure. If it is heated to $100\ ℃$, its volume becomes $125\ cm^3$ at the same pressure, then volume coefficient of the gas at normal pressure is

a) $0.0015/℃$ b) $0.0045/℃$ c) $0.0025/℃$ d) $0.0033/℃$

323. The study of physical phenomenon at low temperatures (below liquid nitrogen temperature) is called

a) Refrigeration b) Radiation c) Cryogenics d) Pyrometry

324. A piece of blue glass heated to a high temperature and a piece of red glass at room temperature, are taken inside a dimly lit room then

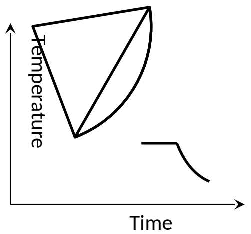
a) The blue piece will look blue and red will look as usual

b) Red look brighter red and blue look ordinary blue

c) Blue shines like brighter red compared to the red piece

d) Both the pieces will look equally red

325. The graph signifies



a) Adiabatic expansion of a gas
b) Isothermal expansion of a gas
c) Change of state from liquid to solid
d) Cooling of a heated solid

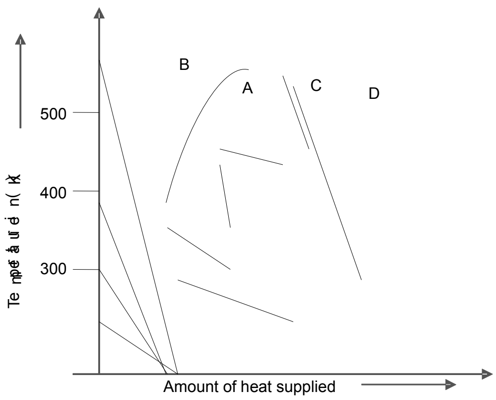
326. The amount of heat conducted out per second through a window, when inside temperature is $10°C$ and outside temperature is $-10\ °C$, is 1000 J. Same heat will be conducted in through the window, when outside temperature $-23\ °C$ and inside temperature is

a) $23°C$
b) $230\ K$
c) $270\ K$
d) $296\ K$

327. In determining the temperature of a distant star, one makes use of

a) Kirchhoff's law
b) Stefan's law
c) Wien's displacement law
d) None of the above

328. Which curve shows the rise of temperature with the amount of heat supplied, for a piece of ice?



a) A
b) B
c) C
d) D

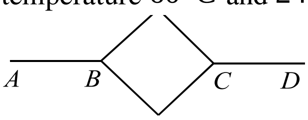
329. An object is at a temperature of $400\ °C$. At what temperature would it radiate energy twice as fast? The temperature of the surroundings may be assumed to be negligible

a) $200\ °C$
b) $200\ K$
c) $800\ °C$
d) $800\ K$

330. At some temperature T, a bronze pin is a little large to fit into a hole drilled in a steel block. The change in temperature required for an exact fit is minimum when

a) Only the block is heated
b) Both block and pin are heated together
c) Both block and pin are cooled together
d) Only the pin is cooled

331. Six identical metallic rods are joined together in a pattern as shown in the figure. Points A and D are maintained at temperature $60\ °C$ and $240\ °C$. The temperature of the junction B will be



a) $120\ °C$
b) $150\ °C$
c) $60\ °C$
d) $80\ °C$

332. For cooking the food, which of the following type of utensil is most suitable

a) High specific heat and low conductivity
b) High specific heat and high conductivity

c) Low specific heat and low conductivity
d) Low specific heat and high conductivity

333. Consider two hot bodies B_1 and B_2 which have temperatures 100 ℃ and 80 ℃ respectively at $t=0$. The temperature of the surroundings is 40 ℃. The ratio of the respective rates of cooling, R_1 and R_2 of these two bodies at $t=0$ will be

a) $R_1:R_2=3:2$
b) $R_1:R_2=5:4$
c) $R_1:R_2=2:3$
d) $R_1:R_2=4:5$

334. There are two spherical balls A and B of the same material with same surface, but the diameter of A is half that of B. If A and B are heated to the same temperature and then allowed to cool, then

a) Rate of cooling is same in both
b) Rate of cooling of A is four times that of B
c) Rate of cooling of A is twice that of B
d) Rate of cooling of A is $\frac{1}{4}$ times that of B

335. A slab consists of two parallel layers of two different materials of same thickness having thermal conductivities K_1 and K_2. The equivalent conductivity of the combination is

a) K_1+K_2
b) $\frac{K_1+K_2}{2}$
c) $\frac{2K_1K_2}{K_1+K_2}$
d) $\frac{K_1+K_2}{2K_1K_2}$

336. Ice formed over lakes has

a) Very high thermal conductivity and helps in further ice formation
b) Very low conductivity and retards further formation of ice
c) It permits quick convection and retards further formation of ice
d) It is very good radiator

337. The layers of atmosphere are heated through

a) Convection
b) Conduction
c) Radiation
d) (b) and (c) both

338. The sprinkling of water reduces slightly the temperature of a closed room because

a) Temperature of water is less than that of the room
b) Specific heat if water is high
c) Water has large latent heat of vaporisation
d) Water is a bad conductor of heat

339. On a clear sunny day, an object at temperature T is placed on the top of a high mountain. An identical object at the same temperature is placed at the foot of mountain. If both the objects are exposed to sun-rays for two hours in an identical manner, the object at the top of the mountain will register a temperature

a) Higher than the object at the foot
b) Lower than the object at the foot
c) Equal to the object at the foot
d) None of the above

340. Two slabs are of the thickness d_1 and d_2. Their thermal conductivities are K_1 and K_2 respectively. They are in series. The free ends of the combination of these two slabs are kept at temperature θ_1 and θ_2. Assume $\theta_1>\theta_2$. The temperature θ of their common junction is

a) $\frac{K_1\theta_1+K_2\theta_2}{\theta_1+\theta_2}$
b) $\frac{K_1\theta_1d_1+K_2\theta_2d_2}{K_1d_2+K_2d_1}$
c) $\frac{K_1\theta_1d_2+K_2\theta_2d_1}{K_1d_2+K_2d_1}$
d) $\frac{K_1\theta_1+K_2\theta_2}{K_1+K_2}$

341. A bucket full of hot water is kept in a room. It cools from 75 ℃ to 70℃ in t_1 minutes, from 70℃ to 65 ℃ in t_2 minutes and from 65℃ to 60℃ in t_3 minutes. Then,

a) $t_1<t_2<t_3$
b) $t_1=t_2=t_3$
c) $t_1<t_2>t_3$
d) $t_1>t_2>t_3$

342. A black body of mass 34.38 g and surface area 19.2 cm^2 is at an initial temperature of 400 K. It is allowed to cool inside an evacuated enclosure kept at constant temperature 300 K. The rate of cooling is 0.04$°C s^{-1}$. The specific heat of the body in $J kg^{-1} K^{-1}$ is
(Stefan's constant $\sigma = 5.73 \times 10^{-8} W m^{-2} K^{-4}$)

a) 2800 b) 2100 c) 1400 d) 1200

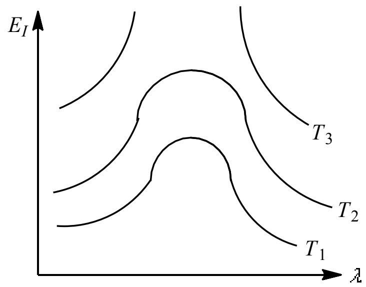
343. The wavelength $\lambda_m = 5.5 \times 10^{-7}$ m when temperature of sun is 5500 K. If the furnace has wavelength λ_m equal to 11×10^{-7}m, then temperature of furnace is

a) 5000 K b) 1750 K c) 3750 K d) 2750 K

344. Energy is being emitted from the surface of a black body at 127 °C temperature at the rate of $1.0 \times 10^6 J/s - m^2$. Temperature of the black body at which the rate of energy emission is $16.0 \times 10^6 J/s - m^2$ will be

a) 254 °C b) 508 °C c) 527 °C d) 727 °C

345. Variation of radiant energy emitted by sun, filament of tungsten lamp and welding are as a function of its wavelength is shown in figure. Which of the following option is the correct match?



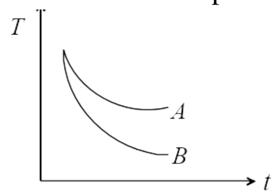
a) Sun-T_1,tungsten filament$-T_2$, welding$arc - T_3$

b) Sun-T_2, tungsten filament$-T_1$, welding$arc - T_3$

c) Sun-T_3,tungsten filament$-T_2$, welding$arc - T_1$

d) Sun-T_1,tungsten filament$-T_3$,welding$arc - T_2$

346. Water and turpentine oil (specific heat less than that of water) are both heated to same temperature. Equal amounts of these placed in identical calorimeters are then left in air



a) Their cooling curves will be identical

b) A and B will represent cooling curves of water and oil respectively

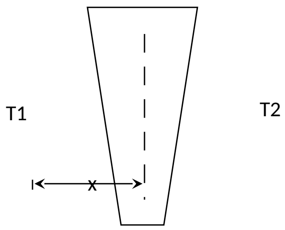
c) B and A will represent cooling curves of water and oil respectively

d) None of the above

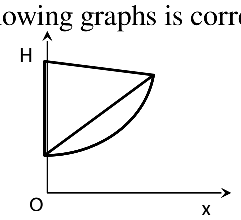
347. At what temperature the centigrade (Celsius) and Fahrenheit, readings are the same

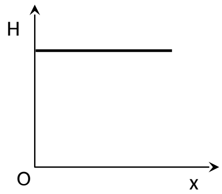
a) -40^o b) $+40^o$ c) 36.6^o d) -37^o

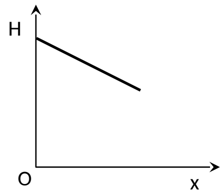
348. Radius of a conductor increases uniformly from left end to right end as shown in fig

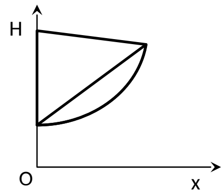


Material of the conductor is isotropic and its curved surface is thermally insulated from surrounding. Its ends are maintained at temperatures T_1 and $T_2 (T_1 > T_2)$: If, in steady state, heat flow rate is equal to H, then which of the following graphs is correct

a) 

b) 

c) 

d) 

349. A black body emits radiations of maximum intensity at a wavelength of $5000\,Å$, when the temperature of the body is $1227\,℃$. If the temperature of the body is increased by $2227\,℃$, the maximum intensity of emitted radiation would be observed at

a) $2754.8\,Å$ b) $3000\,Å$ c) $3500\,Å$ d) $4000\,Å$

350. The surface area of a black body is $5 \times 10^{-4}\,m^2$ and its temperature is $727℃$. the energy radiated by it per minute is ($\sigma = 5.67 \times 10^{-8}\,J\,m^{-2} - s^{-1} - K^{-4}$¿

a) 1.7×10^3 J b) 2.5×10^2 J c) 8×10^3 J d) 3×10^4 J

351. When fluids are heated from the bottom, convection currents are produced because

a) Molecular motion of fluid becomes aligned

b) Molecular collisions take place within the fluid

c) Heated fluid becomes more dense than the cold fluid above it

d) Heated fluid becomes less dense than the cold fluid above it

352. Hot water kept in a beaker placed in a room cools from $70\,℃$ to $60\,℃$ in $4\,minutes$. The time taken by it to cool from $69\,℃$ to $59\,℃$ will be

a) The same 4 minutes b) More than 4 minutes

c) Less than 4 minutes d) We cannot say definitely

353. Latent heat of $1\,gm$ of steam is $536\,cal/gm$, then its value in $joule/kg$ is

a) 2.25×10^6 b) 2.25×10^3 c) 2.25 d) None

354. A liquid of mass M and specific heat S is at a temperature $2t$. If another liquid of thermal capacity 1.5 times, at a temperature of $\frac{t}{3}$ is added to it, the resultant temperature will be

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

355. A steel wire of uniform area 2 mm^2 is heated up to $50℃$ and is stretched by tying its ends rigidly. The change in tension when the temperature falls from $50℃$ to $30℃$ is (Take $Y = 2 \times 10^{11}\,N\,m^{-2}, \alpha = 1.1 \times 10^{-5}\,℃^{-1}$¿

a) $1.5 \times 10^{10}\,N$ b) 5 N c) 88 N d) $2.5 \times 10^{10}\,N$

356. Which one of the following would raise the temperature of 20 g of water at $30℃$ most when mixed with it?

a) 20 g of water at $40℃$ b) 40 g of water at $35\,℃$

c) 10 g of water at 50°*C*　　d) 4 g water at 80°*C*

357. According to Newton's law of cooling, the rate of cooling is proportional to $(\Delta\theta)^n$, where $\Delta\theta$ is the temperature differences between the body and the surroundings and n is equal to

a) 3　　b) 2　　c) 1　　d)

358. If between wavelength λ and $\lambda + d\lambda$, e_λ and a_λ be the emissive and absorptive powers of a body and E_λ be the emissive power of a perfectly black body, then according to Kirchoff's law, which is true

a) $e_\lambda = a_\lambda = E_\lambda$　　b) $e_\lambda E_\lambda = a_\lambda$　　c) $e_\lambda = a_\lambda E_\lambda$　　d) $e_\lambda a_\lambda E_\lambda =$ ¿ constant

359. In which process, the rate of transfer of heat is maximum

a) Conduction　　b) Convection

c) Radiation　　d) In all these, heat is transferred with the same velocity

360. The energy emitted per second by a black body at 27 °*C* is 10 *J*. If the temperature of the black body is increased to 327 °*C*, the energy emitted per second will be

a) 20 *J*　　b) 40 *J*　　c) 80 *J*　　d) 160 *J*

361. A cylindrical rod with one end in a steam chamber and the other end in ice results in melting of 0.1 g of ice per second. If the rod is replaced by another with half the length and double the radius of the first and if the thermal conductivity of the material of the second rod is 1/4 that of the first, the rate at which ice melts in $g s^{-1}$ will be

a) 3.2　　b) 1.6　　c) 0.2　　d) 0.1

362. Woolen clothes are used in winter season because woolen clothes

a) Are good sources for producing heat　　b) Absorb heat from surroundings

c) Are bad conductors of heat　　d) Provide heat to body continuously

363. The energy supply being cut-off, an electric heater element cools down to the temperature of its surroundings, but it will not cool further because

a) Supply is cut off　　b) It is made of metal

c) Surroundings are radiating　　d) Element & surroundings have same temp.

364. If a black body is heated at a high temperature, it seems to be

a) Blue　　b) White　　c) Red　　d) Black

365. The radiation energy density per unit wavelength at a temperature T has a maximum at a wavelength λ_0. At temperature $2T$, it will have a maximum at a wavelength

a) $4\lambda_0$　　b) $2\lambda_0$　　c) $\lambda_0/2$　　d) $\lambda_0/4$

366. Of the following thermometers, the one which can be used for measuring a rapidly changing temperature is a

a) Thermocouple thermometer　　b) Gas thermometer

c) Maximum resistance thermometer　　d) Vapour pressure thermometer

367. A wall has two layers A and B, made of two different materials. The thermal conductivity of material A is twice that of B. If the two layers have same thickness and under thermal equilibrium, the temperature difference across the wall is 48°*C*, the temperature difference across layer B is

a) 40°*C*　　b) 32°*C*　　c) 16°*C*　　d) 24°*C*

368. Two rods of equal length and area of cross-section are kept parallel and lagged between temperature 20°*C* and 80 °*C*. The ratio of the effective thermal conductivity to that of the first rod is $\left[the\, ratio \left(\frac{K_1}{K_2} \right) = \frac{3}{4} \right]$

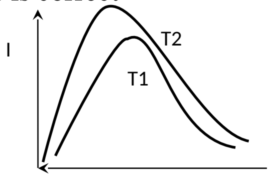
a) 7 : 4 b) 7 : 6 c) 4 : 7 d) 7 : 8

369. A black body at a temperature of $127\ ℃$ radiates heat at the rate of $1\ cal/cm^2 \times sec$. At a temperature of $527\ ℃$ the rate of heat radiation from the body in $(cal/cm^2 \times sec)$ will be

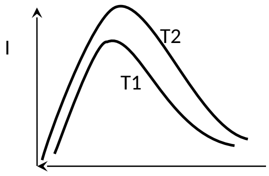
a) 16.0 b) 10.45 c) 4.0 d) 2.0

370. Shown below are the black body radiation curves at temperatures T_1 and $T_2 (T_2 > T_1)$. Which of the following plots is correct

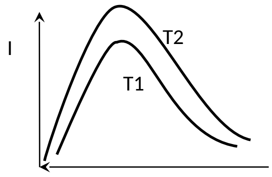
a)



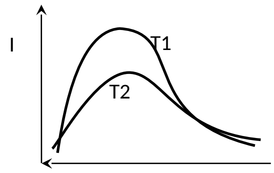
b)



c)



d)



371. Standardisation of thermometers is obtained with

a) Jolly's thermometer
b) Platinum resistance thermometer
c) Thermocouple thermometer
d) Gas thermometer

372. The two opposite faces of a cubical piece of iron (thermal conductivity ¿ $0.2\ CGS$ unit) are at $100\ ℃$ and $0\ ℃$ in ice. If the area of a surface is $4\ cm^2$, then the mass of ice melted in a 10 minutes will be

a) $30\ g$ b) $300\ g$ c) $5\ g$ d) $50\ g$

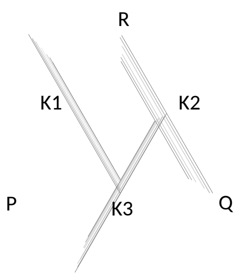
373. Total energy emitted by a perfectly black body is directly proportional to T^n where n is

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

374. A piece of ice (heat capacity=2100JK$g^{-1}\ ℃^{-1}$ and latent heat=$3.36 \times 10^5\ Jkg^{-1}$) of mass m gram is at $-5\ ℃$ at atmospheric pressure. It is given 420 J of heat so that the ice starts melting. Finally when the ice-water mixture is in equilibrium, it is found that 1 g of ice has melted. Assuming there is no other heat exchange in the process, the value of m is

a) 8 b) 6 c) 4 d) 8.5

375. Three rods of same dimensions are arranged as shown in figure. They have thermal conductivities K_1, K_2 and K_3. The points P and Q are maintained at different temperatures for the heat to flow at the same rate along PRQ and PQ then which of the following options is correct



a) $K_3 = \frac{1}{2}(K_1 + K_2)$ b) $K_3 = K_1 + K_2$ c) $K_3 = \frac{K_1 K_2}{K_1 + K_2}$ d) $K_3 = 2(K_1 + K_2)$

376. Two cylinders P and Q have the same length and diameter and are made of different materials having thermal conductivities in the ratio 2:3. These two cylinders are combined to make a cylinder. One end of P is kept of $100\ ℃$ and another end of Q at $0\ ℃$. The temperature at the interface of P and Q is

a) $30\ ℃$ b) $40\ ℃$ c) $50\ ℃$ d) $60\ ℃$

377. What will be the ratio of temperatures of sun and moon, if the wavelengths of their maximum emission radiations rates are 140 $Å$ and 4200 $Å$ respectively?

a) 1:30 b) 30:1 c) 42:14 d) 14:42

378. On Centigrade scale the temperature of a body increases by 30°.The increase in temperature on Fahrenheit scale is

a) 50° b) 40° c) 30° d) 54°

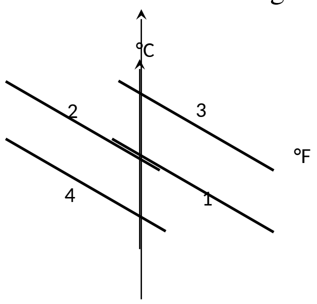
379. Two bodies $A$and B having temperatures 327℃ and 427℃ are radiating heat to the surrounding. The surrounding temperature is 27℃ . The ration of rate of heat radiation of A to that of B is

a) 0.52 b) 0.31 c) 0.81 d) 0.42

380. The absolute zero temperature in Fahrenheit scale is

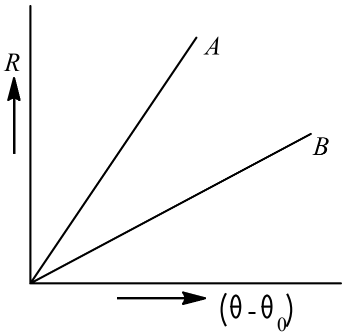
a) $-273^o F$ b) $-32^o F$ c) $-460^o F$ d) $-132^o F$

381. Which of the curves in figure represents the relation between Celsius and Fahrenheit temperatures



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

382. Two circular discs A and B with equal radii are blackened. They are heated to some temperature and are cooled under identical conditions. What inference do you draw from their cooling curves?



a) $A$and B have same specific heats

b) Specific heat of $A$is less

c) Specific heat of B is less

d) Nothing can be said

383. A rod of silver at 0 ℃ is heated to 100 ℃. It's length is increased by 0.19 cm. Coefficient of cubical expansion of the silver rod is

a) $5.7 \times 10^{-5}/℃$ b) $0.63 \times 10^{-5}/℃$ c) $1.9 \times 10^{-5}/℃$ d) $16.1 \times 10^{-5}/℃$

384. An iron bar of length l and having a cross-section A is heated from 0 to 100 ℃. If this bar is so held that it is not permitted to expand or bend, the force that is developed, is

a) Inversely proportional to the cross-sectional area of the bar

b) Independent of the length of the bar

c) Inversely proportional to the length of the bar

d) Directly proportional to the length of the bar

385. 1 g of steam at 100℃ and equal mass of ice at 0℃ are mixed. The temperature of the mixture in steady state will be (latent heat of steam=540$cal g^{-1}$, latent heat of ice=80$cal g^{-1}$)

a) 50℃ b) 100℃ c) 67℃ d) 33℃

386. Two metal strips that constitute a thermostat must necessarily differ in their

a) Mass b) Length

c) Resistivity d) Coefficient of linear expansion

387. The resistance of the wire in the platinum resistance thermometer at ice point is 5Ω and at steam point is 5.25Ω.When the thermometer is inserted in an unknown hot bath its resistance is found to be 5.5Ω.The temperature of the hot bath is

a) 100°C b) 200°C c) 300°C d) 350°C

388. The wavelength of radiation emitted by a body depends upon

a) The nature of its surface b) The area of its surface

c) The temperature of its surface d) All the above factors

389. Two spherical bodies A (radius 6 cm) and B (radius 18 cm) are at temperature T_1 and T_2 respectively. The maximum intensity in the emission spectrum of A is at 500 nm and in that of B is at 1500 nm. Considering them to be black bodies, what will be the ratio of the rate of total energy radiated by A to that of ?

a) 9 b) 9.5 c) 8 d) 8.5

390. What is rise in temperature of a collective drop when initially $1\,gm$ and $2\,gm$ drops travel with velocities $10\,cm/sec$ and $15\,cm/sec$

a) $6.6\times10^{-3}\,°C$ b) $66\times10^{-3}\,°C$ c) $660\times10^{-3}\,°C$ d) $6.6\,°C$

391. A piece of metal weighs $45\,g$ in air and $25\,g$ in a liquid of density $1.5\times10^3\,kg-m^{-3}$ kept at $30\,°C$. When the temperature of the liquid is raised to $40\,°C$, the metal piece is weighs $27\,g$. The density of liquid at $40\,°C$, is $1.25\times10^3\,kg-m^{-3}$. The coefficient of linear expansion of metal is

a) $1.3\times10^{-3}/°C$ b) $5.2\times10^{-3}/°C$ c) $2.6\times10^{-3}/°C$ d) $0.26\times10^{-3}/°C$

392. Absolute scale of temperature is reproduced in the laboratory by making use of a

a) Radiation pyrometer

b) Platinum resistance thermometer

c) Constant volume helium gas thermometer

d) Constant pressure ideal gas thermometer

393. Steam at $100\,°C$ is passed into $1.1\,kg$ of water contained in a calorimeter of water equivalent to $0.02\,kg$ at $15\,°C$ till the temperature of the calorimeter and its contents rises to $80\,°C$. The mass of the steam condensed in kg is

a) 0.130 b) 0.065 c) 0.260 d) 0.135

394. A cylinder of radius R made of a material of thermal conductivity K_1 is surrounded by a cylindrical shell of inner radius R and outer radius $2\,R$ made of material of thermal conductivity K_2. The two ends of the combined system are maintained at two different temperatures. There is no loss of heat across the cylindrical surface and the system is in steady state. The effective thermal conductivity of the system is

a) K_1+K_2 b) $\frac{K_1K_2}{K_1+K_2}$ c) $\frac{K_1+3K_2}{4}$ d) $\frac{3K_1+K_2}{4}$

395. The temperature of two bodies A and B are $727\,°C$ and $127\,°C$. The ratio of rate of emission of radiations will be

a) 727/127 b) 625/16 c) 1000/400 d) 100/16

396. $4200\,J$ of work is required for

a) Increasing the temperature of $10\,gm$ of water through $10\,°C$

b) Increasing the temperature of $100\, gm$ of water through $10\,°C$

c) Increasing the temperature of $1\, kg$ of water through $10\,°C$

d) Increasing the temperature of $10\, kg$ of water through $10\,°C$

397. The coefficient of real expansion of mercury is $0.18\times10^{-3}\,°C^{-1}$. If the density of mercury at $0°C$ is 13.6 g/cc, its density at 473 K will be

a) 13.11 g/cc b) 13.65 g/cc c) 13.51 g/cc d) 13.22 g/cc

398. A uniform metal rod is used as a bar pendulum. If the room temperature rise by $10°C$ and coefficient of linear expansion of the metal of the rod is $2\times10^{6}\,°C^{-1}$, the period of pendulum will increase by

a) $1\times10^{-3}\%$ b) $-1\times10^{-3}\%$ c) $2\times10^{-3}\%$ d) $-2\times10^{-3}\%$

399. A substance of mass $m\, kg$ requires a power input of P watts to remain in the molten state at its melting point. When the power is turned off, the sample completely solidifies in time t sec. What is the latent heat of fusion of the substance

a) $\frac{Pm}{t}$ b) $\frac{Pt}{m}$ c) $\frac{m}{Pt}$ d) $\frac{t}{Pm}$

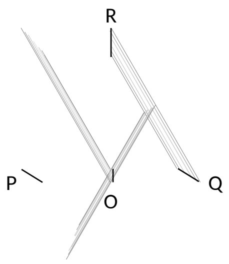
400. If earth suddenly stops rotating about its own axis, the increase in it's temperature will be

a) $\frac{R^2\omega^2}{5Js}$ b) $\frac{R^2\omega^2}{Js}$ c) $\frac{Rm\omega^2}{5Js}$ d) None of these

401. Two spheres made of same material have radii in the ratio 2:1. If both the spheres are at same temperature, then what is the ration of heat radiation energy emitted per second by them?

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

402. Three rods of equal length l are joined to form an equilateral triangle PQR. O is the mid point of PQ. Distance ¿ remains same for small change in temperature. Coefficient of linear expansion for PR and RQ is same, $i.e., \alpha_2$ but that for PQ is α_1. Then



a) $\alpha_2=3\alpha_1$ b) $\alpha_2=4\alpha_1$ c) $\alpha_1=3\alpha_2$ d) $\alpha_1=4\alpha_2$

403. As compared to the person with white skin, the person with black skin will experience

a) Less heat and more cold b) More heat and more cold

c) More heat and less cold d) Less heat and less cold

404. Water is used to cool the radiators of engines in cars because

a) Of its low boiling point b) Of its high specific heat

c) Of its low density d) Of its easy availability

405. A red flower kept in green light will appear

a) Red b) Yellow c) Black d) White

406. Four rods of identical cross-sectional area and made from the same metal form the sides of square. The temperature of two diagonally opposite points are T and $\sqrt{2}T$ respectively in the steady state. Assuming that only heat conduction takes place, what will be the temperature difference between other two points

a) $\frac{\sqrt{2}+1}{2}T$ b) $\frac{2}{\sqrt{2}+1}T$ c) 0 d) None of these

407. There is formation of layer of snow $x\,cm$ thick on water, when the temperature of air is $-\theta\,℃$ (less than freezing point). The thickness of layer increases from x to y in the time t, then the value of t is given by

a) $\frac{(x+y)(x-y)\rho L}{2k\theta}$ b) $\frac{(x-y)\rho L}{2k\theta}$ c) $\frac{(x+y)(x-y)\rho L}{k\theta}$ d) $\frac{(x-y)\rho Lk}{2\theta}$

408. A stationary object at $4\,℃$ and weighing $3.5\,kg$ falls from a height of $2000\,m$ on a snow mountain at $0\,℃$. If the temperature of the object just before hitting the snow is $0\,℃$ and the object comes to rest immediately $(g=10\,m/s^2)$ and (latent heat of ice ¿ $3.5\times10^5\,joule/s$), then the mass of ice that will melt is

a) $2\,kg$ b) $200\,g$ c) $20\,g$ d) $2\,g$

409. In supplying 400 calories of heat to a system, the work done will be

a) $400\,joules$ b) $1672\,joules$ c) $1672\,watts$ d) $1672\,ergs$

410. The temperature gradient in a rod of $0.5\,m$ long is $80\,℃/m$. If the temperature of hotter end of the rod is $30\,℃$, then the temperature of the cooler end is

a) $40\,℃$ b) $-10\,℃$ c) $10\,℃$ d) $0\,℃$

411. The amount of heat energy radiated by a metal at temperature T is E. when the temperature is increased to $3T$, energy radiated is

a) $81E$ b) $9E$ c) $3E$ d) $27E$

412. A bar of iron is $10\,cm$ at $20\,℃$. At $19\,℃$ it will be (α of iron ¿ $11\times10^{-6}/℃$)

a) $11\times10^{-6}\,cm\,longer$ b) $11\times10^{-6}\,cm\,shorter$ c) $11\times10^{-5}\,cm\,shorter$ d) $11\times10^{-5}\,cm\,longer$

413. By increasing the temperature of a liquid its

a) Volume and density decrease b) Volume and density increase

c) Volume increases and density decreases d) Volume decrease s and density increases

414. Two rods, one of aluminium and the other made of steel, having initial length l_1 and l_2 are connected together to form a single rod of length l_1+l_2. The coefficients of linear expansion for aluminium and steel are α_a and α_s respectively. If the length of each rod increases by the same amount when their temperature are raised by $t\,℃$, then find the ratio $\frac{l_1}{(l_1+l_2)}$.

a) $\frac{\alpha_s}{\alpha_a}$ b) $\frac{\alpha_a}{\alpha_s}$ c) $\frac{\alpha_s}{(\alpha_a+\alpha_s)}$ d) $\frac{\alpha_a}{¿¿}$

415. An amount of water of mass 20 g at $0℃$ is mixed with 40 g of water $10℃$, final temperature of the mixture is

a) $5℃$ b) $0℃$ c) $20℃$ d) $6.66℃$

416. The ratio of radiant energies radiated per unit surface area by two bodies is 16 : 1, the temperature of hotter body is $1000\,K$, then the temperature of colder body will be

a) $250\,K$ b) $500\,K$ c) $1000\,K$ d) $62.5\,K$

417. Two identical bodies have temperatures $277℃$ and $67℃$. If the surroundings temperature is $27℃$, the ratio of loss of heats of the two bodies during the same interval of time is(approximately)

a) 4:1 b) 8:1 c) 12:1 d) 19:1

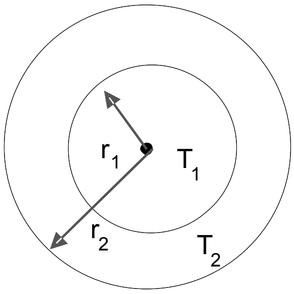
418. The amount of work, which can be obtained by supplying $200\,cal$ of heat, is

a) $840\,dyne$ b) $840\,W$ c) $840\,erg$ d) $840\,J$

419. 2 kg of ice at $-20°C$ is mixed with 5 kg of water at $20\,°C$ in an insulating vessel having a negligible heat capacity. Calculate the final mass of water remaining in the container. It is given that the specific heats of water and ice are 1 kcal/kg/°C and $0.5\,kcal/kg/°C$ while the latent heat of fusion of ice is 80 kcal kg^{-1}

a) 7 kg b) 6 kg c) 4 kg d) 2 kg

420. The figure shows a system of two concentric spheres of radii r_1 and r_2 and kept at temperatures T_1 and T_2 respectively. The radial rate of flow of heat in a substance between the two concentric spheres, is proportional to



a) $\frac{(r_2-r_1)}{(r_1 r_2)}$ b) $\text{In}\left(\frac{r_2}{r_1}\right)$ c) $\frac{(r_1 r_2)}{(r_2-r_1)}$ d) (r_2-r_1)

421. Star A has radius r surface temperature T while star B has radius $4r$ and surface temperature $T/2$. The ratio of the power of two starts, $P_A : P_B$ is

a) 16 : 1 b) 1 : 16 c) 1 : 1 d) 1 : 4

422. 540 g of ice at $0°C$ is mixed with 540 g of water at $80°C$. The final temperature of the mixture is

a) $0°C$ b) $40°C$ c) $80°C$ d) Less than $0°C$

423. The latent heat of vaporization of a substance is always

a) Greater than its latent heat of fusion
b) Greater than its latent heat of sublimation
c) Equal to is latent heat of sublimation
d) Less than its latent of fusion

424. When the pressure on water is increased the boiling temperature of water as compared to $100\,°C$ will be

a) Lower
b) The same
c) Higher
d) On the critical temperature

425. How much heat energy is gained when $5\,kg$ of water at $20\,°C$ is brought to its boiling point (specific heat of water ¿$4.2\,kJ\,kg^{-1}c^{-1}$)

a) $1680\,kJ$ b) $1700\,kJ$ c) $1720\,kJ$ d) $1740\,kJ$

426. An ideal gas is expanding such that $PT^2=$¿ constant. The coefficient of volume expansion of the gas is

a) $\frac{1}{T}$ b) $\frac{2}{T}$ c) $\frac{3}{T}$ d) $\frac{4}{T}$

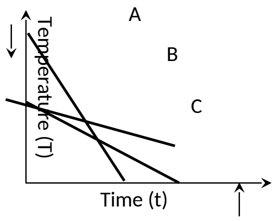
427. On heating, the temperature at which water has minimum volume is

a) $0°C$ b) $4°C$ c) 4K d) $100°C$

428. Newton's law of cooling is used in laboratory for the determination of the

a) Specific heat of the gases
b) The latent heat of gases
c) Specific heat of liquids
d) Latent heat of liquids

429. Which of the substance A, B or C has the highest specific heat? The temperature vs time graph is shown



a) A b) B

c) C d) All have equal specific heat

430. A hot metallic sphere of radius r radiates heat. It's rate of cooling is

a) Independent of r b) Proportional to r c) Proportional to r^2 d) Proportional to $1/r$

431. If wavelengths of maximum intensity of radiations emitted by the sun and the moon are $0.5 \times 10^{-6} m$ and $10^{-4} m$ respectively, the ratio of their temperature is

a) $1/100$ b) $1/200$ c) 100 d) 200

432. On a new scale of temperature (which is linear) and called the W scale, the freezing and boiling points of water are $39^o W$ and $239^o W$ respectively. What will be the temperature on the new scale, corresponding to a temperature of $39\ ℃$ on the Celsius scale

a) $200^o W$ b) $139^o W$ c) $78^o W$ d) $117^o W$

433. A solid cube and a solid sphere of the same material have equal surface area. Both are at the same temperature $120\ ℃$, then

a) Both the cube and the sphere cool down at the same rate

b) The cube cools down faster than the sphere

c) The sphere cools down faster than the cube

d) Whichever is having more mass will cool down faster

434. A hot liquids is filled in a container and kept in a room of temperature of $25\ ℃$. The liquid emits heat at the rate of $200\, J\, s^{-1}$. When its temp. is $75\ ℃$. When the temperature of the liquid becomes $40\ ℃$, the rate of heat loss in $J s^{-1}$ is

a) 160 b) 140 c) 80 d) 60

435. There are two identical vessels filled with equal amounts of ice. The vessels are of different metals., If the ice melts in the two vessels in 20 and 35 minutes respectively, the ratio of the coefficients of thermal conductivity of the two metals is

a) 4 : 7 b) 7 : 4 c) 16 : 49 d) 49 : 16

436. A beaker is completely filled with water at $4℃$. It will overflow

a) When heated, but not when cooled b) When cooled, but not when heated

c) Both when heated or cooled d) Neither when heated nor when cooled

437. Water falls from a height of 500 m. What is the rise in temperature of water at the bottom if whole energy is used up in heating water?

a) $0.96℃$ b) $1.02℃$ c) $1.16℃$ d) $0.23℃$

438. A thin square steel plate with each side equal to $10\, cm$ is heated by a blacksmith. The rate of radiated energy by the heated plate is $1134\, W$. The temperature of the hot steel plate is (Stefan's constant $\sigma = 5.67 \times 10^{-8} watt\, m^{-2} K^{-4}$, emissivity of the plate = 1)

a) $1000\, K$ b) $1189\, K$ c) $2000\, K$ d) $2378\, K$

439. When the room temperature becomes equal to the dew point, the relative humidity of the room is

a) 100% b) zero% c) 70% d) 85%

440. How many grams of a liquid of specific heat 0.2 at a temperature 40 °C must be mixed with 100 gm of a liquid of specific heat of 0.5 at a temperature 20 °C, so that the final temperature of the mixture becomes 32 °C

a) 175 gm b) 300 g c) 295 gm d) 375 g

441. During illness an 80 kg man ran fever of $102.2^o F$ instead of normal body temperature of $98.6^o F$. Assuming that human body is mostly water, how much heat is required to raise his temperature by that amount

a) 100 $kcal$ b) 160 $kcal$ c) 50 $kcal$ d) 92 $kcal$

442. Two solid spheres $A$and B made of the same material have radii $r_A \wedge r_B$respectively. Both the spheres are cooled from the same temperature under the conditions valid for Newton's law of cooling. The ratio of the rate of change of temperature of A and B is

a) $\frac{r_A}{r_B}$ b) $\frac{r_B}{r_A}$ c) $\frac{r_A^2}{r_B^2}$ d) $\frac{r_B^2}{r_A^2}$

443. Assuming the sun to be a spherical body of radius Rat a temperature of $T K$, evaluate the total radiant power, incident on earth, at a distance r from the sun

Where $r_0$is the radius of the earth and σ is stefan's constant.v

a) $4\pi r_0^2 R^2 \sigma T^4 / r^2$ b) $\pi r_0^2 R^2 \sigma T^4 / r^2$ c) $r_0^2 R^2 \sigma T^4 / 4\pi r^2$ d) $R^2 \sigma T^4 / r^2$

444. The area of the glass of a window of a room is $10\, m^2$ and thickness $2\, mm$. The outer and inner temperature are 40 °C and 20 °C respectively. Thermal conductivity of glass in MKS system is 0.2. The heat flowing in the room per second will be

a) 3×10^4 $joules$ b) 2×10^4 $joules$ c) 30 $joules$ d) 45 $joules$

445. Two rods A and B are of equal lengths. Their ends are kept between the same temperature and their area of cross-sections are A_1 and A_2 and thermal conductivities K_1 and K_2. The rate of heat transmission in the two rods will be equal, if

a) $K_1 A_2 = K_2 A_1$ b) $K_1 A_1 = K_2 A_2$ c) $K_1 = K_2$ d) $K_1 A_1^2 = K_2 A_2^2$

446. A vertical column 50 cm long at 50 °C balances another column of same liquid 60 cm long at 100 °C. The coefficient of absolute expansion of the liquid is

a) 0.005/°C b) 0.0005/°C c) 0.002/°C d) 0.0002/°C

447. A cylindrical rod having temperature T_1 and T_2 at its ends. The rate of flow of heat is $Q_1\, cal/s$. If all the linear dimensions are doubled keeping temperature constant then rate of flow of heat Q_2 will be

a) $4Q_1$ b) $2Q_1$ c) $\frac{Q_1}{4}$ d) $\frac{Q_1}{2}$

448. If black wire of platinum is heated, then its colour first appear red, then yellow and finally white. It can be understood on the basis of

a) Wien's displacement law b) Prevost theory of heat exchange

c) Newton's law of cooling d) None of the above

449. The readings of a constant volume gas thermometer at 0°C and 100°C are 40cm of mercury and 60 cm of mercury. If its reading at an unknown temperature is 100cm of mercury column, then the temperature is

a) 100°C b) 50°C c) 25°C d) 300°C

450. The coefficient of superficial expansion of a solid is 2×10^{-5}/°C. Its coefficient of linear expansion is

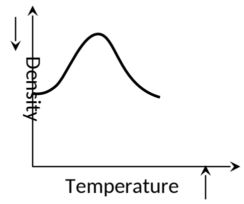
a) 4×10^{-5}/°C b) 3×10^{-5}/°C c) 2×10^{-5}/°C d) 1×10^{-5}/°C

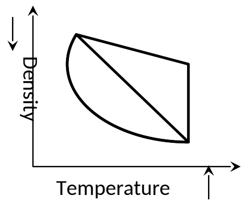
451. Assuming the sun to have a spherical outer surface of radius r, radiating like a black body at temperature $t\,°C$, the power received by a unit surface, (normal to the incident rays) at a distance R from the centre of the sun is

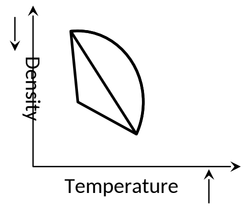
Where σ is the stefan's constant.

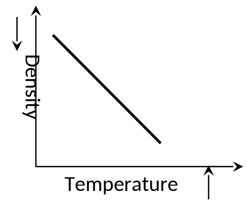
a) $\frac{4\pi r^2 \sigma t^4}{R^2}$ b) $\frac{r^2 \sigma (t+273)^4}{4\pi R^2}$ c) $\frac{16\pi^2 r^2 \sigma t^4}{R^2}$ d) $\frac{r^2 \sigma (t+273)^4}{R^2}$

452. The variation of density of water with temperature is represented by the

a) 

b) 

c) 

d) 

453. Two identical rods of copper and iron are coated with wax uniformly. When one end of each is kept at temperature of boiling water, the length upto which wax melts are $8.4\,cm$ and $4.2\,cm$ respectively. If thermal conductivity of copper is 0.92, then thermal conductivity of iron is

a) 0.23 b) 0.46 c) 0.115 d) 0.69

454. Mud houses are cooler in summer and warmer in winter because

a) Mud is superconductor of heat b) Mud is good conductor of heat

c) Mud is bad conductor of heat d) None of these

455. Two slabs A and B of equal surface area are placed one over the other such that their surfaces are completely in contact. The thickness of slab A is twice that of B. The coefficient of thermal conductivity of slab A is twice that of B. The first surface of slab A is maintained at $100°C$, while the second surface of slab B is maintained at $25°C$. The temperature at contact of their surfaces is

a) $62.5°C$ b) $45°C$ c) $55°C$ d) $85°C$

456. The ratio of energy of emitted radiation of a black body at $27\,°C$ and $927\,°C$ is

a) 1 : 4 b) 1 : 16 c) 1 : 64 d) 1 : 256

457. A metal sphere of radius r and specific heat c is rotated about an axis passing through its centre at a speed of n rotations per second. It is suddenly stopped and 50% of its energy is used in increasing its temperature. Then the rise in temperature of the sphere is

a) $\frac{2}{5}\frac{\pi^2 n^2 r^2}{c}$ b) $\frac{1}{10}\frac{\pi^2 n^2}{r^2 c}$ c) $\frac{7}{8}\pi r^2 n^2 c$ d) $5\left[\frac{\pi r n}{14c}\right]^{-2}$

458. The SI unit of mechanical equivalent of heat is

a) $Joule \times Calorie$ b) $Joule/Calorie$ c) $Calorie \times Erg$ d) $Erg/Calorie$

459. A glass flask of volume one $litre$ at $0\,°C$ is fille, level full of mercury at this temperature. The flask and mercury are now heated to $100\,°C$. How much mercury will spill out, if coefficient of volume expansion of mercury is $1.82 \times 10^{-4}/°C$ and linear expansion of glass is $0.1 \times 10^{-4}/°C$ respectively

a) $21.2\,cc$ b) $15.2\,cc$ c) $1.52\,cc$ d) $2.12\,cc$

460. Two rods of same length and material transfer a given amount of heat in 12 s, when they are joined end to end (ie, in series). But when they are joined in parallel, they will transfer same heat under same conditions in

a) 24 s b) 3 s c) 48 s d) 1.5 s

461. The amount of radiation emitted by a perfectly black body is proportional to

a) Temperature of ideal gas scale

b) Fourth root of temperature on ideal gas scale

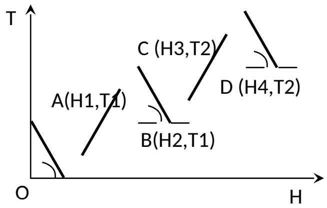
c) Fourth power of temperature on ideal gas scale

d) Source of temperature on ideal gas scale

462. Distribution of energy in the spectrum of a black body can be correctly represented by

a) Wien's law b) Stefan's law c) Planck's law d) Kirchhoff's law

463. The graph shows the variation of temperature (T) of one *kilogram* of a material with the heat (H) supplied to it. At O, the substance is in the solid state. From the graph, we can conclude that



a) T_2 is the melting point of the solid

b) BC represents the change of state from solid to liquid

c) (H_2-H_1) represents the latent heat of fusion of the substance

d) (H_3-H_1) represents the latent heat of vaporization of the liquid

464. Heat capacity of a substance is infinite. It means

a) Heat is given out

b) Heat is taken in

c) No change in temperature whether heat is taken in or given out

d) All of the above

465. On a cold morning, a metal surface will feel colder to touch than a wooden surface because

a) Metal has high specific heat b) Metal has high thermal conductivity

c) Metal has low specific heat d) Metal has low thermal conductivity

466. 1.56×10^5 J of heat is conducted through is 2 m^2 wall of 12 cm thick in one hour. Temperature difference between the two sides of the wall is 20℃. The thermal conductivity of the material of the wall is (in $Wm^{-1}K^{-1}$)

a) 0.11 b) 0.13 c) 0.15 d) 1.2

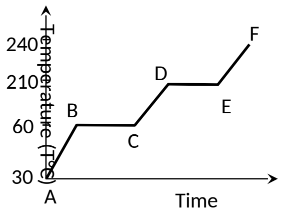
467. Two rods P and Q have equal lengths. Their thermal conductivities are $K_1 \wedge K_2$ and cross sectional areas are $A_1 \wedge A_2$. When the temperature at ends of each rod are $T_1 \wedge T_2$ respectively, the rate of flow of heat through $P \wedge Q$ will be equal, if

a) $\frac{A_1}{A_2}=\frac{K_2}{K_1}$ b) $\frac{A_1}{A_2}=\frac{K_2}{K_1}\times\frac{T_2}{T_1}$ c) $\frac{A_1}{A_2}=\sqrt{\frac{K_1}{K_2}}$ d) $\frac{A_1}{A_2}=\left(\frac{K_2}{K_1}\right)^2$

468. Which of the following is the example of ideal black body

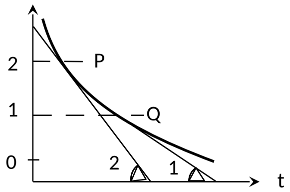
a) Kajal b) Black board c) A pin hole in a box d) None of these

469. A solid substance is at 30 ℃. To this substance heat energy is supplied at a constant rate. Then temperature versus time graph is as shown in the figure. The substance is in liquid state for the portion (of the graph)



a) BC b) CD c) ED d) EF

470. A body cools in a surrounding which is at a constant temperature of θ_0. Assume that of obeys Newton's law of cooling. Its temperature θ is plotted against time t. Tangents are drawn to the curve at the points $P(\theta=\theta_2)$ and $Q(\theta=\theta_1)$. These tangents meet the time axis at angles of ϕ_2 and ϕ_1, as shown



a) $\frac{\tan\phi_2}{\tan\phi_1}=\frac{\theta_1-\theta_0}{\theta_2-\theta_0}$ b) $\frac{\tan\phi_2}{\tan\phi_1}=\frac{\theta_2-\theta_0}{\theta_1-\theta_0}$ c) $\frac{\tan\phi_1}{\tan\phi_2}=\frac{\theta_1}{\theta_2}$ d) $\frac{\tan\phi_1}{\tan\phi_2}=\frac{\theta_2}{\theta_1}$

471. When a liquid in a glass vessel is heated, is apparent expansion is $10.30\times10^{-4}\,°C^{-1}$. When the same liquid is heated in a metal vessel, its apparent expansion is $10.06\times10^{-4}\,°C^{-1}$. If the coefficient of linear expansion of glass = $9\times10^{-6}\,°C^{-1}$, what is the coefficient of linear expansion of metal?

a) $51\times10^{-6}\,°C^{-1}$ b) $17\times10^{-6}\,°C^{-1}$ c) $25\times10^{-6}\,°C^{-1}$ d) $43\times10^{-6}\,°C^{-1}$

472. When a bimetallic strip is heated, it

a) Does not bend at all

b) Gets twisted in the from of an helix

c) Bend in the form of an arc with the more expandable metal outside

d) Bends in the form of an arc with the more expandable metal inside

473. Relation between the colour and the temperature of a star is given by

a) Wien's displacement law b) Planck's law

c) Hubble's law d) Fraunhoffer diffraction law

474. The factor not needed to calculate heat lost or gained when there is no change of state is

a) Weight b) Specific heat c) Relative density d) Temperature change

475. A black metal foil is warmed by radiation from a small sphere at temperature T and at a distance d. It is found that the power received by the foil is $'P'$. If both the temperature and the distance are doubled, the power received by the foil will be

a) $16P$ b) $4P$ c) $2P$ d) P

476. A lead bullet at $27\,°C$ just melts when stopped by an obstacle. Assuming that 25% of heat is absorbed by the obstacle, then the velocity of the bullet at the time of striking (M.P. of lead ¿$327\,°C$, specific heat of lead ¿$0.03\,cal/g\,°C$, latent heat of fusion of lead ¿$6\,cal/g$ and $J=4.2\,joule/cal$)

a) $410\,m/s$ b) $1230\,m/s$ c) $307.5\,m/s$ d) None of the above

477. The velocity of heat radiation in vacuum is

a) Equal to that of light b) Less than that of light

c) Greater than that of light   d) Equal to that of sound

478. Consider a compound slab consisting of two different materials having equal lengths, thicknesses and thermal conductivities K and $2K$ respectively. The equivalent thermal conductivity of the slab is

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

479. If γ is the ratio of specific heats and R is the universal gas constant, then the molar specific heat at constant volume C_v is given by

a) $\frac{R}{\gamma-1}$ b) $\frac{\gamma R}{\gamma-1}$ c) γR d) $\frac{(\gamma-1)R}{\gamma}$

480. If a cylinder a diameter $1.0\,cm$ at $30\,℃$ is to be fitted into a hole of diameter $0.9997\,cm$ in a steel plate at the same temperature, then minimum required rise in the temperature of the plate is : (Coefficient of linear expansion of steel ¿ $12\times10^{-6}/℃$)

a) $25\,℃$ b) $35\,℃$ c) $45\,℃$ d) $55\,℃$

481. The lengths and radii of two rods made of same material are in the ratios 1:2 and 2:3 respectively. If the temperature difference between the ends for the two rods be the same, then in the steady state, the amount of heat flowing per second through them will be in the ratio

a) 1 : 3   b) 4 : 3   c) 8 : 9   d) 3 : 2

482. If temperature of an object is $140^o F$, then its temperature in centigrade is

a) $105\,℃$ b) $32\,℃$ c) $140\,℃$ d) $60\,℃$

483. On increasing the temperature of a substance gradually, which of the following colours will be noticed by you

a) White   b) Yellow   c) Green   d) Red

484. The temperature of the sun is measured with

a) Platinum thermometer   b) Gas thermometer

c) Pyrometer   d) Vapour pressure thermometer

485. We consider the radiation emitted by the human body. Which of the following statements is true?

a) The radiation is emitted during the summers and absorbed during the winters

b) The radiation emitted lies in the ultraviolet region and hence is not visible

c) The radiation emitted is in the infrared region

d) The radiation is emitted only during the day

486. Absolute temperature can be calculated by

a) Mean square velocity   b) Motion of the molecule

c) Both (a) and (b)   d) None of the above

487. A brass rod of length 500 mm and diameter 3 mm is joined to a steel rod of same length and diameter at $50℃$. If the coefficients of linear expansion of brass and steel are $2.5\times10^{-5}℃^{-1}$ and $1.25\times10^{-5}℃^{-1}$, then change in length of the combined rod at $200℃$ is

a) 2.4mm   b) 2.8mm   c) 3.2mm   d) 3.6mm

488. A solid ball of metal has a concentric spherical cavity within it. If the ball is heated, the volume of the cavity will

a) Increase   b) Decrease   c) Remain unaffected   d) None of these

489. Amount of heat required to convert 10 g of ice to water at 20℃ is

a) 80 cal b) 100 cal c) 1000 cal d) 540 cal

490. Two rods of equal lengths and areas of cross-section are kept parallel and hanged between temperatures 20℃ and 80℃. The ratio of the effective thermal conductivity to that of the first rod is (the ratio=$\frac{K_1}{K_2}=\frac{3}{4}$)

a) 7:4 b) 7:6 c) 4:7 d) 7:8

491. Liquid is filled in a vessel which is kept in a room with temperature 20 ℃. When the temperature of the liquid is 80 ℃, then it loses heat at the rate of $60\, cal/s$. What will be the rate of loss of heat when the temperature of the liquid is 40 ℃

a) $180\, cal/s$ b) $40\, cal/s$ c) $30\, cal/s$ d) $20\, cal/s$

492. The temperature of a body on Kelvin scale is found to be $x\,K$. When it is measured by Fahrenheit thermometer, it is found to be $x^o F$, then the value of x is

a) 40 b) 313 c) 574.25 d) 301.25

493. Steam is passed into $22\, g$ of water at 20 ℃. The mass of water that will be present when the water acquires a temperature of 90 ℃ (Latent heat of steam is $540\, cal/g$) is

a) $24.8\, g$ b) $24\, g$ c) $36.6\, g$ d) $30\, g$

494. If the temperature of a hot body is increased by 50% then the increase in the quantity of emitted heat radiation will be

a) 125% b) 200% c) 300% d) 400%

495. A faulty thermometer has its fixed points marked 5 and 95. When this thermometer reads 68, the correct temperature in Celsius is

a) 68℃ b) 70℃ c) 66℃ d) 72℃

496. A liquid cools down from 70 ℃ to 60 ℃ in $5\, minutes$. The time taken to cool it from 60 ℃ to 50 ℃ will be

a) $5\, minutes$

b) Lesser than $5\, minutes$

c) Greater than $5\, minutes$

d) Lesser or greater than $5\, minutes$ depending upon the density of the liquid

497. The resistance of a resistance thermometer has values 2.71 and $3.70\, ohm$ at 10 ℃ and 100 ℃. The temperature at which the resistance is $3.26\, ohm$ is

a) 40 ℃ b) 50 ℃ c) 60 ℃ d) 70 ℃

498. Three identical rods A, $B$and $C$are placed end to end. A temperature difference is maintained between the free ends of $A$and C. The thermal productivity of B is thrice that if $C$and half of that of A. the effective thermal conductivity of the system will be (KA is the thermal conductivity of rod A)

a) $\frac{3}{2}\, KA$ b) $2\, KA$ c) $3\, KA$ d) $\frac{1}{3} KA$

499. A copper block of mass 4 kg is heated in a furnance to a temperature 425℃ and then placed on a large ice block. The mass of ice that will melt in this process will be (Specific heat of copper=500 J kg^{-1} ℃$^{-1}$ and heat of fusion of ice=336 k J kg^{-1})

a) 0.5 kg b) 1 kg c) 1.5 kg d) 2.5 kg

500. A quantity of heat required to change the unit mass of a solid substance, from solid state to liquid state, while the temperature remains constant, is known as

a) Latent heat b) Sublimation c) Hoar frost d) Latent heat of fusion

501. An aluminium sphere of 20 cm diameter is heated from $0\,°C$ to $100\,°C$.Its volume changes by (given that coefficient of linear expansion for aluminium $(\alpha_{Al}=23\times10^{-6}/°C)$

a) 28.9 cc b) 2.89 cc c) 9.28 cc d) 49.8 cc

502. The point on the pressure-temperature phase diagram where all the three phases co-exist is called

a) Sublimation point b) Fusion point

c) Triple point d) Vaporization point

503. A hot body at temperature T losses heat to the surrounding temperature T_s by radiation. If the difference in the temperature is small then, the rate of loss of heat by the hot body is proportional to

a) $(T-T_s)$ b) $(T-T_s)^2$ c) $(T-T_s)^{1/2}$ d) $(T-T_s)^4$

504. A black body radiates $20\,W$at temperature $227\,°C$. If temperature of the black body is changed to $727\,°C$ then its radiating power will be

a) $120\,W$ b) $240\,W$ c) $320\,W$ d) $360\,W$

505. Infrared radiations are detected by

a) Spectrometer b) Pyrometer c) Nanometer d) Photometer

506. A gas undergoes an adiabatic change. Its specific heat in the process is

a) Zero b) 1 c) ∞ d) None of these

507. In order that the heat flows from one part of a solid to another part, what is required

a) Uniform density b) Density gradient

c) Temperature gradient d) Uniform temperature

508. Four rods of silver, copper, brass and wood are of same shape. They are heated together after wrapping a paper on it, the paper will burn first on

a) Silver b) Copper c) Brass d) Wood

509. 5 g of ice at $0°C$ is dropped in a beaker containing 20 g of water at $40°C$. The final temperature will be

a) $32°C$ b) $16°C$ c) $8\,°C$ d) $24°C$

510. A conductor of area of cross-section $100 cm^2$ and length 1 cm has coefficient of thermal conductivity $0.76 cal s^{-1} m^{-1} K^{-1}$. If 30 cal of heat flows through the conductor per second. Find the temperature difference across the conductor.

a) $40°C$ b) $20°C$ c) $25°C$ d) $35°C$

511. Two spherical black bodies of radii r_1 and r_2 and with surface temperature T_1 and T_2 respectively radiate the same power. Then the ratio of r_1 and r_2 will be

a) $\left(\frac{T_2}{T_1}\right)^2$ b) $\left(\frac{T_2}{T_1}\right)^4$ c) $\left(\frac{T_1}{T_2}\right)^2$ d) $\left(\frac{T_1}{T_2}\right)^4$

512. At a common temperature, a block of wood and a block of metal feel equally cold or hot. The temperature of block of wood and block of metal are

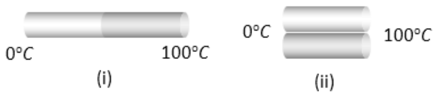
a) Equal to temperature of the body b) Less than the temperature of the body

c) Greater than temperature of the body d) Either (b) or (c)

513. Oxygen boils at $-183\,°C$. This temperature is approximately

a) $215^o F$ b) $-297^o F$ c) $329^o F$ d) $361^o F$

514. Two identical square rods of metal are welded end to end as shown in figure (i), 20 calories of heat flows through it in 4 minutes. If the rods are welded as shown in figure (ii), the same amount of heat will flow through the rods in



a) 1 minute b) 2 minutes c) 4 minutes d) 16 minutes

515. When the temperature of a rod increases from t to $t+\Delta t$, its moment of inertia increases from I to $I+\Delta I$. If α be the coefficient of linear expansion of the rod, then the value of $\frac{\Delta I}{I}$ is

a) $2\alpha\Delta t$ b) $\alpha\Delta t$ c) $\frac{\alpha\Delta t}{2}$ d) $\frac{\Delta t}{\alpha}$

516. The relative humidity on a day when partial pressure of water vapour is 0.012×10^5 Pa at $12°C$ is (Take vapour pressure of water at this temperature as 0.016×10^5 Pa)

a) 70% b) 40% c) 75% d) 25%

517. A brass disc fits simply in a hole of a steel plate. The disc from the hole can be loosened if the system

a) First heated then cooled b) First cooled then heated

c) Is heated d) Is cooled

518. According to Wien's law

a) $\lambda_m T =$ ¿ constant b) $\frac{\lambda_m}{T} =$ ¿ constant c) $\frac{T}{\lambda_m} =$ ¿ constant d) $T+\lambda_m =$ ¿ constant

519. Mode of transmission of heat, in which heat is carried by the moving particles, is

a) Radiation b) Conduction c) Convection d) Wave motion

520. The radiation emitted by a star A is 10,000 times that of the sun. If the surface temperature of the sun and the star A are 6000 K and 2000 K respectively, the ratio of the radii of the star A and the sun is

a) 300:1 b) 600:1 c) 900:1 d) 1200:1

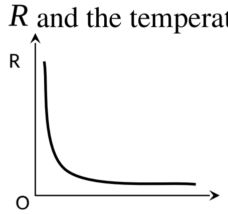
521. An iron bar of length 10m is heated from $0°C$ to $100°C$. If the coefficient of linear thermal expansion of iron is $10\times10^{-6}\,°C^{-1}$, the increase in the length of bar is

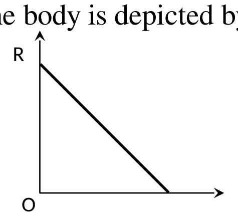
a) 0.5 cm b) 1.0 cm c) 1.5 cm d) 2.0 cm

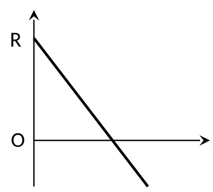
522. A rectangular block is heated from $0°C$to $100°C$. The percentage increase in its length is 0.2%. What is the percentage increase in its volume?

a) 0.6% b) 0.10% c) 0.2% d) 0.4%

523. For a small temperature difference between the body and the surroundings the relation between the rate of loss heat R and the temperature of the body is depicted by

a)


b)


c)


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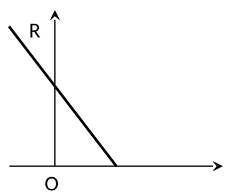


524. The spectral energy distribution of a star is maximum at twice temperature as that of sun. the total energy radiated by star is

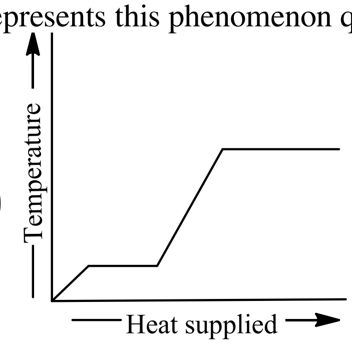
a) Twice as that of the sun b) Same as that of the sun

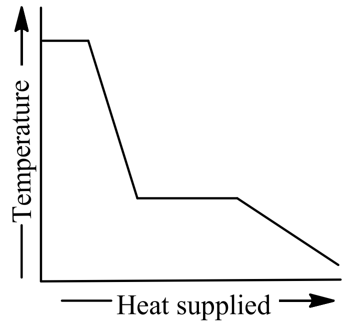
c) Sixteen times as that of the sun d) One-sixteenth of the sun

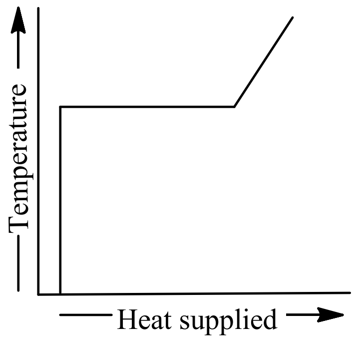
525. The temperature of a liquid drops from $365\,K$ to $361\,K$ in $2\,minutes$. Find the time during which temperature of the liquid drops from $344\,K$ to $342\,K$. Temperature of room is $293\,K$

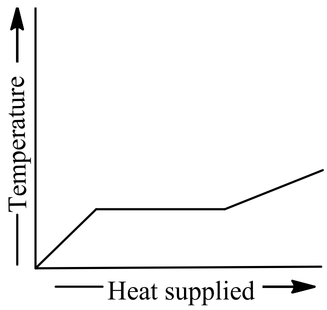
a) $84\,s$ b) $72\,s$ c) $66\,s$ d) $60\,s$

526. A block of ice at -10 ° c slowly heated and converted to steam at 100℃. Which of the following curves represents this phenomenon qualitatively?

a)


b)


c)


d)


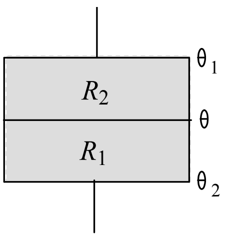
527. The correct value of 0 ℃ on Kelvin scale will be

a) $273.15\,K$ b) $273.00\,K$ c) $273.05\,K$ d) $273.63\,K$

528. If temperature of a black body increases from 7 ℃ to 287 ℃, then the rate of energy radiation increases by

a) $\left(\frac{287}{7}\right)^4$ b) 16 c) 4 d) 2

529. Consider two insulating sheets with thermal resistances $R_1 \wedge R_2$as shown in figure. The temperature θ *is*



a) $\frac{\theta_1 R_2 + \theta_2 R_1}{R_1 + R_2}$ b) $\frac{(\theta_1 + \theta_2) R_1 R_2}{R_1^2 + R_2^2}$ c) $\frac{\theta_1 R_1 + \theta_2 R_2}{R_1 + R_2}$ d) $\frac{\theta_1 \theta_2 R_1 R_2}{(\theta_1 + \theta_2)(R_1 R_2)}$

530. The maximum energy in thermal radiation from a source occurs at the wavelength $4000\,Å$. The effective temperature of the source is

a) 7325 K b) 800 K c) 10^4 K d) 10^6 K

531. Wien's displacement law for emission of radiation can be written as

a) λ_{max} is proportional to absolute temperature(T)

b) λ_{max} is proportional to square of absolute temperature(T^2)

c) λ_{max} is inversely proportional to square of absolute temperature(T)

d) λ_{max} is inversely proportional to square of absolute temperature(T^2)

¿¿=wavelength whose energy density is greatest)

532. Solids expand on heating because

a) Kinetic energy of the atoms increases

b) Potential energy of the atoms increases

c) Total energy of the atoms increases

d) The potential energy curve is asymmetric about the equilibrium distance between neighbouring atoms

533. On which of the following scales of temperature, the temperature is never negative

a) Celsius b) Fahrenheit c) Reaumur d) Kelvin

534. 0.1 m^3 of water at $80℃$ is mixed with $0.3m^3$ of water at $60℃$. The final temperature of the mixture is

a) $65℃$ b) $70℃$ c) $60℃$ d) $75℃$

535. A container contains hot water at $100\ ℃$. If in time T_1 temperature falls to $80\ ℃$ and in time T_2 temperature falls to $60\ ℃$ from $80\ ℃$, then

a) $T_1=T_2$ b) $T_1>T_2$ c) $T_1<T_2$ d) None

536. The temperature on Celsius scale is $25\ ℃$. What is the corresponding temperature on the Fahrenheit scale

a) $40^o F$ b) $77^o F$ c) $50^o F$ d) $45^o F$

537. A black body emits radiations of maximum intensity for the wavelength of $5000Å$ when the temperature of the body is $1227℃$. If the temperature of the body is increased by $1000℃$, the maximum intensity would be observed at

a) $1000Å$ b) $2000Å$ c) $5000Å$ d) $3000Å$

538. If the length of a cylinder on heating increases by 2%, the area of its base will increase by

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

539. A body takes 5 minutes for cooling from $50\ ℃$ to $40\ ℃$. Its temperature comes down to $33.33\ ℃$ in next 5 minutes. Temperature of surroundings is

a) $15\ ℃$ b) $20\ ℃$ c) $25\ ℃$ d) $10\ ℃$

540. A bubble of 8 mole of helium is submerged at a certain depth in water. The temperature of water increases by $30\ ℃$. How much that is added approximately to helium during expansion

a) $4000\ J$ b) $3000\ J$ c) $3500\ J$ d) $5000\ J$

541. A thermos flask is polished well

a) To make attractive

b) For shining

c) To absorb all radiations from outside

d) To reflect all radiations from outside

542. In which mode of transmission, the heat waves travel along straight line with the speed of light?

a) Thermal radiation

b) Forced convection

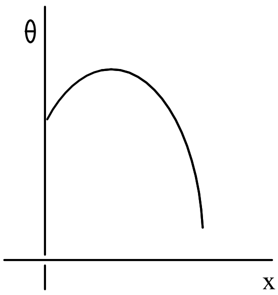
c) Natural convection

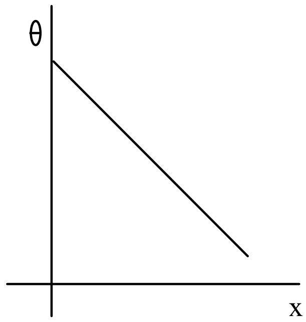
d) Thermal conduction

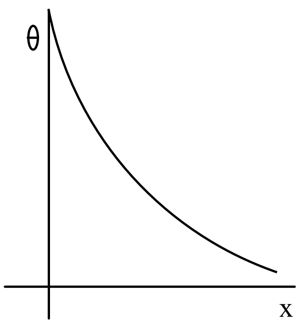
543. If on heating liquid through $80\ ℃$, the mass expelled is $(1/100)^{th}$ of mass still remaining, the coefficient of apparent expansion of liquid is

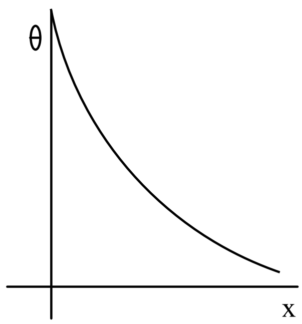
a) $1.25 \times 10^{-4}/°C$ b) $12.5 \times 10^{-4}/°C$ c) $1.25 \times 10^{-5}/°C$ d) None of these

544. A long metallic bar is carrying heat from one of its ends to the other end under steady-state. The variation of temperature θ along the length x of the bar from its hot end is best described by which of the following figure?

a) 

b) 

c) 

d) 

545. 300 gm of water at 25 °C is added to 100 g of ice at 0 °C. The final temperature of the mixture is

a) $\frac{-5}{3}$ °C b) $\frac{-5}{2}$ °C c) -5 °C d) 0 °C

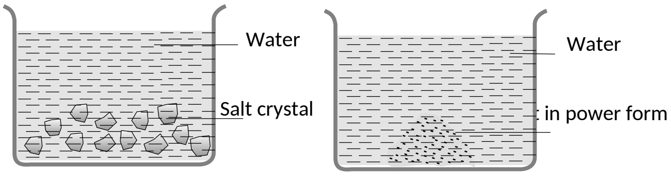
546. A black body is at a temperature 300 K. It emits energy at a rate, which is proportional to

a) 300 b) $(300)^2$ c) $(300)^3$ d) $(300)^4$

547. A centigrade and a Fahrenheit thermometer are dipped in boiling water. The water temperature is lowered until the Fahrenheit thermometer registers 140^o. What is the fall in temperature as registered by the Centigrade thermometer

a) 30^o b) 40^o c) 60^o d) 80^o

548. Out of the following, in which vessel will the temperature of the solution be higher after the salt is completely dissolved



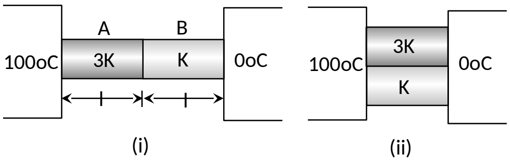
a) A b) B

c) Equal in both d) Information is not sufficient

549. Two uniform brass rods A and B of lengths l and $2l$ and radii $2r$ and r respectively are heated to the same temperature. The ratio of the increase in the volumes of A to that of B is

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

550. Two conducting rods A and B of same length and cross-sectional area are connected (i) In series (ii) In parallel as shown. In both combination a temperature difference of 100 °C is maintained. If thermal conductivity of A is $3K$ and that of B is K then the ratio of heat current flowing in parallel combination to that flowing in series combination is



a) $\frac{16}{3}$ b) $\frac{3}{16}$ c) $\frac{1}{1}$ d) $\frac{1}{3}$

551. Calorimeters are made of which of the following

a) Glass b) Metal c) Wood d) Either (a) or (c)

552. In a closed room, which method is based on gravitation

a) Conduction b) Convection c) Radiation d) All of these

553. Two thermometers A and B are exposed in sun light. The valve of A is pointed black, but that of B is not pointed. The correct statement regarding this case is

a) Temperature of A will rise faster than B but the final temperature will be the same in both

b) Both A and B show equal rise in beginning

c) Temperature of A will remain more than B

d) Temperature of B will rise faster

554. The wavelength of maximum energy, released during an atomic explosion was $2.93 \times 10^{-10} m$. Given that the Wien's constant is $2.93 \times 10^{-3} m-K$, the maximum temperature attained must be of the order of

a) $10^{-7} K$ b) 10^{7} K c) 10^{-3} K d) 5.86×10^{7} K

555. Amount of heat required to raise the temperature of a body through $1 K$ is called its

a) Water equivalent b) Thermal capacity c) Entropy d) Specific heat

556. Surface of the lake is at $2\,°C$. Find the temperature of the bottom of the lake

a) $2\,°C$ b) $3\,°C$ c) $4\,°C$ d) $1\,°C$

557. Two rigid boxes containing different ideal gases are placed on a table. Box A contains one mole of nitrogen at temperature T_0, while box B contains one mole of helium at temperature $(7/3)T_0$. The boxes are then put into thermal contact with each other and heat flows between them until the gases reach a common final temperature (Ignore the heat capacity of boxes). Then, the final temperature of the gases, T_f, in terms of T_0 is

a) $T_f = \frac{7}{3} T_0$ b) $T_f = \frac{3}{2} T_0$ c) $T_f = \frac{5}{2} T_0$ d) $T_f = \frac{3}{7} T_0$

558. The quantity of heat which crosses per unit area of a metal plate during conduction depends upon

a) The density of the metal b) The temperature gradient perpendicular to the area

c) The temperature to which the metal is heated d) The area of the metal plate

: ANSWER KEY :

1)	a	2)	a	3)	d	4)	a	169)	b	170)	a	171)	d	172)	c
5)	b	6)	b	7)	c	8)	b	173)	b	174)	b	175)	a	176)	c
9)	a	10)	c	11)	c	12)	c	177)	c	178)	a	179)	d	180)	a
13)	d	14)	d	15)	d	16)	d	181)	b	182)	b	183)	d	184)	a
17)	b	18)	d	19)	a	20)	b	185)	d	186)	c	187)	d	188)	d
21)	d	22)	a	23)	d	24)	a	189)	c	190)	c	191)	a	192)	c
25)	b	26)	a	27)	c	28)	d	193)	c	194)	c	195)	a	196)	b
29)	b	30)	c	31)	c	32)	a	197)	d	198)	a	199)	a	200)	d
33)	b	34)	a	35)	b	36)	a	201)	c	202)	b	203)	a	204)	b
37)	b	38)	a	39)	b	40)	a	205)	a	206)	b	207)	d	208)	a
41)	d	42)	a	43)	a	44)	b	209)	a	210)	c	211)	d	212)	b
45)	c	46)	c	47)	d	48)	c	213)	a	214)	c	215)	c	216)	b
49)	b	50)	d	51)	a	52)	a	217)	a	218)	c	219)	a	220)	c
53)	d	54)	c	55)	b	56)	b	221)	a	222)	c	223)	a	224)	c
57)	b	58)	d	59)	c	60)	b	225)	b	226)	c	227)	a	228)	d
61)	c	62)	d	63)	c	64)	c	229)	c	230)	b	231)	b	232)	d
65)	d	66)	d	67)	d	68)	c	233)	b	234)	a	235)	b	236)	c
69)	b	70)	c	71)	a	72)	c	237)	a	238)	d	239)	d	240)	a
73)	c	74)	a	75)	c	76)	b	241)	c	242)	a	243)	d	244)	b
77)	b	78)	c	79)	b	80)	c	245)	b	246)	c	247)	d	248)	d
81)	d	82)	c	83)	c	84)	d	249)	a	250)	a	251)	b	252)	b
85)	b	86)	c	87)	d	88)	c	253)	c	254)	a	255)	a	256)	d
89)	b	90)	a	91)	d	92)	b	257)	b	258)	b	259)	c	260)	a
93)	b	94)	a	95)	a	96)	d	261)	a	262)	a	263)	c	264)	c
97)	c	98)	d	99)	b	100)	a	265)	a	266)	b	267)	a	268)	c
101)	d	102)	a	103)	d	104)	b	269)	a	270)	d	271)	a	272)	a
105)	b	106)	c	107)	d	108)	b	273)	a	274)	a	275)	d	276)	c
109)	a	110)	a	111)	b	112)	a	277)	b	278)	a	279)	a	280)	a
113)	a	114)	c	115)	c	116)	a	281)	b	282)	b	283)	c	284)	c
117)	d	118)	a	119)	b	120)	c	285)	c	286)	c	287)	b	288)	d
121)	c	122)	a	123)	b	124)	a	289)	c	290)	a	291)	a	292)	d
125)	a	126)	b	127)	d	128)	c	293)	c	294)	d	295)	c	296)	b
129)	c	130)	d	131)	b	132)	a	297)	b	298)	c	299)	b	300)	b
133)	a	134)	b	135)	c	136)	b	301)	b	302)	b	303)	d	304)	a
137)	a	138)	c	139)	c	140)	c	305)	c	306)	c	307)	a	308)	b
141)	c	142)	c	143)	a	144)	d	309)	a	310)	d	311)	b	312)	c
145)	d	146)	b	147)	a	148)	b	313)	d	314)	d	315)	a	316)	b
149)	a	150)	a	151)	d	152)	d	317)	c	318)	a	319)	b	320)	d
153)	c	154)	a	155)	b	156)	a	321)	a	322)	d	323)	c	324)	c
157)	b	158)	a	159)	d	160)	b	325)	c	326)	c	327)	c	328)	d
161)	b	162)	c	163)	b	164)	a	329)	d	330)	a	331)	a	332)	d
165)	b	166)	c	167)	c	168)	c	333)	a	334)	c	335)	b	336)	b

337)	a	338)	c	339)	b	340)	c
341)	a	342)	c	343)	d	344)	c
345)	c	346)	b	347)	a	348)	b
349)	b	350)	a	351)	d	352)	b
353)	a	354)	b	355)	c	356)	c
357)	d	358)	c	359)	c	360)	d
361)	c	362)	c	363)	d	364)	b
365)	c	366)	a	367)	b	368)	b
369)	a	370)	a	371)	d	372)	b
373)	d	374)	a	375)	c	376)	b
377)	b	378)	d	379)	a	380)	c
381)	a	382)	b	383)	a	384)	b
385)	b	386)	d	387)	b	388)	c
389)	a	390)	c	391)	c	392)	c
393)	a	394)	c	395)	b	396)	b
397)	a	398)	a	399)	b	400)	a
401)	b	402)	d	403)	b	404)	b
405)	c	406)	c	407)	a	408)	b
409)	b	410)	b	411)	a	412)	c
413)	c	414)	c	415)	d	416)	b
417)	d	418)	d	419)	b	420)	c
421)	c	422)	a	423)	a	424)	c
425)	a	426)	c	427)	b	428)	c
429)	c	430)	d	431)	d	432)	d
433)	b	434)	d	435)	b	436)	c
437)	c	438)	b	439)	a	440)	d
441)	b	442)	b	443)	b	444)	b
445)	b	446)	a	447)	b	448)	a
449)	d	450)	d	451)	d	452)	a
453)	a	454)	c	455)	a	456)	d
457)	a	458)	b	459)	b	460)	b
461)	c	462)	c	463)	c	464)	c
465)	b	466)	b	467)	a	468)	c
469)	b	470)	b	471)	b	472)	c
473)	a	474)	c	475)	b	476)	a
477)	a	478)	c	479)	a	480)	a
481)	c	482)	d	483)	a	484)	c
485)	c	486)	a	487)	b	488)	b
489)	c	490)	b	491)	d	492)	c
493)	a	494)	d	495)	b	496)	c
497)	b	498)	d	499)	d	500)	d
501)	a	502)	c	503)	a	504)	c
505)	b	506)	a	507)	c	508)	d
509)	d	510)	a	511)	a	512)	a
513)	b	514)	a	515)	a	516)	c
517)	d	518)	a	519)	c	520)	c
521)	b	522)	a	523)	c	524)	c
525)	a	526)	a	527)	a	528)	b
529)	a	530)	a	531)	c	532)	d
533)	d	534)	a	535)	c	536)	b

537)	d	538)	d	539)	b	540)	d
541)	d	542)	a	543)	a	544)	b
545)	d	546)	d	547)	b	548)	b
549)	c	550)	a	551)	b	552)	b
553)	a	554)	b	555)	b	556)	c
557)	b	558)	b				

: HINTS AND SOLUTIONS :

1 **(a)**

The rate of heat loss is proportional to the difference in temperature. The difference of temperature between the tea in cup A and the surrounding is reduced, so it loses less heat. The tea in cup B loses more heat because of large temperature difference. Hence the tea in cup A will be hotter

2 **(a)**

The Stefan's law,

$E=\sigma T^4$ where σ is Stefan's constant,

Given, $T_1=27\,℃=27+273=300$ K

$T_2=84\,℃=273+84=357$ K

$\therefore \quad \frac{E_1}{E_2}=\frac{T_1^4}{T_2^4}$

¿ $\frac{(300)^4}{(357)^4}=\frac{1}{(1.19)^4}$

Rate of increase of energy is

$$\frac{E_2}{E_1}=(1.19)^4=2$$

3 **(d)**

$$E \propto A T^4 \Rightarrow \frac{E_{sphere}}{E_{Disc}}=\frac{4\pi r^2}{2\pi r^2}\times\left(\frac{T}{T}\right)^4=\frac{2}{1}$$

4 **(a)**

Here, $\alpha(steel)=1.1\times10^{-5}\,℃^{-1}$

$\alpha(copper)=1.7\times10^{-5}\,℃^{-1}$

$\frac{l_0(s)}{l_0(c)}=\frac{\alpha(c)}{\alpha(s)}=\frac{1.7\times10^{-5}}{1.1\times10^{-5}}=1.545$

$\therefore l_0(s)=1.545\,l_0(c)$

Also, $l_0(s)-l_0(c)=5$

$0.545 l_0(c)=5$

$l_0(c)=\frac{5}{0.545}=9.17\,cm$

And $l_0(s)=1.545\times9.17\,cm\,14.17\,cm$

6 **(b)**

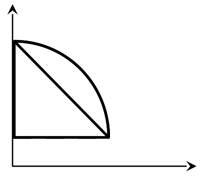
$$K_1:K_2=l_1^2:l_2^2\Rightarrow\frac{l_1}{l_2}=\sqrt{\frac{K_1}{K_2}}=\sqrt{\frac{10}{9}}=\frac{\sqrt{10}}{3}$$

7 **(c)**

$$\frac{T_2}{T_1}=\frac{\lambda_{m_1}}{\lambda_{m_2}}=\frac{1.75}{14.35}\Rightarrow T_2=\frac{1.75}{14.35}\times1640=200\,K$$

8 **(b)**

According to Newton's law of cooling



Rate of cooling ∝ Temperature difference

$\Rightarrow-\frac{d\theta}{dt}\propto(\theta-\theta_0)\Rightarrow-\frac{d\theta}{dt}=\alpha(\theta-\theta_0)$ ¿ constant]

$\Rightarrow\int_{\theta_1}^{\theta}\frac{d\theta}{(\theta-\theta_0)}=-\alpha\int_0^1 dt\Rightarrow\theta=\theta_0+(\theta_1-\theta_0)e^{-\alpha t}$

This relation tells us that, temperature of the body varies exponentially with time from θ_1 to θ_0

Hence graph (b) is correct

9 **(a)**

For small difference of temperature, it is the special case of Stefan's law

10 **(c)**

$$\frac{E_2}{E_1}=\left(\frac{T_2}{T_1}\right)^4\Rightarrow\frac{E_2}{20}=\left(\frac{2T}{T}\right)^4=16\Rightarrow E_2=320\,kcal/m^2\,\imath$$

11 **(c)**

All wavelength are emitted

12 **(c)**

Temperature of liquid oxygen will first increase in the same phase. The phase change (liquid to gas) will take place. During which temperature will remain constant. After that temperature of oxygen in gaseous state will further increase.

13 **(d)**

$W=JQ\Rightarrow(2m)gh=J\times m'c\Delta\theta$

$\Rightarrow2\times5\times10\times10=4.2(2\times1000\times\Delta\theta)$

$\Rightarrow\Delta\theta=0.1190\,℃=0.12\,℃$

14 **(d)**

Given $A_1=A_2$ and $\frac{K_1}{K_2}=\frac{5}{4}$

$\because R_1=R_2 \Rightarrow \frac{l_1}{K_1 A}=\frac{l_2}{K_2 A} \Rightarrow \frac{l_1}{l_2}=\frac{K_1}{K_2}=\frac{5}{4}$

15 **(d)**

$V=V_0(1+\gamma\Delta\theta) \Rightarrow Change \in volume$

$V-V_0=\Delta V=A.\Delta l=V_0\gamma\Delta\theta$

$\Rightarrow \Delta l=\frac{V_0.\gamma\Delta\theta}{A}=\frac{10^{-6}\times 18\times 10^{-5}\times(100-0)}{0.004\times 10^{-4}}$

¿$45\times 10^{-3} m=4.5 cm$

16 **(d)**

According to Kirchhoff's law the ratio of emissive power to absorptive power is same for all surfaces at the same temperature and is equal to the emissive power of a perfectly black body at that temperature

Hence, $\frac{e_1}{a_1}=\frac{e_2}{a_2}=\ldots\left[\frac{E}{A}\right]_{perfectly ¿} body ¿$

Now, since $(E\lambda)_{¿}$ is constant at a given temperature, this implies that good absorber is a good emitter (or radiator).

17 **(b)**

When water falls from a height, it has potential energy (*mgh*),

this is used in heating up the water ($mc\,\Delta\theta$).

Hence, we have

$$mg\,h=mc\Delta\theta$$

$\Rightarrow \Delta\theta=\frac{gh}{c}$

¿$\frac{9.8\times 500}{4.2\times 10^3}=1.16\,℃$

18 **(d)**

The moment of inertia of a solid sphere about the axis along its diameter is

$$I=\frac{2}{5}mR^2 \Rightarrow I \propto R^2$$

$\therefore \quad \frac{\Delta I}{I}\times 100=2\left[\frac{\Delta R}{R}\right]100$

But $\quad \alpha=\frac{\Delta R}{R\times\Delta t} \Rightarrow \frac{\Delta R}{R}=\alpha\Delta t$

$\therefore \quad \frac{\Delta I}{I}\times 100=2(\alpha)(\Delta t)100$

$= 2(10^{-5})(200)(100)$

$= 0.4\%$

19 **(a)**

We know $\lambda_{max}T=b$

$\Rightarrow T=\frac{b}{\lambda_{max}}=\frac{2898\times 10^{-6}}{289.8\times 10^{-9}}=10^4 K$

According to Stefan's law

$E=\sigma T^4=(5.67\times 10^{-8})(10^4)^4=5.67\times 10^8 W/m^2$

20 **(b)**

In vapor to liquid phase transition, heat liberates

21 **(d)**

Black and rough surfaces are good absorber that's why they emit well. (Kirchhoff's law)

22 **(a)**

Rate of heat loss per unit area due to radiation *i.e.* emissive power $e=\varepsilon\sigma(T^4-T_0^4)$

¿$0.6\times\frac{17}{3}\times 10^{-8}\times[(400)^4-(300)^4]$

¿$3.4\times 10^{-8}\times(175\times 10^8)=3.4\times 175=595\,J/m^2\times s$

23 **(d)**

For the two sheets $H_1=H_2$¿ Rate of heat flow]

$\Rightarrow \frac{(100-\theta)}{R}=\frac{(\theta-20)}{3R} \Rightarrow \theta=80\,℃$

24 **(a)**

$\frac{\Delta T}{\Delta t}=KA\left(\frac{\Delta T}{\Delta x}\right)=K(\pi r^2)\frac{\Delta T}{(l)}$

$\therefore \left(\frac{\Delta Q}{\Delta t}\right)\propto\frac{r^2}{l}$, which is maximum in case (a).

25 **(b)**

The formula for rate of cooling is given by ¿$\frac{mc\theta}{t}$

As, mass = volume × density

Mass of sphere ¿$\frac{4}{3}\pi r^3\times\rho$, where ρ is density

Mass of unit area ¿$\frac{\frac{4}{3}\pi r^3\times\rho}{4\pi r^2}=\frac{1}{3}r\rho$

Hence, rate of cooling per unit area must be proportional to $r\rho$, (here r is the radius of sphere and ρ is the density

Hence, ratio of rate of cooling for two spheres is

¿$\frac{r_1\rho_1}{r_2\rho_2}$

Where, $r_1:r_2=1:2$ and $\rho_1:\rho_2=2:1$

¿$\frac{1}{2}\times\frac{2}{1}=1:1$

27 **(c)**

Heat given for raising the temperature of W g of water from

$0\,℃ ¿ 100\,℃=W\times 1\times 100\,cal$

Time taken = $10\times 60\,s$.

$\therefore Heat\ given\ per\ second = \frac{W \times 1 \times 100}{10 \times 60}$ cal

Heat given out to convert W g to steam = $W \times L$

This is the heat supplied in $55 \times 60\ s$

$\therefore Heat\ given = 100 \times W \times \frac{55 \times 60}{10 \times 60} = WL$

$\therefore L = \frac{100 \times 55 \times 60}{10 \times 60} = 100 \times 5.5$

$L = 550\, cal\, g^{-1}$

28 **(d)**

As batteries wear out, temperature of filament of flash light attains a lesser value, therefore intensity of radiation reduces. Also dominating wavelength (λ_m) in spectrum, which is the red colour, increases.

29 **(b)**

$E_2 = E_1 \frac{T_2^4}{T_1^4} = Q \times \frac{(273+151)^4}{(273+27)^4} = \left(\frac{424}{300}\right)^4 = 3.99\, Q = 4$

30 **(c)**

Increase in area of disc

$\Delta A = A(2\alpha)\Delta t$

$= \pi(0.5)^2(2 \times 11 \times 10^{-6}) \times 10$

$= 0.000055\,\pi$

New area of the disc,

$A' = A + \Delta A$

$\therefore A' = \pi(0.5)^2 + 0.000055\,\pi$

Or $\pi r'^2 = 0.250055\,\pi\, m^2$

Or $r'^2 = 0.500055\, m$

Increase in moment of inertia,

$\frac{I' - I}{I} = \frac{(0.500055)^2 - (0.5)^2}{(0.5)^2}$

$= 0.00022 = 0.022\%$

31 **(c)**

The densest layer of water will be at bottom. The density of water is maximum at $4\ ℃$. So the temperature of bottom of lake will be $4\ ℃$

32 **(a)**

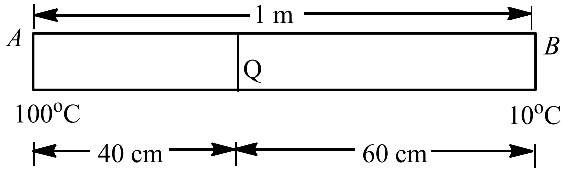
$\frac{E_1}{E_2} = \left(\frac{T_1}{T_2}\right)^4 \Rightarrow \frac{E}{E_2} = \left(\frac{273+0}{273+273}\right)^4 \Rightarrow E_2 = 16\,E$

33 **(b)**

As $\alpha_B > \alpha_A$, therefore, strip B will appear on outer side.

34 **(a)**

The situation is given in the figure. Let θ be the temperature at point C.



We know that the rate flow of heat

$\frac{Q}{t} = \frac{KA(\theta_1 - \theta_2)}{d}$

Here, K= coefficient of thermal conductivity

A=area of cross-section

$\Rightarrow \frac{KA(100-\theta)}{40} = \frac{KA(\theta - 10)}{60}$

$\frac{100-\theta}{2} = \frac{\theta - 10}{3}$

$300 - 3\theta = 2\theta - 20$

$5\theta = 320$

$\theta = \frac{320}{5}$

$\theta = 64\ ℃$

35 **(b)**

According to Newton's law of cooling

$\frac{\theta_1 - \theta_2}{t} = K\left[\frac{\theta_1 + \theta_2}{2} - \theta_0\right]$

In the first case,

$\Rightarrow \frac{80-64}{5} = K\left[\frac{80+64}{2} - \theta_0\right]$

$\Rightarrow 3.2 = K[72 - \theta_0]$ …(i)

In the second case,

$\Rightarrow \frac{64-52}{5} = K\left[\frac{64+52}{2} - \theta_0\right]$

$\Rightarrow 2.4 = K[58 - \theta_0]$ …(ii)

Dividing Eq. (i) by Eq. (ii), we get

$\frac{3.2}{2.4} = \frac{72-\theta_0}{58-\theta_0}$

$185.6 - 3.2\theta_0 = 172.8 - 2.4\,\theta_0$

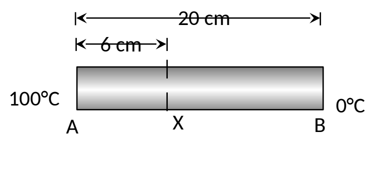
$\Rightarrow \theta_0 = 16\ ℃$

36 **(a)**

A perfectly black body is a good absorber of radiations falls on it. So it's absorptive power is 1

37 **(b)**

In steady state, temperature gradient = constant



$$\Rightarrow \frac{(\theta_A - \theta_x)}{6} = \frac{(\theta_A - \theta_B)}{20} \Rightarrow (100 - \theta_x) = \frac{6}{20} \times (100 - ($$

$$\Rightarrow \theta_x = 70\,°C$$

38 **(a)**

In vacuum heat flows by the radiation mode only

39 **(b)**

In summer alcohol expands, density decreases. So 1 litre of alcohol will weigh less in summer than in winter

40 **(a)**

Rate of cooling $\frac{\Delta\theta}{t}=\frac{A\varepsilon\sigma(T^4-T_0^4)}{mc}$

As surface area, material and temperature difference are same, so rate of loss of heat is same in both, the spheres. Now in this case rate of cooling depends on mass

$\Rightarrow$ Rate of cooling $\frac{\Delta\theta}{t}\propto\frac{1}{m}$

$\because m_{solid}>m_{hollow}$. Hence hollow sphere will cool fast

41 **(d)**

$T=273.15+t\,℃\Rightarrow 0=273.15+t\,℃$

$\Rightarrow t=-273.15\,℃$

42 **(a)**

If l_t be length of rod at $t\,℃$ and l_0 at $0\,℃$, then

$l_t=l_0(1+\alpha t)$

Where α is coefficient of linear expansion.

$\Rightarrow l_t$ is proportional to α. Since $\alpha_c>\alpha_s$, therefore copper will expand more, so rod bends with copper on convex side and steel on concave side.

43 **(a)**

$As\,\alpha=\frac{\beta}{2}=\frac{\gamma}{3}\Rightarrow\alpha:\beta:\gamma=1:2:3$

44 **(b)**

During clear nights object on surface of earth radiate out heat and temperature falls. Hence option (a) is wrong

The total energy radiated by a body per unit time per unit area $E\propto T^4$. Hence option (c) is wrong

Energy radiated per second is given by $\frac{Q}{t}=PA\varepsilon\sigma T^4$

$\Rightarrow\frac{P_1}{P_2}=\frac{A_1}{A_2}\cdot\left(\frac{T_1}{T_2}\right)^4=\left(\frac{r_1}{r_2}\right)^2\cdot\left(\frac{T_1}{T_2}\right)^4=\left(\frac{1}{4}\right)^2\left(\frac{4000}{200}\right)=\frac{1}{1}$

$\because P_1=P_2$, hence option (d) is wrong

Newton's law is an approximate form of Stefan's law of radiation and works well for natural convection. Hence option (b) is correct

45 **(c)**

$\frac{A-42}{110}=\frac{B-72}{220}$

$\frac{A-42}{110}=\frac{A-72}{220}$

2A−¿84=A−¿72

A=12

46 **(c)**

We know that thermal capacity of a body expressed in calories is equal to water equivalent of the body expressed in grams

47 **(d)**

Thermal capacity ¿ $mc=40\times0.2=8\,cal/℃$

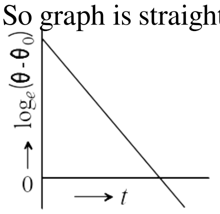
51 **(a)**

$\frac{d\theta}{dt}=-k(\theta-\theta_0)$

$\int_{\theta_0}^{\theta}\frac{d\theta}{\theta-\theta_0}=-k\int_0^t dt$

$\ln|\theta-\theta_0|=-kt+C$

So graph is straight line



52 **(a)**

The volume of matter in portion AB of the curve is almost constant and pressure is decreasing. These are the characteristics of liquid state

53 **(d)**

According to Stefan's law $E=\sigma T^4$

$\Rightarrow\ln E=\ln\sigma+4\ln T\Rightarrow\ln E=4\ln T+\ln\sigma$

On comparing this equation with $y=mx+C$

We find that graph between $\ln E$ and $\ln T$ will be a straight line, having positive slope $(m=4)$ and intercept on $\ln E$ axis equal to $\ln\sigma$

54 **(c)**

Energy supplied

¿ $0.93\times3600\,joules=3348\,joules$

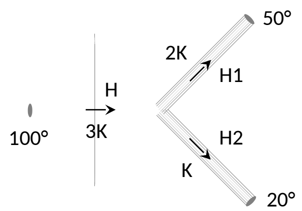
Heat required to melt $10\,gms$ of ice

¿ $10\times80\times4.18=3344\,joules$

Hence block of ice just melts

55 **(b)**

Let the temperature of junction be θ then according to the following figure



$H=H_1+H_2$

$\Rightarrow\frac{3K\times A\times(100-\theta)}{l}=\frac{2KA(\theta-50)}{l}+\frac{KA(\theta-20)}{l}$

$\Rightarrow 300-3\theta=3\theta-120\Rightarrow\theta=70\,℃$

56 **(b)**

Melting point of ice decreases with increase in pressure (as ice expands on solidification)

57 **(b)**

The surface temperature of the stars is determined using Wien's displacement law. According to this (law)$\lambda_m T = b$ where b is Wien's constant whose value is 2.898×10^{-3} mK.

58 **(d)**

From Stefan's law of radiation,

$$E \propto T^4 \Rightarrow \frac{E_1}{E_2} = \frac{T_1^4}{T_2^4}$$

Given, $T_1 = T, T_2 = 2T$

$$\therefore \quad \frac{E_1}{E_2} = \frac{(T)^4}{(2T)^4} = \frac{1}{2^4} = \frac{1}{16}$$

$$E_2 = 16E_1$$

Heat taken by water from radiation

$$E = mc\Delta\theta$$

Where c is specific heat, $\Delta\theta$ the change in temperature and $m$the mass.

$$\therefore \quad E = m \times 1 \times (20.5 - 20)$$

$$E = m \times 0.5 \quad \ldots$$

(i)

When energy supplied is 16 times the previous one, then let temperature rise to θ'

$$\therefore 16E = m \times 1 \times (\theta' - 20) \quad \ldots(ii)$$

Dividing Eq. (i) by (ii), we get

$$\frac{1}{16} = \frac{0.5}{\theta' - 20}$$

$$\Rightarrow \theta' - 20 = 16 \times 0.5 = 8$$

$$\Rightarrow \theta' = 20 + 8 = 28\,℃$$

59 **(c)**

Convection significantly transfer heat upwards (Gravity effect)

60 **(b)**

$$\lambda_{m_2} = \frac{T_1}{T_2} \times \lambda_{m_1} = \frac{2000}{3000} \times \lambda_{m_1} = \frac{2}{3}\lambda_{m_1} = \frac{2}{3}\lambda_m$$

61 **(c)**

From given curve,

Melting point for $A = 60\,℃$

And melting point for $B = 20\,℃$

Time taken by A for fusion $¿(6-2) = 4$ minute

Time taken by B for fusion $¿(6.5-4) = 2.5$ minute

Then $\frac{H_A}{H_B} = \frac{6 \times 4 \times 60}{6 \times 2.5 \times 60} = \frac{8}{5}$

62 **(d)**

According to Stefan's law,

$$E \propto T^4$$

or $\frac{E_2}{E_1} = \left(\frac{T_2}{T_1}\right)^4$

or $\frac{E_2}{E} = \left(\frac{T/2}{T}\right)^4 = \left(\frac{1}{2}\right)^4$

or $E_2 = \frac{E}{16}$

63 **(c)**

As is clear from figure.

$$\frac{dQ}{dt} = \frac{dQ_1}{dt} + \frac{dQ_2}{dt}$$

$$\frac{K(A_1 + A_2)dT}{dx} = K_1 A_1 \frac{dT}{dx} + K_2 A_2 \frac{dT}{dx}$$

$$K = \frac{K_1 A_1 + K_2 A_2}{A_1 + A_2}$$

64 **(c)**

The Stefan's law,

$E = \sigma T^4$

Given, $T_1 = 227\,℃ = 227 + 273 = 500$ K

$T_2 = 727\,℃ = 273 + 727 = 1000$ K

$$\therefore \quad \frac{E_1}{E_2} = \frac{T_1^4}{T_2^4}$$

$$\Rightarrow \quad E_2 = \frac{T_2^4}{T_2^4} E_1$$

$$E_2 = \frac{(1000)^4}{(500)^4} \times 20$$

$E_2 = 16 \times 20$

$E_2 = 320\, cal\, m^{-2} s^{-1}$

65 **(d)**

$$\lambda_m T = 2892 \times 10^{-6} \Rightarrow T = \frac{2892 \times 10^{-6}}{14.46 \times 10^{-6}} = 200\,K$$

66 **(d)**

Growth of ice in a pond is conduction process governed by the relation $t = \frac{\rho L}{K\theta}\frac{y^2}{2}$

The ratio of times for thickness of ice from 0 to y ; $y ¿ 2y$ = 1 : 3

∴Time taken to increase the thickness from 1 cm to 2 cm is equal to $3 \times 7 = 21$h.

67 **(d)**

$$\frac{Q}{t} = P = A\varepsilon\sigma T^4$$

68 **(c)**

When a copper ball is heated, it's size increases. As Volume $\propto (radius)^3$ and Area $\propto (radius)^2$, so percentage increase will be largest in it's volume. Density will decrease with rise in temperature

69 **(b)**

$$\frac{Q_2}{Q_1}=\left(\frac{r_2^2}{r_1^2}\right)^2\times\left(\frac{T_2}{T_1}\right)^4=\left(\frac{100}{1}\right)^2\times\left(\frac{1}{2}\right)^4=625$$

70 **(c)**

Total energy radiated from a body

$$Q=A\varepsilon\sigma T^4 t$$

$$\Rightarrow \quad Q\propto AT^4\propto r^2T^4 \quad (\therefore A=4\pi r^2)$$

$$\Rightarrow \quad \frac{Q_P}{Q_Q}=\left(\frac{r_P}{r_Q}\right)^2\left(\frac{T_P}{T_Q}\right)^4$$

$$¿\left(\frac{8}{2}\right)^2\left[\frac{(273+127)}{(273+527)}\right]^4=1$$

71 **(a)**

With temperature rise (same $20\,℃$ for both), steel scale and copper wire both expand. Hence length of copper wire $w.r.t.$ steel scale or apparent length of copper wire after rise in temperature

$$L_{app}=L'_{cu}-L'_{steel}=[L_0(1+\alpha_{Cu}\Delta\theta)-L_0(1+\alpha_s\Delta\theta)]$$

$$\Rightarrow L_{app}=L_0(\alpha_{Cu}-\alpha_s)\Delta\theta$$

$$¿80(17\times10^{-6}-11\times10^{-6})\times20=0.0096\,cm$$

$\therefore$ Length of the wire read $¿80.0096\,cm$

72 **(c)**

Let n slabs each of length l, areas $A_1, A_2, A_3, \ldots\ldots, A_n$ and thermal conductivities $K_1, K_2, K_3, \ldots\ldots, K_n$ are connected in parallel, then,

$$K_{eq}=\frac{K_1+K_2+K_3+\ldots+K_n}{n}$$

For two slabs of equal area $K_{eq}=\dfrac{K_1+K_2}{2}$

73 **(c)**

Ist case

$$ms_A(t-t_A)=ms_B(t_B-t)$$

$$s_A(16-12)=s_B(19-16)$$

$$4s_A=3s_B$$

IInd case

$$ms_B(t-t_B)=ms_C(t_C-t)$$

$$s_B(23-19)=s_C(28-23)$$

$$4s_B=5s_C$$

$$3s_B=\frac{15}{4}s_C$$

$$\therefore \quad 4s_A=3s_B=\frac{15}{4}s_C$$

$$\Rightarrow \quad 16s_A=12s_B=15s_C=k$$

$$s_A:s_B:s_C=\frac{1}{16}:\frac{1}{12}:\frac{1}{15}$$

$$s_A=\frac{k}{16}\ ,\quad s_C=\frac{k}{15}$$

When A and C are mixed

$$ms_A(t-t_A)=ms_C(t_C-t)$$

$$\frac{k}{16}(t-12)=\frac{k}{15}(28-t)$$

$$15t-180=448-16t$$

$$31t=628$$

$$\Rightarrow \quad t=20.2\,℃$$

74 **(a)**

According to energy conservation, change in kinetic energy appears in the form of heat (thermal energy) $\Rightarrow i.e.$ Thermal energy

$$¿\frac{1}{2}m(v_1^2-v_2^2)\left[\because \frac{W}{(Joule)}=\frac{Q}{(Joule)}\right]$$

$$¿\frac{1}{2}(100\times10^{-3})(10^2-5^2)=3.75\,J$$

75 **(c)**

Open window behaves like a perfectly black body

76 **(b)**

Temperature of water just below the lower surface of ice layer is $0\,℃$

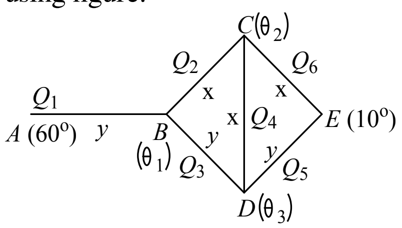
77 **(b)**

Let L be the length of each rod.

Temperature of $A=60\,℃$ temperature of $E=10\,℃$

Let $\theta_1, \theta_2, \theta_3$ be respective temperature of B, C, D.

If $Q_1, Q_2, Q_3, Q_4, Q_5, Q_6$ are the amounts of heat following/sec respectively from $A¿B; B¿C; B¿D; C¿D; D¿E \wedge C¿E,$ then using figure.



$$Q_1=\frac{0.46\,A(60-\theta_1)}{L},\ Q_2=\frac{0.92\,A(\theta_1-\theta_2)}{L}$$

$$Q_3=\frac{0.46\,A(\theta_1-\theta_3)}{L},\ Q_4=\frac{0.92\,A(\theta_2-\theta_3)}{L}$$

$$Q_5=\frac{0.46\,A(\theta_3-10)}{L},\ Q_6=\frac{0.92\,A(\theta_2-10)}{L}$$

Now $Q_1=Q_2+Q_3$

$$\frac{0.46\,A(60-\theta_1)}{L}=\frac{0.92\,A(\theta_1-\theta_2)}{L}+\frac{0.46\,A(\theta_1-\theta_3)}{L}$$

$60-\theta_1=2(\theta_1-\theta_2)+\theta_1-\theta_3$

Or $4\theta_1=2\theta_2-\theta_3=60°$ ……(i)

Again , $Q_2=Q_4+Q_6$ gives

$\theta_1-3\theta_2-\theta_3=10^{\circ}$ …..(ii)

Again, $Q_5=Q_3+Q_4$given

$\theta_1+2\theta_2-4\theta_3=-10°$ …..(iii)

Solving Eqs.(i), (ii) and (iii), we get

$\theta_1=30℃, \theta_2=20℃, \theta_3=20℃$

78 **(c)**

Let $F=K-X$

As $\frac{F-32}{9}=\frac{K-273}{5}$

$\therefore \frac{x-32}{9}=\frac{x-273}{5}$

$9x-2457=5x-160$

$4x-2457+160=0$

$x=\frac{2297}{4}=574.25°$

79 **(b)**

$c=\frac{Q}{m.\Delta\theta}; as\, \Delta\theta=0$, hence c becomes ∞

80 **(c)**

When the temperature of black body becomes equal to the temperature of the furnace, the black body will radiate maximum energy and it will be brightest of all. Initially it will absorb all the radiant energy incident on it. So, it is the darkest one.

81 **(d)**

Radiated power by blackbody $P=\frac{Q}{t}=A\sigma T^4$

$\Rightarrow P\propto AT^4\propto r^2T^4 \Rightarrow \frac{P_1}{P_2}=\left(\frac{r_1}{r_2}\right)^2\left(\frac{T_1}{T_2}\right)^4$

$\Rightarrow \frac{440}{P_2}=\left(\frac{12}{6}\right)^2\left(\frac{500}{1000}\right)^4 \Rightarrow P_2=1760\,W\approx1800\,W$

82 **(c)**

Temperature of interface

$\theta=\frac{K_1\theta_1 l_2+K_2\theta_2 l_1}{K_1 l_2+K_2 l_1}=\frac{K\times0\times2+3K\times100\times1}{K\times2+3K\times1}$

¿ $\frac{300K}{5K}=60℃$

83 **(c)**

Linear expansion

$\Delta L=\alpha V\Delta T=\frac{FL}{AY}$

Stress ¿ $\frac{F}{A}=\gamma\alpha\Delta T$

84 **(d)**

Density of water is maximum at $4℃$. In both heating and cooling of water from this temperature, level of water rises due to decrease in density, $i.e.$, water will over flow in both A and B

85 **(b)**

As we know $\gamma_{real}=\gamma_{app.}+\gamma_{vessel}$

$\Rightarrow \gamma_{app.}=\gamma_{glycerine}-\gamma_{glass}$

¿ $0.000597-0.000027=0.00057$ ¿ ^oC

86 **(c)**

Heat current, $\frac{dQ}{dt}=L.\left(\frac{dm}{dt}\right)$

Or $\frac{Temperature\,difference}{Thermal\,resistance}=L.\left(\frac{dm}{dt}\right)$

Or $\left(\frac{dm}{dt}\right)\propto\frac{1}{Thermal\,resistance}$

Or $q\propto\frac{1}{R}$

In the first case rods are in parallel and thermal resistance is $\frac{R}{2}$ while in second case rods are in series and thermal resistance is $2R$.

$\therefore \frac{q_1}{q_2}=\frac{2R}{R/2}=\frac{4}{1}$

87 **(d)**

A good absorber is a good emitter hence option (a) is wrong. Every body stops absorbing and emitting radiation at $0K$ hence option (b) is wrong

The energy of radiation emitted from a black body is not same for all wavelength hence (c) is wrong

Plank's law relates the wavelength (λ) and temperature (T) according to the relation

$E_\lambda d_\lambda=\frac{8\pi hc}{\lambda^5}\frac{1}{[e^{hc/kT}-1]}d_\lambda$

Hence option (d) is correct

88 **(c)**

From, $l_2=l_1[1+\alpha(t_2-t_1)]$

$t_2=t_1+\frac{l_2-l_1}{l_1\alpha}$

$=20+\frac{-10^{-3}}{1.0\times2\times10^{-5}}=-30℃$

89 **(b)**

Thermoelectric thermometer is based on Seebeck Effect

91 **(d)**

$$\frac{Q_1}{Q_2}=\frac{T_1^4}{T_2^4}=\left(\frac{273+27}{273+127}\right)^4=\left(\frac{300}{400}\right)^4=\frac{81}{256}$$

92 **(b)**

Rate of cooling $(R)=\frac{\Delta\theta}{t}=\frac{A\epsilon\sigma(T^4-T_0^4)}{mc}$

$$\Rightarrow R\propto\frac{A}{m}\propto\frac{Area}{Volume}\propto\frac{r^2}{r^3}\propto\frac{1}{r}$$

$$\Rightarrow Rate(R)\propto\frac{1}{r}\propto\frac{1}{m^{1/3}}\left[\because m=\rho\times\frac{4}{3}\pi r^3\Rightarrow r\propto m^{1/3}\right]$$

$$\Rightarrow\frac{R_1}{R_2}=\left(\frac{m_2}{m_1}\right)^{1/3}=\left(\frac{1}{3}\right)^{1/3}$$

93 **(b)**

Wavelength of radiation $\lambda_1=12000\,\text{Å}$

Temperature of star $T_1=2600\,K$

Wavelength of star spectrum $\lambda_2=5000\,\text{Å}$

Temperature of star $T_2=?$

From Wien law

$$\lambda_1 T_1=\lambda_2 T_2$$

$$T_2=\frac{\lambda_1 T_1}{\lambda_2}$$

¿ $\frac{12000\times 2600}{5000}$

$$T_2=6240\,K$$

94 **(a)**

According to the question,

$$\frac{1}{2}\times\frac{1}{2}mv^2=m\times s\times\Delta T$$

$$\frac{1}{4}m\times 4\times 10^4=125\times m\times\Delta T$$

$$\Delta T=\frac{4\times 10^4}{500}=80\,°C$$

95 **(a)**

Here, $p_0=50\,cm,\,p_{100}=90\,cm,\,p_t=60\,cm$

$$t=\frac{p_t-p_0}{p_{100}-p_0}\times 100=\frac{(60-50)\times 100}{(90-50)}=25\,°C$$

96 **(d)**

According to Newton’s law of cooling

$$\frac{\theta_2-\theta_1}{t}=K\left[\frac{\theta_1+\theta_2}{2}-\theta_s\right]$$

Where, θ_s is the temperature of the surroundings.

$$\frac{60-50}{10}=K\left[\frac{60+50}{2}-\theta_s\right]$$

$$1=K[55-\theta_s]$$

…(i)

Similarly, $\frac{50-42}{10}=K(46-\theta_s)$

$$\frac{8}{10}=K(46-\theta_s)$$

…(ii)

Dividing Eq. (i) by Eq. (ii), we get

$$\frac{10}{8}=\frac{K(55-\theta_s)}{K(46-\theta_s)}$$

$\Rightarrow \qquad \theta_s=10\,°C$

97 **(c)**

According to Kirchhoff's law, a good emitter is also a good absorber

98 **(d)**

$$R_{th}=\frac{\Delta T}{(\Delta Q/\Delta t)}=\frac{\Delta x}{KA}=\frac{l}{KA}$$

99 **(b)**

$$\lambda_m T=\lambda_m' T' \Rightarrow \frac{\lambda_m}{\lambda_m'}=\frac{T'}{T}=\frac{3000}{2000}=\frac{3}{2}$$

100 **(a)**

Time period, $T=2\pi\sqrt{\frac{1}{g}}$

$$\frac{\Delta T}{T}=\frac{1}{2}\frac{\Delta l}{l}=\frac{1}{2}\alpha\,\Delta\theta$$

$$=\frac{1}{2}\times 12\times 10^{-6}(40-20)=12\times 10^{-5}$$

$$\Delta T=T\times 12\times 10^{-5}$$

$= 24\times 60\times 60\times 12\times 10^{-5}$

$= 10.3$ s day^{-1}

101 **(d)**

Increase of vapour pressure increases the boiling point of water.

102 **(a)**

Temperature gradient

$$\frac{d\theta}{dx}=\frac{(125-25)°C}{50\,cm}=2\,°C/cm$$

103 **(d)**

According to Wien's law

$$\lambda_m \propto \frac{1}{T}$$

And from the figure

$$(\lambda_m)_1<(\lambda_m)_3<(\lambda_m)_2$$

Therefore, $\quad T_1>T_3>T_2$

104 **(b)**

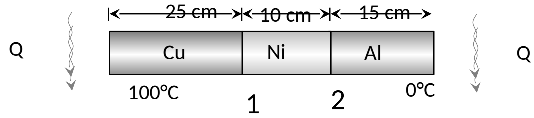
If suppose $K_{¿}=K \Rightarrow K_{Al}=3K$ and $K_{Cu}=6K$

Since all metal bars are connected in series

So $\left(\frac{Q}{t}\right)_{Combination}=\left(\frac{Q}{t}\right)_{Cu}=\left(\frac{Q}{t}\right)_{Al}=\left(\frac{Q}{t}\right)_{¿}$

¿ $\frac{3}{K_{eq}}=\frac{1}{K_{Cu}}+\frac{1}{K_{Al}}+\frac{1}{K_{¿}}=\frac{1}{6K}+\frac{1}{3K}+\frac{1}{K}=\frac{9}{6K}$

$\Rightarrow K_{eq}=2K$



Hence, it $\left(\frac{Q}{t}\right)_{Combination}=\left(\frac{Q}{t}\right)_{Cu}$

$$\Rightarrow \frac{K_{eq}A(100-0)}{l_{Combination}}=\frac{K_{Cu}A(100-\theta_1)}{l_{Cu}}$$

$$\Rightarrow \frac{2K\,A(100-0)}{(25+10+15)}=\frac{6K\,A(100-\theta_1)}{25}\Rightarrow \theta_1=83.33$$

Similar if $\left(\frac{Q}{t}\right)_{Combination}=\left(\frac{Q}{t}\right)_{Al}$

$$\Rightarrow \frac{2K\,A(100-0)}{50}=\frac{3K\,A(\theta_2-0)}{15}\Rightarrow \theta_2=20\,°C$$

105 **(b)**

If we fill nitrogen gas at high pressure above mercury level, the boiling point of mercury is increased which can extend the range upto $500°C$.

106 **(c)**

Since specific heat

¿ $0.6\,kcal/g\times °C=0.6\,cal/g\times °C$

From graph it is clear that in a minute, the temperature is raised from $0\,°C$ to $50\,°C$.

$\Rightarrow$ Heat required for a minute

¿ $50\times 0.6\times 50=1500\,cal$

Also from graph, Boiling point of wax is $200\,°C$

107 **(d)**

We know that when solid carbondioxide is heated, it becomes vapour directly without passing through its liquid phase. Therefore it is called dry ice

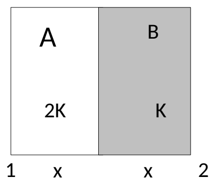
108 **(b)**

Suppose conductivity of layer B is K, then it is $2K$ for layer A. Also conductivity of combination layers

A and B is $K_S=\frac{2\times 2K\times K}{(2K+K)}=\frac{4}{3}K$

Hence $\left(\frac{Q}{t}\right)_{Combination}=\left(\frac{Q}{t}\right)_{A}$

$$\Rightarrow \frac{4}{3}\frac{KA\times 60}{2x}=\frac{2K.A\times(\Delta\theta)_A}{x}\Rightarrow (\Delta\theta)_A=20\,K$$



109 **(a)**

Boiling occurs when the vapour pressure of liquid becomes equal to the atmospheric pressure. At the surface of moon, atmospheric pressure is zero, hence boiling point decreases and water begins to boil at $30\,°C$

110 **(a)**

Temperature of interface

$$\theta=\frac{K_1\theta_1 l_2+K_2\theta_2 l_1}{K_1 l_2+K_2 l_1}$$

It is given that $K_{Cu}=9K_s$. So, if $K_s=K_1=K$, then

$$K_{Cu}=K_2=9K$$

$$\Rightarrow \quad \theta=\frac{9K\times 100\times 6+K\times 0\times 18}{9K\times 6+K\times 18}$$

$¿\dfrac{5400K}{72K}=75\,°C$

111 **(b)**

Power radiated,

$Q\propto AT^4 \wedge \lambda_m T=constant.Hence, Q\propto\dfrac{A}{(\lambda_m)^4}$

$Q\propto\dfrac{A}{(\lambda_m)^4}$

or $\quad Q\propto\dfrac{r^2}{(\lambda_m)^4}$

$$Q_A:Q_B:Q_C=\frac{(2)^2}{(3)^4}:\frac{(4)^2}{(4)^4}:\frac{(6)^2}{(5)^4}$$

$$¿\frac{4}{81}:\frac{1}{16}:\frac{36}{625}$$

= 0.05:0.0625:0.0576

$ie., Q_B$ is maximum.

112 **(a)**

Thermal stress is a measure of the internal distribution of force per unit area within body that is applied to the body, in the form of heat

Thermal stress=$Y\alpha\Delta T$

Where Y is Young's modulus, α the coefficient of linear expansion and ΔT the change in temperature

Both the rods are heated,

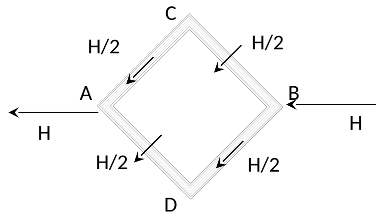
$\therefore \quad Y_1\alpha_1\Delta T_1=Y_2\alpha_2\Delta T_2$

Since, $\quad \Delta T_1=\Delta T_2$

$$\Rightarrow \quad \frac{Y_1}{Y_2}=\frac{\alpha_2}{\alpha_1}=\frac{3}{2}$$

113 **(a)**

Suppose temperature difference between A and B is $100\,°C$ and $\theta_A>\theta_B$



Heat current will flow from A and B via path ACB and ADB. Since all the rods are identical so $(\Delta\theta)_{AC}=(\Delta\theta)_{AD}$

[Because heat current $H=\dfrac{\Delta\theta}{R}$; here $R=¿$ same for all]

$\Rightarrow\theta_A-\theta_C=\theta_A-\theta_D\Rightarrow\theta_C-\theta_D$

$i.e.$ temperature difference between C and D will be zero

114 **(c)**

According to Wien's law, $\lambda_m T=¿$ constant

$\lambda_r>\lambda_y>\lambda_b\Rightarrow T_r<T_y$ or $T_A<T_C<T_B$

115 **(c)**

In first case

$$\frac{m\times s\times(61°-59°)}{4}=K\left[\left(\frac{(61°-59°)}{2}\right)-30°\right]$$

…(i)

In second case

$$\frac{m\times s\times(51°-49)}{t}=K\left[\left(\frac{(51°-49°)}{2}\right)-30°\right]$$

…(ii)

Dividing Eq.(i) by Eq.(ii), we obtain

$$\frac{t}{4}=\frac{30}{20}=\frac{3}{2}\vee t=6\,min$$

116 **(a)**

Red and green colours are complementary to each other. When red glass is heated it emits green light strongly, hence according to Kirchhoff's law, the emissive power of red glass should be maximum for green light. That's why when this heated red glass is taken in dark room it strongly emits green light and looks greenish

117 **(d)**

$$\frac{Q}{t}=\frac{KA\,\Delta\theta}{l}\Rightarrow\frac{Q}{t}\propto\frac{A}{l}\propto\frac{r^2}{l}$$

$\because\frac{r^2}{l}$ is maximum in option (d), hence it will conduct more heat

118 **(a)**

Rate of cooling $\frac{\Delta\theta}{t}=\frac{A\varepsilon\sigma\left(T^4-T_0^4\right)}{mc}\Rightarrow\frac{\Delta\theta}{t}\propto A.$

Since area of plate is largest so it will cool fastest

119 **(b)**

As we know

$$\alpha=\frac{\Delta L}{L_0\Delta\theta}\Rightarrow\Delta\theta=\frac{\Delta L}{\alpha L_0}=\frac{5\times10^{-5}}{10\times10^{-6}\times1}=5\,℃$$

120 **(c)**

According to Wien's displacement law

121 **(c)**

Rate of heat loss $E=\sigma eA\left(T^4-T_0^4\right)$

$5.67\times10^{-8}\times0.4\times200\times10^{-4}\times[(273+527)^4-(27$

$5.67\times10^{-8}\times0.4\times200\times10^{-4}\times(800)^4-(300)^4=18$

122 **(a)**

$Q=\frac{KA(\theta_1-\theta_2)t}{l}$; in both the cases, A, l and

$(\theta_1-\theta_2)$ are same so $Kt=¿$ constant

$$\Rightarrow\frac{K_1}{K_2}=\frac{t_2}{t_1}=\frac{30}{20}=\frac{3}{2}=1.5$$

123 **(b)**

According to Wien's displacement law

$\therefore\qquad \lambda_m=\frac{b}{T}$

(b=constant)

$\therefore\qquad \frac{\lambda_1}{\lambda_2}=\frac{T_2}{T_1}$

$\Rightarrow\qquad \lambda_2=\frac{\lambda_1T_1}{T_2}$

Given, $\lambda_1=4800\,Å, T_1=6000\,K, T_2=3000\,K$

$\therefore\qquad \lambda_2=\frac{4800\times6000}{3000}=9600\,Å$

124 **(a)**

According to Newton's law of cooling

$$\frac{\theta_1-\theta_2}{t}=K\left[\frac{\theta_1+\theta_2}{2}-\theta_0\right]$$

In the first case,

$$\Rightarrow\quad\frac{60-50}{10}=K\left[\frac{60+50}{2}-\theta_0\right]$$

$\Rightarrow1=K(55-\theta)$ ...(i)

In the second case,

$$\Rightarrow\quad\frac{60-50}{10}=K\left[\frac{50+42}{2}-\theta_0\right]$$

$\Rightarrow\quad 0.8=K[46-\theta]$ ...(ii)

Dividing Eq. (i) by Eq. (ii), we get

$$\frac{1}{0.8}=\frac{55-\theta}{46-\theta}$$

or $\quad 40-\theta=44-0.8\theta$

$\Rightarrow\quad \theta=10$

125 **(a)**

Energy gained by water (in 1 s)

= Energy supplied $-¿$energy lost

= (1000 J-160 J)=840 J

Total heat required to raise the temperature of water from $27℃¿77℃$ is $ms\,\Delta\theta$. Hence, the required time,

$$t=\frac{ms\,\Delta\theta}{rate\ by\ which\ energy\ is\ gained\ by\ water}$$

$$¿\frac{(2)(4.2\times10^3)(50)}{840}=500\,s$$

= 8 min 20 s.

126 **(b)**

$$W=JQ\Rightarrow\frac{1}{2}\left(\frac{1}{2}mV^2\right)=J\times mS\,\Delta\theta\Rightarrow\Delta\theta=\frac{V^2}{4\,JS}$$

127 **(d)**

Temperature of interface $T=\frac{K_1\theta_1+K_2\theta_2}{K_1+K_2}$

$$¿\frac{300\times100+200\times0}{300+200}=60\,℃$$

129 **(c)**

$'J'$ is a conversion

130 **(d)**

If the temperature of a body on Celsius and Fahrenheit scales are recorded as C and F respectively, then

$$\frac{C-0}{100-0}=\frac{F-32}{212-32}$$

or $\quad\frac{C}{5}=\frac{F-32}{9}$

Here, $C=95\,℃$

$\therefore\quad\frac{95}{5}=\frac{F-32}{9}$

Or $\quad 5F=1015$

$\therefore \quad F=\frac{1015}{5}=203°F$

132 **(a)**

$\frac{F-32}{9}=\frac{K-273}{5} \Rightarrow \frac{F-32}{9}=\frac{95-273}{5} \Rightarrow F=-28$

133 **(a)**

$\therefore \frac{\lambda_{m_2}}{\lambda_{m_1}}=\frac{T_1}{T_2} \Rightarrow \lambda_{m_2}=\frac{2000}{2400} \times 4=3.33\, \mu m$

134 **(b)**

Density of hot air is lesser than the density of cold air so hot air rises up

135 **(c)**

Mass and volume of the gas will remain same, so density will also remain same

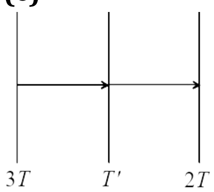
136 **(b)**

Pressure inside the mines is greater than that of normal pressure. Also we know that boiling point increases with increase in pressure

137 **(a)**

1 calorie is the heat required to raise the temperature of 1 g of water from $14.5\,°C$ ¿ $15.5\,°C\ at\ 760\, mm\ of\ Hg$.

140 **(c)**



In steady state energy absorbed by middle plate is equal to energy released by middle plate

$\sigma A(3T)^4-\sigma A(T'')^4=\sigma A(T'')^4-\sigma A(2T)^4$

$(3T)^4-(T'')^4=(T'')^4-(2T)^4$

$2(T'')^4-(16+81)T^4$

$T''=\left(\frac{97}{2}\right)^{1/4} T$

141 **(c)**

Variations of density with temperature is given by

$\rho'=\frac{\rho}{1+\gamma \Delta \theta}$

Fraction change is

$\frac{\rho'-\rho}{\rho}=\left[\frac{1}{1+49 \times 10^{-5} \times 30}-1\right]$

¿ 1.5×10^{-2}

142 **(c)**

$\frac{90-60}{5}=K\left(\frac{90+60}{2}-20\right) \Rightarrow 6-K \times 55 \Rightarrow K-\frac{6}{55}$

And, $\frac{60-30}{t}=\frac{6}{55}\left(\frac{60+30}{2}-20\right) \Rightarrow t=11$ minute

143 **(a)**

At low temperature short wavelength radiation is emitted. As the temperature rises colour of emitted radiations are in the following order

Red → Yellow → Blue → White (at highest temperature)

144 **(d)**

$-200\,°C$ to $600\,°C$ can be measured by platinum resistance thermometer

145 **(d)**

A thermopile is a sensitive instrument, used for detection of heat radiation and measurement of their intensity

146 **(b)**

When the light emitted from the sun's photosphere passes through it's outer part Chromosphere, certain wave lengths are absorbed. In the spectrum of sunlight, a large number of dark lines are seen called Fraunhoffer lines

148 **(b)**

Heat required to melt 1 g of ice at $0°C$ to water at 0 $°C$

= 1×80cal.

Heat required to raise temperature of 1 g of water from $0°C$to $100°C=1 \times 1 \times 100$ cal

Total heat required for maximum temperature of 100 $°C=80+100=180$cal

As one gram of steam gives 540 cal of heat when it is converted to water at $100°C$, therefore, temperature of the mixture would be $100°C$

149 **(a)**

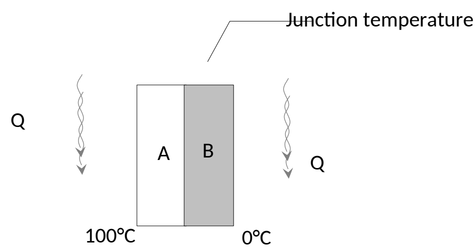
Thermal resistance

¿ $\frac{l}{KA}=\left[\frac{L}{MLT^{-3}K^{-1} \times L^2}\right]=[M^{-1}L^{-2}T^3K]$

150 **(a)**

It is given that $\frac{K_1}{K_2}=\frac{1}{3} \Rightarrow K_1=K$ then $K_2=3K$ the temperature of the junction in contact

$\theta=\frac{K_1\theta_1+K_2\theta_2}{K_1+K_2}=\frac{1 \times 100+3 \times 0}{1+3}=\frac{100}{4}=25°C$



151 **(d)**

If temperature of surrounding is considered then net loss of energy of a body by radiation

$Q = A\varepsilon\sigma\left(T^4 - T_0^4\right)t \Rightarrow Q \propto \left(T^4 - T_0^4\right) \Rightarrow \frac{Q_1}{Q_2} = \frac{T_1^4 - T_0^4}{T_2^4 - T_0^4}$

¿ $\frac{(273+200)^4 - (273+27)^4}{(273+400)^4 - (273+27)^4} = \frac{(473)^4 - (300)^4}{(673)^4 - (300)^4}$

152 **(d)**

Due to large specific heat of water, it releases large heat with very small temperature change

153 **(c)**

Rate of cooling $\left(\frac{-dT}{dt}\right) \propto$ emissivity(e)

From the graph,

$\left(\frac{-dT}{dt}\right)_x > \left(\frac{-dT}{dt}\right)_y$

$\therefore \quad e_x > e_y$

Further emissivity $(e) \propto$ absorptive power (a) (good absorbers are good emitters also)

$\therefore \quad a_x > a_y$

154 **(a)**

$\frac{Q_1}{Q_2} = \frac{r_1^2 T_1^4}{r_2^2 T_2^4} = \frac{4^2}{1^2} \times \left(\frac{2000}{4000}\right)^4 = 1$

155 **(b)**

In convection, the heated lighter particles move upwards and colder heavier particles move downwards to their place. This depends on weight and hence, on gravity.

156 **(a)**

The temperature of the body is same that of its surroundings, so the amount of heat absorbed by it should be equal to amount of heat radiated by it.

157 **(b)**

$\lambda_m \propto \frac{1}{T} \Rightarrow \lambda_{m_1} T_1 = \lambda_{m_2} T_2$

$\Rightarrow T_2 = \frac{\lambda_{m_1} T_1}{\lambda_{m_2}} = \frac{1.4 \times 10^{-6} \times 1000}{2.8 \times 10^{-6}} = 500\,K$

158 **(a)**

$\frac{Q_2}{Q_1} = \left(\frac{T_2}{T_1}\right)^4 = \left(\frac{273+927}{273+327}\right)^4 = \left(\frac{1200}{600}\right)^4 = 16$

$\Rightarrow Q_2 = 32\,KJ$

159 **(d)**

$\frac{Q}{t} = \frac{KA(\theta_1 - \theta_2)}{l} \Rightarrow \frac{mL}{t} = \frac{KA(\theta_1 - \theta_2)}{l}$

$\Rightarrow K \propto \frac{1}{t}$ ¿ remaining quantities are same]

$\Rightarrow \frac{K_1}{K_2} = \frac{t_2}{t_1} = \frac{40}{20} = \frac{2}{1}$

160 **(b)**

Suppose person climbs upto height h, then by using $W = JQ \Rightarrow mgh = JQ$

$\Rightarrow 60 \times 9.8 \times h = 4.2 \times \left(10^5 \times \frac{28}{100}\right) \Rightarrow h = 200\,m$

161 **(b)**

$\frac{Q}{t} = \frac{KA\,\Delta\theta}{l} \Rightarrow 6000 = \frac{200 \times 0.75 \times \Delta\theta}{1}$

$\therefore \Delta\theta = \frac{6000 \times 1}{200 \times 0.75} = 40\,°C$

163 **(b)**

$c = \frac{Q}{m.\Delta\theta} \rightarrow \frac{J}{kg \times °C}$

164 **(a)**

$P = \left(\frac{Q}{t}\right) \propto T^4 \Rightarrow \frac{W}{P_2} = \left(\frac{T}{T/3}\right)^4 \Rightarrow P_2 = \frac{W}{81}$

165 **(b)**

From Wien's displacement law

$\lambda_m T = \text{constant}$

$\Rightarrow \lambda_{m1} T_1 = \lambda_{m2} T_2$

Or $\quad \frac{T_1}{T_2} = \frac{\lambda_{m2}}{\lambda_{m1}} \quad$ …(i)

Here, $\lambda_{m1} = 510\,nm, \lambda_{m2} = 350\,nm$

So, on putting these values in Eq. (i)

$\frac{T_1}{T_2} = \frac{350}{510} \Rightarrow \frac{T_1}{T_2} = \frac{35}{51} = 0.69$

166 **(c)**

$P \times t = mc\,\Delta\theta$

$\Rightarrow t = \frac{mc\,\Delta\theta}{P} = \frac{4200 m\,\Delta\theta}{P} = \frac{4200 \times m \times \Delta\theta}{VI}$

$\left\{\because C_{water} = 4200 \frac{J}{kg \times °C}\right\}$

$\Rightarrow t = \frac{4200 \times 1 \times (100 - 20)}{220 \times 4} = 381\,sec \approx 6.3\,min$

167 **(c)**

Solids, liquids and gases all expand on being heated, as a result density (= mass/volume) decreases

168 **(c)**

Heat capacity/volume = $c \times \frac{m}{V} = c \times \rho$

Desired ratio = $\frac{c_1\rho_1}{c_2\rho_1} = \frac{3}{5} \times \frac{5}{6} = 1:2$

169 **(b)**

Heat current, $\frac{Q}{t}=\frac{KA(\theta_1-\theta_1)}{l}$

$=\frac{100\times 100\times 10^{-4}(100-0)}{1}$

$\Rightarrow \frac{Q}{t}$ = 100J/s=6×10^3 J/min

171 **(d)**

Heat released to convert $x\,g$ of steam at $100\,℃$ to water at $100\,℃$ is $x\times 540\,cals$.

If $y\,g$ of ice is converted from $0\,℃$ to water at $100\,℃$ it requires heat $y\times 80+y\times 1\times 100=180\,y$

$\therefore x\times 540=180\,y$ or $\frac{y}{x}=\frac{540}{180}=\frac{3}{1}$

172 **(c)**

$\frac{\Delta Q}{\Delta t}=\frac{KA\,\Delta\theta}{\Delta x}\Rightarrow$ Thermal gradient $\frac{\Delta\theta}{\Delta x}$

¿$\frac{(\Delta Q/\Delta t)}{KA}=\frac{10}{0.4}=25\,℃/cm$

173 **(b)**

In M.K.S. system unit of σ is $\frac{J}{m^2\times s\times K^4}$

$\Rightarrow 1\frac{J}{m^2\times s\times K^4}=\frac{10^7\,erg}{10^4\,cm^2\times s\times K^4}=10^3\frac{erg}{cm^2\times s\times}$

174 **(b)**

From Newton's law of cooling when a hot body is cooled in air, the rate of loss of heat by the body is proportional to the temperature difference between the body and its surroundings.

Given, $\theta_1=60℃,\theta_2=50℃,\theta=25℃$

$\therefore$ Rate of loss of heat=K (Mean temp.-Atmosphere temp.)

Where K is coefficient of thermal conductivity

$$\frac{\theta_1-\theta_2}{t}=K\left(\frac{\theta_1+\theta_2}{2}-\theta\right)$$

$$\frac{60-50}{10}=K\left(\frac{60+50}{2}-25\right)$$

$\Rightarrow K=\frac{1}{30}$

Also putting the value of K, we have

$$\frac{50-\theta_3}{10}=\frac{1}{30}\left(\frac{50+\theta_3}{2}-25\right)$$

$\Rightarrow \theta_3=42.85\,℃$

175 **(a)**

The temperature at which a black body ceases to radiate energy is 0 K.

176 **(c)**

Thermoelectric thermometer is used for finding rapidly varying temperature

177 **(c)**

Heat current, $H=\frac{Q}{t}=\frac{KA(\theta_1-\theta_2)}{d}$

$=\frac{0.01\times 0.8(30°-0°)}{2\times 10^{-2}}$ = 12 J s^{-1}

178 **(a)**

Natural convection arises due to difference of density at two places and is a consequence of gravity

179 **(d)**

At boiling point, vapour pressure becomes equal to the external pressure

180 **(a)**

Newton's law of cooling states that the rate of cooling of a body is directly proportional to temperature difference between the body and the surroundings, provided the temperature difference is small, (less than 10℃), and Newton's law of cooling is given by

$$\frac{dT}{dt}\propto(\theta-\theta_0)$$

181 **(b)**

According to Stefan's law of radiation

$U\propto T^4$

$(\because U\,\text{is the energy})$

$\Rightarrow \frac{U_1}{U_2}=\left(\frac{T_1}{T_2}\right)^4$

$\frac{U_1}{U_2}=\left(\frac{T}{T/2}\right)^4$ $(\because T_2=\frac{T}{2}$¿

Or $\frac{U_1}{U_2}=\left(\frac{2}{1}\right)^4$

Or $\frac{U_1}{U_2}=\left(\frac{16}{1}\right)$

Or $U_2=\frac{U_1}{16}$

$\Rightarrow U_2=\frac{U}{16}$ $(\because U_1=U$¿

182 **(b)**

In series, $R_{eq}=R_1+R_2\Rightarrow\frac{2l}{K_{eq}A}=\frac{l}{K_1A}+\frac{l}{K_2A}$

$$\Rightarrow \frac{2}{K_{eq}} = \frac{1}{K_1} + \frac{1}{K_2} \Rightarrow K_{eq} = \frac{2K_1K_2}{K_1+K_2}$$

183 **(d)**

From Stefan law, the energy radiated by sun is given by. $P = \sigma e A T^4$, assuming e=1 for sun.

In Ist case, $P_1 = \sigma e \times 4\pi R^2 \times T^4$

In 2nd case, $P_2 = \sigma e \times 4\pi (2R^2) \times (2T^4)$

$$¿ \sigma e \times 4\pi R^2 \times T^4 \times 64 = 64 P_1$$

The rate at which energy is received by earth is,

$$E = \frac{P}{4\pi R_{SE}^2} \times A_E$$

where A_E= area of earth

R_{SE}= distance between sun and earth

So, In Ist case, $E_1 = ¿ \frac{P_1}{4\pi R_{SE}^2} \times A_E$

$$E_2 = \frac{P_2}{4\pi R_{SE}^2} \times A_E = 64 E_1$$

184 **(a)**

For gases γ is more

185 **(d)**

Suppose $m\,gm$ ice melted, then heat required for its melting $¿ mL = m \times 80\,cal$

Heat available with steam for being condensed and then brought to $0\,°C$

$¿ 1 \times 540 + 1 \times 1 \times (100 - 0) = 640\,cal$

⇒ Heat lost = Heat taken

$\Rightarrow 640 = m \times 80 \Rightarrow m = 8\,gm$

Short trick : You can remember that amount of steam (m') at 100 °C required to melt $m\,gm$ ice at 0 °C is

$$m' = \frac{m}{8}$$

Here, $m = 8 \times m' = 8 \times 1 = 8\,gm$

186 **(c)**

Rate of energy $\frac{Q}{t} = P = A\varepsilon\sigma T^4 \Rightarrow P \propto T^4$

$$\Rightarrow \frac{P_2}{P_1} = \left(\frac{T_2}{T_1}\right)^4 = \left(\frac{927+273}{127+273}\right)^4 \Rightarrow P_1 = 405\,W$$

188 **(d)**

$\frac{Q}{t} = \frac{KA\,\Delta\theta}{l} \Rightarrow \frac{Q}{t} \propto \frac{A}{l} \propto \frac{d^2}{l}$ ¿ diameter of rod]

$$\Rightarrow \frac{(Q/t)_1}{(Q/t)_2} = \left(\frac{d_1}{d_2}\right)^2 \times \frac{l_2}{l_1} = \left(\frac{1}{2}\right)^2 \times \left(\frac{1}{2}\right) = \frac{1}{8}$$

189 **(c)**

Heat required is proportional to square of radius

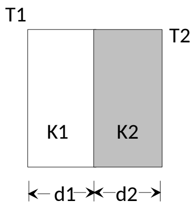
$$\frac{Q_1}{Q_2} = \frac{r_1^2}{r_2^2} = \frac{(1.5)^2}{(1)^2} = \frac{9}{4}$$

191 **(a)**

In series both walls have same rate of heat flow. Therefore

$$\frac{dQ}{dt}=\frac{K_1 A(T_1-\theta)}{d_1}=\frac{K_2 A(\theta-T_2)}{d_2}$$

$$\Rightarrow K_1 d_2(T_1-\theta)=K_2 d_1(\theta-T_2)$$



$$\Rightarrow \theta=\frac{K_1 d_2 T_1+K_2 d_1 T_2}{K_1 d_2+K_2 d_1}$$

193 **(c)**

Due to evaporation cooling is caused which lowers the temperature of bulb wrapped in wet hanky

194 **(c)**

$$t=\frac{Ql}{KA(\theta_1-\theta_2)}=\frac{mLl}{KA(\theta_1-\theta_2)}=\frac{V\rho Ll}{KA(\theta_1-\theta_2)}$$

$$¿\frac{5\times A\times 0.92\times\frac{5+10}{2}}{0.004\times A\times 10\times 3600}=19.1\,hours$$

195 **(a)**

If $m\,gm$ ice melts then

Heat lost = Heat gain

$80\times 1\times(30-0)=m\times 80\Rightarrow m=30\,gm$

196 **(b)**

Substances are classified into two categories

(i) water like substances which expand on solidification.

(ii) CO_2 like (Wax, Ghee $etc.$) substances which contract on solidification.

Their behaviour regarding solidification is opposite. Melting point of ice decreases with rise of pressure but that of wax etc increases with increase in pressure. Similarly ice starts forming from top to downwards whereas wax starts its formation from bottom to upwards

197 **(d)**

According to Stefan's law

$$E\propto T^4\vee E=\sigma T^4$$

Where σ is Stefan's constant. It's value is

$$¿5.67\times 10^{-8}\,W\,m^{-2}\,K^{-4}$$

Here, $T_1=27+273=300\,K$

$T_2=927+273=1200\,K$

$$\therefore \quad \frac{E_1}{E_2}=\left(\frac{300}{1200}\right)^4=1:256$$

198 **(a)**

The equivalent electrical circuit, figure in these cases is of Wheatstone bridge. No current would flow through central rod CD when the bridge is balanced. The condition for balanced Wheatstone bridge is

$\frac{P}{Q}=\frac{R}{S}$ (in terms of resistances)

$\frac{1/K_1}{1.K_2}=\frac{1/K_3}{1/K_4}$ or $\frac{K_2}{K_1}=\frac{K_4}{K_3}$

Or $K_1 K_4=K_2 K_3$

199 **(a)**

$$\text{Thermal resistivity} = \frac{1}{Thermal\,conductivity}$$

$$=\frac{1}{2}=0.5$$

200 **(d)**

Because steady state has been reached

201 **(c)**

$$E=\sigma T^4\Rightarrow 5.6\times 10^{-8}\times T^4=1$$

$$\Rightarrow T=\left[\frac{1}{5.6\times 10^{-8}}\right]^{1/4}=65\,K$$

202 **(b)**

Density at $0℃$, ρ_0=1.0127

Density at $100℃$, ρ_{100}=1

Coefficient of real expansion of liquid

$$\gamma_{real}=\frac{\rho_0-\rho_{100}}{\rho_{100}\times\Delta t}$$

$$=\frac{1.0127-1}{1\times 100}=0.0127\times 10^{-2}$$

$$=1.27\times 10^{-4}$$

$\gamma_{real}=\gamma_{app}+\gamma_g$

γ_g=coefficient of volume expansion of glass=3α

$$\therefore \quad 1.27\times 10^{-4}=\gamma_{app}+3\alpha$$

$$1.27\times 10^{-4}=\gamma_{app}+3\times 9\times 10^{-6}$$

$$\gamma_{app}=1.27\times 10^{-4}-27\times 10^{-6}$$

$$=1.27\times 10^{-4}-0.27\times 10^{-4}$$

$$=1\times 10^{-4}$$

$$\therefore \quad \gamma_{app}=\frac{Mass\,expelled}{Remaining\,mass\times\Delta t}$$

$$1\times 10^{-4}=\frac{m_1-m_2}{m_2\times 100}$$

$$\left(\frac{m_1}{m_2}-1\right)=1\times 10^{-4}\times 100=10^{-2}$$

$$\frac{m_1}{m_2}=1+10^{-2}=1.01$$

$$m_2=\frac{m_1}{1.01}=\frac{300}{1.01}$$

Mass expelled=m_1-m_2

$$¿300-\frac{300}{1.01}=\frac{3}{1.01}$$

203 **(a)**

Here, $\Delta T=20-15=5℃$

$\alpha=0.000012℃^{-1}=12\times10^{-6}℃^{-1}$

Time lost per day = $\frac{1}{2}\alpha(\Delta T)\times86400\,s$

$=\frac{1}{2}\times12\times10^{-6}\times5\times86400\,s=2.590\,s$

204 **(b)**

No, in convection the hot liquid at the bottom becomes lighter and hence it rises up. In this way the base of the convection is the difference in weight and upthrust. In the state of weightlessness this difference does not occur, so convection is not possible

205 **(a)**

Let the temperature of junction be θ.

$$\left(\frac{\Delta Q}{d_1}\right)_{copper}=\left(\frac{\Delta Q}{\Delta T}\right)_{steel}$$

$$K_1A=\frac{(100-\theta)}{18}=\frac{K_2A(\theta-0)}{6}$$

$$9K_2\frac{(100-\theta)}{3}=K_2\theta$$

$$3\theta=900-9\theta$$

$$12\theta=900$$

$$\theta=75℃$$

206 **(b)**

The wavelength corresponding to maximum emission of radiation from the sun is $\lambda_{max}=4753\,Å$ (close to the wavelength of violet colour of visible region). Hence if temperature is doubled λ_m is decreased $\left(\lambda_m\propto\frac{1}{T}\right)$, $i.e.$, mostly ultraviolet radiations are emitted

207 **(d)**

Loss of heat $\Delta Q=A\varepsilon\sigma\left(T^4-T_0^4\right)t$

$\Rightarrow$ Rate of loss of heat $\frac{\Delta Q}{t}=A\varepsilon\sigma\left(T^4-T_0^4\right)$

$¿10\times10^{-4}\times1\times5.67\times10^{-8}\{(273+127)^4-(273+2$

$¿0.99\,W$

208 **(a)**

Here, $A=1\,cm^2=10^{-4}\,m^2, T=1000\,K, t=1\,s$ and $\sigma=5.67\times10^{-8}\,W\,m^{-2}\,K^{-4}$

According to Stefan-Boltzmann law, energy radiated by a body is

$E=\sigma AT^4t=5.67\times10^{-8}\times10^{-4}\times(1000)^4\times1=5.67$

210 **(c)**

$Q=A\varepsilon\sigma T^4\Rightarrow Q\propto A\propto r^2$ ¿ constant]

$$\Rightarrow\frac{Q_1}{Q_2}=\frac{r_1^2}{r_2^2}=\left(\frac{1}{2}\right)^2=\frac{1}{4}$$

212 **(b)**

Temperature gradient $¿\frac{100-20}{20}=4℃/cm$

Temperature of centre $¿100-4\times10=60℃$

213 **(a)**

$$\frac{dQ}{dt}=\frac{K(\pi r^2)d\theta}{dt}\Rightarrow\frac{\left(\frac{dQ}{dt}\right)_s}{\left(\frac{dQ}{dt}\right)_l}=\frac{K_s\times r_s^2\times l_1}{K_l\times r_1^2\times l_s}=\frac{1}{2}\times\frac{1}{4}\times$$

$$\Rightarrow\left(\frac{dQ}{dt}\right)_s=\frac{\left(\frac{dQ}{dt}\right)_l}{4}=\frac{4}{4}=1$$

214 **(c)**

Let θ be temperature of middle point C and in series rate of heat flow is same

$\Rightarrow K(2A)(100-\theta)=KA(\theta-70)$

$\Rightarrow200-2\theta=\theta-70\Rightarrow3\theta=270\Rightarrow\theta=90℃$

215 **(c)**

Good absorbers are always good emitters of heat

216 **(b)**

According to Stefan's law radiant energy emitted by a perfectly black body per unit area per sec (ie, emissive power of black body) is directly proportional to the fourth power of its absolute temperature ie $E\propto T^4$

$$\Rightarrow\quad\frac{E_1}{E_2}=\frac{T_1^4}{T_2^4}$$

$$\frac{5}{E_2}=\frac{(273+227)^4}{(273+727)^4}$$

$$E_2=5\times\left[\frac{1000}{500}\right]^4$$

$$=5\times16=80\,cal\,cm^{-2}s^{-1}$$

217 **(a)**

According to Wien's displacement law $\lambda_m \propto \frac{1}{T}$.

Hence, it temperature increases λ_m decreases $i.e.$, peak of the $E-\lambda$ curve shift towards left

218 **(c)**

According to Wien's law,

$$\lambda \propto \frac{1}{T}$$

$ie.$, it depends on the temperature of the surface.

219 **(a)**

The black spot on heating absorbs radiations and so emits them in the dark room while the polished shining part reflects radiation and absorbs nothing and so does not emit radiations and becomes invisible in the dark

221 **(a)**

Work done $W=JQ$

$=4.2(0.5\times10+1\times80+1\times100+1\times540)$

$=3045$ J

222 **(c)**

Modulus of elasticity $=\frac{Force}{Area}\times\frac{l}{\Delta l}$

$$3\times10^{11}=\frac{33000}{10^{-3}}\times\frac{l}{\Delta l}$$

$$\frac{\Delta l}{l}=\frac{33000}{10^{-3}}\times\frac{1}{3\times10^{11}}$$

$$¿11\times10^{-5}$$

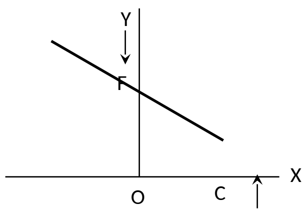
Change in length, $\frac{\Delta l}{l}=\alpha\Delta T$

$$11\times10^{-5}=1.1\times10^{-5}\times\Delta T$$

$\Rightarrow$ $\Delta T = 10\text{K or } 10°C$

223 **(a)**

We know that, $\frac{C}{100}=\frac{F-32}{180}\vee F=\frac{9}{5}C+32$



Equation of straight line is, $y=mx+c$

Hence, $m=(9/5)$, positive and $c=32$ positive. The graph is shown in figure

225 **(b)**

$$mc\,(\Delta T ¿=\frac{\frac{1}{2}\left(\frac{1}{2}mv^2\right)}{J}$$

$$\Delta T=\frac{v^2}{4Jc}=\frac{480\times480}{4\times4.2\times(0.03\times10^3)}=457°C$$

226 **(c)**

At absolute zero ($i.e.,0K ¿ v_{rms}$ becomes zero

227 **(a)**

$\Delta\theta=0.0023h=0.0023\times100=0.23°C$

228 **(d)**

The thermal radiation from a hot body travels with a velocity of light in vacuum $i.e. 3\times10^8 ms^{-1}$

229 **(c)**

Heat transferred in one minute is utilised in melting the ice so, $\frac{KA(\theta_1-\theta_2)t}{l}=m\times L$

$$\Rightarrow m=\frac{10^{-3}\times92\times(100-0)\times60}{1\times8\times10^4}=6.9\times10^{-3}kg$$

230 **(b)**

Triple point of water is $273.16\,K$

231 **(b)**

According to Wien's law

$$T\propto\frac{1}{\lambda}$$

Red colour has maximum wavelength, so its temperature will be minimum and hence, it will cool at the earliest

232 **(d)**

Let the temperature of common interface be $T°C$. Rate of heat flow

$$H=\frac{Q}{t}=\frac{KA\Delta T}{l}$$

$\therefore$ $H_1=\left(\frac{Q}{t}\right)_1=2KA¿¿$

And $H_2=\left(\frac{Q}{t}\right)_2=\frac{KA(T_2-T)}{x}$

In steady state, the rate of heat flow should be same in whole system ie,

$$H_1=H_2$$

$\Rightarrow$ $\frac{2KA(T-T_1)}{4x}=\frac{KA(T_2-T)}{x}$

$\Rightarrow$ $\frac{T-T_1}{2}=T_2-T$

$\Rightarrow$ $T-T_1=2T_2-2T$

$\Rightarrow$ $T=\frac{2T_2+T_1}{3}$

…(i)

Hence, heat flow from composite slab is

$$H=\frac{KA(T_2-T)}{x}$$

$$=\frac{KA}{x}\left(T_2-\frac{2T_2+T_1}{3}\right)=\frac{KA}{3x}(T_2-T_1)$$

…(ii)

[from Eq. (i)]

Accordingly, $H=\left[\frac{A(T_2-T_1)K}{x}\right]f$

… (iii)

By comparing Eqs. (ii) and (iii), we get

$\Rightarrow \qquad f=\frac{1}{3}$

233 **(b)**

According to Wien's displacement law

$$\lambda_m T=constant$$

$\therefore \frac{(\lambda_m)_1}{(\lambda_m)_2}=\frac{T_2}{T_1}$

Here $\frac{T_1}{T_2}=\frac{3}{2},(\lambda_m)_1=4000\,Å=4000\times10^{-10}$m

$\therefore (\lambda_m)_2=\frac{4000\times10^{-10}\times3}{2}=6000\,Å$

234 **(a)**

When the relative humidity is low (approx. 25%), the evaporation from our body is faster. Thus we feel colder

235 **(b)**

The metal X has a higher coefficient of expansion compared to that for metal Y so, on placing bimetallic strip in a cold bath, X will shrink more than Y. Hence, the strip will bend towards the left.

236 **(c)**

$\frac{X-L}{U-L}=\frac{C}{100}\Rightarrow\frac{62-(-10)}{110-(-10)}=\frac{C}{100}(C=60℃)$

237 **(a)**

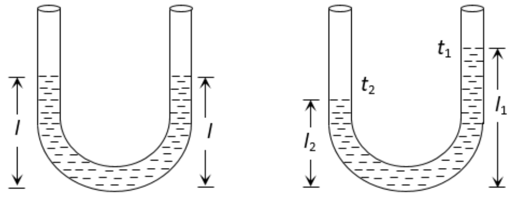
Ordinary glass prism (crown, flint) absorbs the infrared radiation but rock salt prism transmit them. Hence it is used to obtain the spectrum of infrared radiation

239 **(d)**

$Q\propto T^4\Rightarrow\frac{H_A}{H_B}=\left(\frac{273+727}{273+327}\right)^4=\left(\frac{10}{6}\right)^4=\left(\frac{5}{3}\right)^4=\frac{625}{81}$

240 **(a)**

Suppose, height of liquid in each arm before rising the temperature is l.



With temperature rise height of liquid in each arm increases $i.e.\,l_1>l\wedge l_2>l$

Also $l=\frac{l_1}{1+\gamma t_1}=\frac{l_2}{1+\gamma t_2}$

$\Rightarrow l_1+\gamma l_1 t_2=l_2+\gamma l_2 t_1\Rightarrow\gamma=\frac{l_1-l_2}{l_2t_1-l_1t_2}$

241 **(c)**

Since specific heat of lead is given in $Joules$, hence use $W=Q$ instead of $W=JQ$.

$\Rightarrow\frac{1}{2}\times\left(\frac{1}{2}mv^2\right)=m.c.\Delta\theta\Rightarrow\Delta\theta=\frac{v^2}{4c}=\frac{(300)^2}{4\times150}=1$

242 **(a)**

Anomalous density of water is given by (a). It has maximum density at 4℃.

243 **(d)**

Area under given curve represents emissive power and emissive power $\propto T^4\Rightarrow A\propto T^4$

$\Rightarrow\frac{A_2}{A_1}=\frac{T_2^4}{T_1^4}=\frac{(273+327)^4}{(273+27)^4}=\left(\frac{600}{300}\right)^4=\frac{16}{1}$

244 **(b)**

When length of the liquid column remains constant, then the level of liquid moves down with respect to the container, thus γ must be less than 3α

Now we can write $V=V_0(1+\gamma\Delta T)$

Since $V=Al_0=[A_0(1+2\alpha\Delta T)]l_0=V_0(1+2\alpha\Delta T)$

Hence $V_0(1+\gamma\Delta T)=V_0(1+2\alpha\Delta T)\Rightarrow\gamma=2\alpha$

245 **(b)**

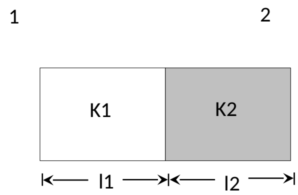
Highly polished mirror like surfaces are good reflectors, but not good radiators

246 **(c)**

At steady state, rate of heat flow for both blocks will be same,

$i.e.,\frac{K_1A(\theta_1-\theta)}{l_1}=\frac{K_2A(\theta-\theta_2)}{l_2}[Given\,l_1-l_2]$

$\Rightarrow K_1A(\theta_1-\theta)=K_2A(\theta-\theta_2)\Rightarrow\theta=\frac{K_1\theta_1+K_2\theta_2}{K_1+K_2}$

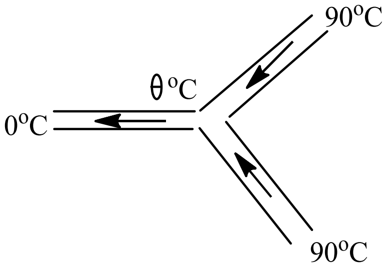


247 **(d)**

Let the temperature of function be θ, then

$$H=H_1+H_2$$

$$\Rightarrow \quad \frac{KA(\theta-0)}{L}=\frac{KA(90-\theta)}{L}+\frac{KA(90-\theta)}{L}$$



Or $\theta=90-\theta+90-\theta$

Or $\theta=180-2\theta$

Or $3\theta=180$

Or $\theta=60\,℃$

248 **(d)**

Amount of energy radiated $\propto (Temperature)^4$

249 **(a)**

Convection is not possible in weightlessness. So the liquid will be heated through conduction

250 **(a)**

Luminosity of a star depends upon the total radiations emitted by the star.

The star emits 17000 times the radiations emitted by the sun.

$\therefore \quad E=\sigma T^4$

Hence, $\frac{E_1}{E}=\left(\frac{T_1}{T}\right)^4$

So, $(17000)^{1/4}=\frac{T_1}{T}$ (Given, $E_1=17000\,E$ ¿

$$T_1=6000\times 11.4=68400\,K$$

251 **(b)**

Intensity is directly proportional to energy.

252 **(b)**

Heat current $\frac{Q}{t}\propto\frac{r^2}{l}$, from the given options,

option (b) has higher value of $\frac{r^2}{l}$.

253 **(c)**

Stress ¿ $Y\alpha\Delta\theta$; hence it is independent of length

254 **(a)**

Heat required to raise the temperature of 40 g of water from 25℃ to 54.3℃, is equivalent to sum of heat required to condense the steam.

∴ *Heat required ¿ raise the temperature of water b*

is

¿ $m_1 c\Delta t_1$

…(i)

Where c is specific heat of water and m the mass.

Heat required to condense steam

¿ $m_2 L+m_2 c\Delta t_2$

…(ii)

Equating eqs. (i) and (ii), we get

$$m_2 L+m_2 c\Delta t_2=m_1 c\Delta t_1$$

Given, $m_2=2\,g$

$\Delta t_2=(100-54.3)℃=45.7\,℃$

$m_1=40\,g$

$\Delta t_1=(54.3-25)℃=29.3\,℃$

$c=1\,cal\,g^{-1}$

$\Rightarrow 2\times L+2\times 1\times 45.7=40\times 1\times 29.3$

$\Rightarrow 2L+91.4=1172$

$\Rightarrow 2L=1080.6$

$\Rightarrow L=540.3\,cal\,g^{-1}$

255 **(a)**

Rate of cooling $\propto (T^4-T_0^4)$

$$\Rightarrow \frac{H}{H'}=\frac{(T_1^4-T_0^4)}{(T_2^4-T_0^4)}=\frac{600^4-200^4}{400^4-200^4}$$

Or $H'=\frac{(16+4)(16-4)H}{(36+4)(36-4)}=\frac{3}{16}H$

256 **(d)**

$$\theta_{mix}=\frac{m_W\theta_W-\frac{m_i L_i}{c_W}}{m_i+m_W}=\frac{100\times 50-10\times\frac{80}{1}}{10+100}=38.2\,℃$$

257 **(b)**

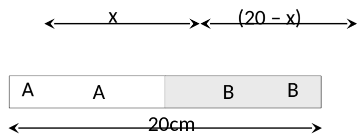
$\Delta L=L_0\alpha\Delta\theta$

Rod

$A: 0.075=20\times\alpha_A\times 100\Rightarrow\alpha_A=\frac{75}{2}\times 10^{-6}/℃$

rod B: $0.045=20\times\alpha_B\times 100\Rightarrow\alpha_B=\frac{45}{2}\times 10^{-6}/℃$

For composite rod : $x\,cm$ of A and $(20-x)cm$ of B we have



$0.060=x\alpha_A\times 100+(20-x)\alpha_B\times 100$

¿ $x\left[\frac{75}{2}\times 10^{-6}\times 100+(20-x)\times\frac{45}{2}\times 10^{-6}\times 100\right]$

On solving we get $x=10\,cm$

258 **(b)**

Suppose thickness of each wall is x then

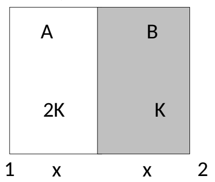
$$\left(\frac{Q}{t}\right)_{combination}=\left(\frac{Q}{t}\right)_A \Rightarrow \frac{K_S A(\theta_1-\theta_2)}{2x}=\frac{2KA(\theta_1-\theta}{x}$$

$$\because K_S=\frac{2\times 2K\times K}{(2K+K)}=\frac{4}{3}K \text{ and } (\theta_1-\theta_2)=36°$$

$$\Rightarrow \frac{\frac{4}{3}KA\times 36}{2x}=\frac{2KA(\theta_1-\theta)}{x}$$

Hence temperature difference across will A is

$(\theta_1-\theta)=12℃$



259 **(c)**

As the coefficient expansion of metal is less as compared to the coefficient of cubical expansion of liquid, we may neglect the expansion of metal ball. So when the ball is immersed in alcohol at $0℃$, it displaces some volume V of alcohol at $0℃$, and has weight W_1

$\therefore W_1=W_0-V\rho_0 g$

Where $W_0=weight\ of\ ball \in air$

similarly, $W_2=W_0-V\rho_{59}g$

where $\rho_0=density\ of\ alcohol\ at\ 0℃$

and $\rho_{59}=density\ of\ alcohol\ at\ 59℃$

As $\rho_{59}<\rho_0, \Rightarrow W_2>W_1 \vee W_1<W_2$

260 **(a)**

Water has maximum specific heat

261 **(a)**

When a piece of glass is heated, due to low thermal conductivity it does not conduct heat fast. Hence unequal expansion of it's layers crack the glass

262 **(a)**

Latent heat is independent of configuration. Ordered energy spent in stretching the spring will not contribute to heat which is disordered kinetic energy of molecules of substance

263 **(c)**

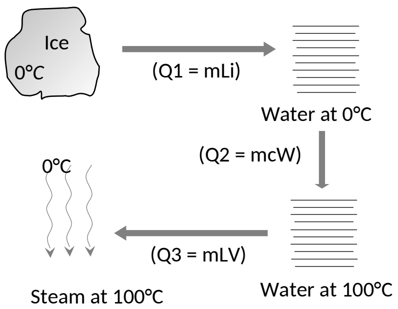
$$\frac{T_1}{T_2}=\frac{\lambda_{m_2}}{\lambda_{m_1}}=\frac{5.5\times 10^5}{11\times 10^5}=\frac{1}{2}\Rightarrow n=\frac{1}{2}[Given\,T_1=nT_2]$$

264 **(c)**

Ice $(0℃)$ converts into steam $(100℃)$ in following three steps.

Total heat required $Q=Q_1+Q_2+Q_3$

¿$5\times80+5\times1\times(100-0)+5\times540=3600\,cal$



266 **(b)**

According to Newton's law $\frac{\theta_1-\theta_2}{t}=k\left[\frac{\theta_1+\theta_2}{2}-\theta_0\right]$

Initially,

$\frac{(80-64)}{5}=K\left(\frac{80+64}{2}-\theta_0\right)\Rightarrow3.2=K(72-\theta_0)\ldots(i$

Finally

$\frac{(64-52)}{10}=K\left[\frac{64+52}{2}-\theta_0\right]\Rightarrow1.2=K[58-\theta_0]\ldots(i$

On solving equation (i) and (ii), $\theta_0=49\,°C$

267 **(a)**

Let the common temperature is x on both scales.

$$\frac{C}{5}=\frac{F-32}{9}$$

Put $C=F=x$

$\therefore\frac{x}{5}=\frac{x-32}{9}$

Or $9x=5x-160$

Or $4x=-160$

$\therefore x=-40\,°C$

268 **(c)**

$\frac{dQ}{dt}=-KA\frac{d\theta}{dx}$

$\because\frac{dQ}{dt}$, K and A are constants for all points

$\Rightarrow d\theta\propto-dx;i.e.,$ temperature will decrease linearly with x

269 **(a)**

The contraction in the length of the wire due to change in temperature=$\alpha<$¿$1.2\times10^{-5}\times3\times(-170-30)$

$$=-7.2\times10^{-3}m$$

The expansion in the length of wire due to stretching force

¿$\frac{FL}{AY}=\frac{(10\times10)\times3}{(0.75\times10^{-6})(2\times10^{11})}$

$=2\times10^{-3}$ m

Resultant change in length

¿$-7.2\times10^{-3}+2\times10^{-3}$

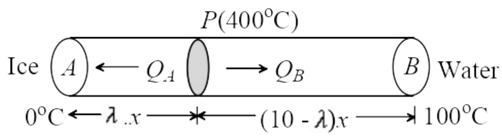
¿$-5.2\times10^{-3}\text{m}=-5.2\text{mm}$

Negative sign shows a contradiction.

271 **(a)**

$K\propto l^2\Rightarrow\frac{K_1}{K_2}=\frac{l_1^2}{l_2^2}=\left(\frac{10}{25}\right)^2=\frac{1}{6.25}$

272 **(a)**



Hear received by end A, for melting of ice

$Q_A=\frac{KA(400-0)t}{\lambda\cdot x}=mL_{ice}$ …(i)

Heat received by end B, for vaporization of water

$Q_B=\frac{KA(400-100)t}{(10-\lambda)x}=mL_{vap}$ …(i)

Dividing both equation, $\frac{\frac{400}{\lambda\cdot x}}{\frac{300}{(10-\lambda)x}}=\frac{L_{ice}}{L_{vap}}$

$\Rightarrow\frac{4}{3}\frac{(10-\lambda)}{\lambda}=\frac{80}{540}\Rightarrow\lambda=9$

273 **(a)**

Freezing point of water decreases when pressure increases, because water expands on solidification. "Except water" for other liquid freezing point increases with increase in pressure.

Since the liquid in question is water. Hence, it expands on freezing

274 **(a)**

Thermal conductivity is independent of temperatures of the wall, it is a constant for the material, so it will remain unchanged

275 **(d)**

$\gamma_{real}=\gamma_{app}+\gamma_{vessel};\gamma_{vessel}=3\alpha$

For vessel $'A'\Rightarrow\gamma_{real}=\gamma_1+3\alpha$

For vessel $'B'\Rightarrow\gamma_{real}=\gamma_2+3\alpha_B$

$Hence,\gamma_1+3\alpha=\gamma_2+3\alpha_B\Rightarrow\alpha_B=\frac{\gamma_1-\gamma_2}{3}+\alpha$

276 **(c)**

$\frac{d\theta}{dt}=\frac{\varepsilon A\sigma}{mc}4\theta_0^3\Delta\theta$

For given sphere and cube $\frac{\varepsilon A\sigma}{mc}4\theta_0^3\Delta\theta$ is constant so for both rate of fall of temperature $\frac{d\theta}{dt}=$¿ constant

277 **(b)**

Loss in time per second $\frac{\Delta T}{T}=\frac{1}{2}\alpha\Delta\theta=\frac{1}{2}\alpha(t-0)$

⇒ loss in time per day

$\Delta t=\left(\frac{1}{2}\alpha t\right)t=\frac{1}{2}\alpha t\times(24\times60\times60)=\frac{1}{2}\alpha t\times86400$

278 **(a)**

Cu is better conductor than Al and Ag is better conductor than Cu. Hence conductivity in increasing order is $Al<Cu<Ag$

279 **(a)**

Temperature of interface $\theta=\frac{K_1\theta_1+K_2\theta_2}{K_1+K_2}$

$[\because\frac{K_1}{K_2}=\frac{1}{4}\Rightarrow If\ K_1=K\,\text{then}\,K_2=4K]$

$\Rightarrow\theta=\frac{K\times0+4K\times100}{5K}=80\ ℃$

280 **(a)**

Change in volume, $\Delta V=V\gamma\Delta t$

⇒ $0.24=100\times\gamma\times40$

$\gamma=\frac{0.24}{100\times40}$

¿$0.00006=6\times10^{-5}$

$\alpha=\frac{\gamma}{3}$

⇒ $\alpha=2\times10^{-5}℃^{-1}$

281 **(b)**

$\frac{Q_2}{Q_1}=\left(\frac{T_2}{T_1}\right)^4\Rightarrow\frac{2}{1}=\left(\frac{T_2}{T_1}\right)^4$

$\Rightarrow T_2^4=2\times T_1^4=2\times(273+727)^4\Rightarrow T_2=1190\,K$

282 **(b)**

An ideal black body absorbs all the radiations incident upon it and has an emissivity equal to 1. If a black body and an identical another body are kept the same temperature, then the black body will radiate maximum power.

Hence, the black object at a temperature of 2000 ℃ will glow brightest.

283 **(c)**

The boiling point of mercury is $400\ ℃$. Therefore, the mercury thermometer can be used to measure the temperature upto $360\ ℃$

284 **(c)**

Total energy radiated from a body

$Q=A\varepsilon\sigma T^4t$

Or $\frac{Q}{t}\propto AT^4$

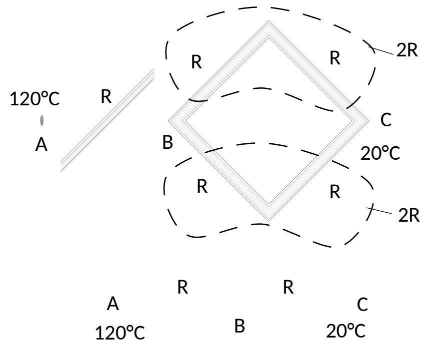
$\frac{Q}{t}\propto r^2T^4$ (

$\because A=4\pi r^2$¿

$\frac{Q_1}{Q_2}=\left(\frac{r_1}{r_2}\right)^2\left(\frac{T_1}{T_2}\right)^4 j=\left(\frac{8}{2}\right)^2\left[\frac{273+127}{273+527}\right]^4=1$

285 **(c)**

If thermal resistance of each rod is considered R then, the given combination can be redrawn as follows



$(Heat\ current)_{AC}=(Heat\ current)_{AB}$

$\frac{(120-20)}{2R}=\frac{(120-\theta)}{R}\Rightarrow\theta=70\ ℃$

286 **(c)**

At boiling point saturation vapour pressure becomes equal to atmospheric pressure. Therefore, at $100\ ℃$ for water. $S.V.P.=760\,mm\,of\,Hg\,(atm\ pressure)$

287 **(b)**

Thermal capacity = Mass × Specific heat

Due to same material both spheres will have same specific heat. Also mass = $Volume\,(V)\times Density\,(\rho)$

∴ Ratio of thermal capacity

¿$\frac{m_1}{m_2}=\frac{V_1\rho}{V_2\rho}=\frac{\frac{4}{3}\pi r_1^3}{\frac{4}{3}\pi r_2^3}=\left(\frac{r_1}{r_2}\right)^3=\left(\frac{1}{2}\right)^3=1:8$

288 **(d)**

$\frac{A_T}{A_{2000}}=\frac{16}{1}$ [Given]

Area under $e_\lambda-\lambda$ curve represents the emissive power of body and emissive power $\propto T^4$

[Hence area under $e_\lambda-\lambda$ curve) $\propto T^4$

$\Rightarrow\frac{A_T}{A_{2000}}=\left(\frac{T}{2000}\right)^4\Rightarrow\frac{16}{1}=\left(\frac{T}{2000}\right)^4\Rightarrow T=4000\,K$

289 **(c)**

Initial volume $V_1=47.5$ units

Temperature of ice cold water $T_1=0\ ℃=273\,K$

Final volume of $V_2=67$ units

Applying Charle's law, we have $\frac{V_1}{T_1}=\frac{V_2}{T_2}$

(where temperature T_2 is the boiling point)

$¿T_2=\frac{V_2}{V_1}\times T_1=\frac{67\times 273}{47.5}=385\,K=112\,℃$

290 **(a)**

$W=JQ\Rightarrow\frac{1}{2}\left(\frac{1}{2}Mv^2\right)=J(m.c.\Delta\theta)$

$\Rightarrow\frac{1}{4}\times 1\times(50)^2=4.2[200\times 0.105\times\Delta\theta]\Rightarrow\Delta\theta=7.1$

291 **(a)**

According to Stefan's law

$E\propto T^4$

$\frac{E_1}{E_2}=\left[\frac{T_1}{T_2}\right]^4$

$\frac{E_1}{0.5}=\left[\frac{273+627}{273+27}\right]^4$

$E_1=0.5\left(\frac{900}{300}\right)^4$

$\Rightarrow\quad E_1=40.5$ J

292 **(d)**

Rate of cooling (here it is rate of loss of heat)

$\frac{dQ}{dt}=(mc+W)\frac{d\theta}{dt}=(m_l c_l+m_c c_c)\frac{d\theta}{dt}$

$\Rightarrow\frac{dQ}{dt}=(0.5\times 2400+0.2\times 900)\left(\frac{60-55}{60}\right)=115\frac{J}{s}$

293 **(c)**

With rise of altitude pressure decreases and boiling point decreases

294 **(d)**

Let final temperature of water be θ

Heat taken = Heat given

$100\times 1\times(\theta-10)+10(\theta-10)=220\times 1(70-\theta)$

$\Rightarrow\quad\theta=48.8\,℃=50\,℃$

295 **(c)**

$E\propto T^4\Rightarrow\frac{E_1}{E_2}=\left(\frac{T_1}{T_2}\right)^4\Rightarrow\frac{7}{E_2}=\left(\frac{273+227}{273+727}\right)^4=\frac{1}{16}$

$\Rightarrow E_2=112\frac{cal}{cm^2\times sec}$

296 **(b)**

According to Newton's law of cooling t_1 will be less than t_2.

297 **(b)**

Liquid having more specific heat has slow rate of cooling because for equal masses rate of cooling

298 **(c)**

We know that $P=P_0(1+\gamma t)$ and $V=V_0(1+\gamma t)$

And $\gamma=(1/273)/℃$ for $t=-273\,℃$, we have

$P=0$ and $V=0$

Hence, at absolute zero, the volume and pressure of the gas become zero

299 **(b)**

In series rate of flow of heat is same

$\Rightarrow\frac{K_A A(\theta_1-\theta)}{l}=\frac{K_B A(\theta-\theta_2)}{l}$

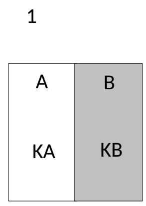
$\Rightarrow 3K_B(\theta_1-\theta)=K_B(\theta-\theta_2)$

$\Rightarrow 3(\theta_1-\theta)=(\theta-\theta_2)$

$\Rightarrow 3\theta_1-3\theta=\theta-\theta_2\Rightarrow 4\theta_1-4\theta=\theta_1-\theta_2$

$\Rightarrow 4(\theta_1-\theta)=(\theta¿¿1-\theta_2)¿$

$\Rightarrow 4(\theta_1-\theta)=20\Rightarrow(\theta¿¿1-\theta)=5\,℃¿$



300 **(b)**

$\gamma_r=\gamma_a+\gamma_v$; where $\gamma_r=¿$ coefficient of real expansion,

$\gamma_a=¿$ coefficient of apparent expansion and

$\gamma_v=¿$ coefficient of expansion of vessel.

For copper $\gamma_r=C+3\alpha_{Cu}=C+3A$

For silver $\gamma_r=S+3\alpha_{Ag}$

$¿C+3A=S+3\alpha_{Ag}\Rightarrow\alpha_{Ag}=\frac{C-S+3A}{3}$

301 **(b)**

Thermal conductivity of composite plate

$K_{eq}=\frac{2K_1K_2}{K_1+K_2}=\frac{2\times 2\times 3}{2+3}=\frac{12}{5}=2.4$

302 **(b)**

According to Newton's law of cooling

$\frac{(\theta_1-\theta_2)}{t}=K\left(\frac{\theta_1+\theta_2}{2}-\theta_0\right)$

$\therefore\frac{(62-50)}{10}=K\left(\frac{62+50}{2}-\theta_0\right)$

$\frac{12}{10}=K(56-\theta_0)\quad\ldots$(i)

For further cooling

$$\frac{(50-42)}{10}=K\left(\frac{50+42}{2}-\theta_0\right)$$

$$\frac{8}{10}=K(46-\theta_0) \qquad \ldots\text{(ii)}$$

Dividing Eq (i) by Eq. (ii), we get,

$$\frac{12}{8}=\frac{(56-\theta_0)}{(46-\theta_0)}$$

$$3(46-\theta_0)=2(56-\theta_0)$$

$$138-3\theta_0=112-2\theta_0 \qquad \theta_0=26\,℃$$

303 **(d)**

Water has maximum density at $4\,℃$

304 **(a)**

An opaque body does not transmit any radiation, hence transmission coefficient of an opaque body is zero.

305 **(c)**

Temperature change in Celsius scale ¿ Temperature change in Kelvin scale ¿ $27\,K$

306 **(c)**

As coefficient of cubical expansion of liquid equals coefficient of cubical expansion of vessel, the level of liquid will not change on heating

307 **(a)**

Suppose $m'\,kg$ ice melts out of $m\,kg$. Then by using $W=JQ \Rightarrow mgh=J(m'L)$. Hence fraction of ice melts

¿ $\frac{m'}{m}=\frac{gh}{JL}=\frac{9.8\times 1000}{4.18\times 80}=\frac{1}{33}$

308 **(b)**

According to Wien's displacement law

$$\lambda_m T=b \vee \lambda_m=\frac{b}{T}=\frac{0.0029}{5\times 10^4}=58\times 10^{-9}\,m=58\,nm$$

309 **(a)**

From Stefan's law $E=\sigma T^4$

$$T^4=\frac{E}{\sigma}=\frac{6.3\times 10^7}{5.7\times 10^{-8}}=1.105\times 10^{15}=0.1105\times 10^{16}$$

$$T=0.58\times 10^4\,K=5.8\times 10^3\,K$$

310 **(d)**

$$Q=\sigma e A T^4$$

$$T=\left[\frac{Q}{\sigma(4\pi R^2)}\right]^{1/4}$$

Here $e=1, A=4\pi R^2$

311 **(b)**

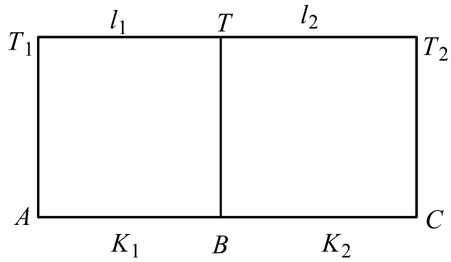
Maximum density of water is at $4\,℃$

$$Also\,\frac{C}{5}=\frac{F-32}{9} \Rightarrow \frac{4}{5}=\frac{F-32}{9} \Rightarrow F=39.2^o F$$

312 **(c)**

Let temperature at the interface is T.

For part AB,



$$\frac{Q_1}{t} \propto \frac{(T_1-T)K_1}{l_1}$$

For part BC,

$$\frac{Q_2}{t} \propto \frac{(T-T_2)K_2}{l_2}$$

At equilibrium, $\frac{Q_1}{t}=\frac{Q_2}{t}$

$$\therefore \qquad \frac{(T_1-T)K_1}{l_1}=\frac{(T-T_2)K_2}{l_2}$$

$$\Rightarrow \qquad T=\frac{T_1K_1l_2+T_2K_2l_1}{K_1l_2+K_2l_1}$$

313 **(d)**

Power radiated $P \propto T^4 \Rightarrow \frac{P_1}{P_2}=\left(\frac{T_1}{T_2}\right)^4$

$$\Rightarrow \frac{Q}{P_2}=\left(\frac{T}{3T}\right)^4 \Rightarrow P_2=81\,Q$$

314 **(d)**

Let the quantity of heat supplied per minute be Q.

Then quantity of heat supplied in

$2\,min=mC(90-80)$

In $4\,min$,heat supplied ¿ $2\,mC(90-80)$

$$\therefore 2\,mC(90-80)=mL \Rightarrow \frac{L}{C}=20$$

315 **(a)**

Here, $\Delta x=4\,mm=4\times 10^{-3}\,m$

$\Delta T=32\,℃$

Transmit heat per hours

$$\frac{\Delta Q}{\Delta T}=200\,kcal/h=\frac{200\times 1000\times 4.2}{60\times 60}\,J/s=233.33$$

$$A=5\,cm^2=5\times 10^{-4}\,m^2$$

We know that, $\frac{\Delta Q}{\Delta T}=KA\left(\frac{\Delta T}{\Delta x}\right)$

∴ Thermal conductivity of material,

$$K=\frac{\Delta Q/\Delta T}{A(\Delta T/\Delta x)}$$

Or $K=\frac{233.33\times4\times10^{-3}}{5\times10^{-4}\times32}=58.33\,W/m\text{-}°C$

316 **(b)**

We can relate an absorbed energy Q and the resulting temperature increase ΔT with relation $Q=cm\Delta T$. In that equation, m is the mass of the material absorbing the energy and c is the specific heat of the material. An absorbed dose of 3 Gy corresponds to an absorbed energy per unit mass of $3\,J/kg$. Let us assume that c the specific heat of human body, is the same as that of water, $4180\,J/kg\,K$. Then we find that

$$\Delta T=\frac{Q/m}{c}=\frac{3}{4180}=7.2\times10^{-4}\,K=700\,\mu K$$

Obviously the damage done by ionizing radiation has nothing to do with thermal heating. The harmful effects arise because the radiation damages DNA and thus interferes with the normal functioning of tissues in which it is absorbed

317 **(c)**

The emissive power of a perfectly black body is unity.

319 **(b)**

$\frac{dT}{dt}=\frac{\sigma A}{mcJ}(T^4-T_0^4)$ [In the given problem fall in temperature of body $dT=(200-100)=100\,K$, temp. of surrounding $T_0=0\,K$, Initial temperature of body $T=200\,K$]

$$\frac{100}{dt}=\frac{\sigma 4\pi r^2}{\frac{4}{3}\pi r^3\rho cJ}(200^4-0^4)$$

$$\Rightarrow dt=\frac{r\rho cJ}{48\sigma}\times10^{-6}s=\frac{r\rho c}{\sigma}.\frac{4.2}{48}\times10^{-6}$$

$$¿\frac{7}{80}\frac{r\rho c}{\sigma}\mu s\approx\frac{7}{72}\frac{r\rho c}{\sigma}\mu s[As\,J=4.2]$$

320 **(d)**

$$\frac{Q}{t}=\frac{KA\Delta\theta}{l}\Rightarrow\frac{K_A}{K_B}=\frac{A_B}{A_A}=\left(\frac{r_B}{r_A}\right)^2=\frac{1}{4}\Rightarrow K_A=\frac{K_B}{4}$$

321 **(a)**

Here, $\rho_0=10\,g/cc$

$\rho_{100}=9.7\,g/cc,\alpha=?$

From $\rho_0=\rho_{100}(1+\gamma\times100)$

$$\gamma=\frac{\rho_0-\rho_{100}}{\rho_{100}\times100}=\frac{10-9.7}{9.7\times100}=3.09\times10^{-4}$$

$$\alpha=\frac{\gamma}{3}=\frac{3.09\times10^{-4}}{3}=1.03\times10^{-4}\,°C^{-1}$$

322 **(d)**

$$\frac{V_1}{V_2}=\frac{1+\gamma t_1}{1+\gamma t_2}\Rightarrow\frac{100}{125}=\frac{1+\gamma\times20}{1+\gamma\times100}$$

$\Rightarrow\gamma=0.0033/°C$

323 **(c)**

Production and measurement of temperature close to $0\,K$ is done in cryogenics

324 **(c)**

When blue glass is heated at high temperature, it absorbs all the radiations of higher wavelength except blue. If it is taken inside a dark room, it emits all the radiation of higher wavelength, hence it looks brighter red as compared to the red piece

326 **(c)**

For the same heat to be conducted, temperature difference must be same.

Initial temperature difference $10-(-10)=¿20$ $°C=20\,K$

Outside temperature = $-23\,°C=-23+273=250\,K$

Inside temperature =250+20=270K

327 **(c)**

Star emits thermal radiations these radiations are a mixture of wavelengths and bear the following relation, with temperature (T) as

$\lambda_m T=$ constant

Where λ_m is maximum wavelength. This is Wien's displacement law and is used in determining the temperature of stars.

328 **(d)**

Initially on heating temperature rises from $-73\,°C$ (200K) to 0°(273K). Then ice melts and temperature does not rise. After the whole ice has melted, temperature begins to rise until it reaches $100°C$ (373K). Then it becomes constant and after that it changes to vapours.

329 **(d)**

$$\frac{E_2}{E_1}=\left(\frac{T_2}{T_1}\right)^4\Rightarrow\frac{2}{1}=\left(\frac{400+273}{T}\right)^4=\left(\frac{673}{T}\right)^4$$

$\Rightarrow T=2^{1/4}\times673=800\,K$

330 **(a)**

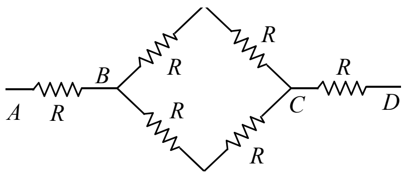
Since coefficient of expansion of steel is greater than that of bronze, hence with small increase in it's temperature the hole expands sufficiently

331 **(a)**

$$R=\frac{l}{KA}$$

$$\frac{T_A-T_B}{R}=\frac{T_B-T_C}{R}=\frac{T_C-T_D}{R}$$

$60-T_B=T_B-T_C$ ...(i)



$60-T_B=T_C-240$ ...(ii)

Solving (i) and (ii)

$T_B=120°C$

332 **(d)**

For cooking utensils, low specific heat is preferred for it's material as it should need less heat to raise it's temperature and it should have high conductivity, because, it should transfer heat quickly

333 **(a)**

Initially at $t=0$

Rate of cooling $(R) \propto$ Fall in temperature of body $(\theta-\theta_0)$

$$\Rightarrow \frac{R_1}{R_2}=\frac{\theta_1-\theta_0}{\theta_2-\theta_0}=\frac{100-40}{80-40}=\frac{3}{2}$$

334 **(c)**

Rate of cooling $R_C=\frac{A\varepsilon\sigma(T^4-T_0^4)}{mc}=\frac{A\varepsilon\sigma(T^4-T_0^4)}{V\rho C}$

$$\Rightarrow R_C \propto \frac{A}{V} \propto \frac{1}{r} \propto \frac{1}{(Diameter)}[\because m=\rho V]$$

Since diameter of A is half that of B so it's rate of cooling will be doubled that of B

335 **(b)**

In parallel combination equivalent conductivity

$$K=\frac{K_1A_1+K_2A_2}{A_1+A_2}=\frac{K_1+K_2}{2}[As\, A_1=A_2]$$

338 **(c)**

The latent heat of vaporisation of water is large, so when water is sprinkled over a large area, evaporation takes place, thus, causes cooling.

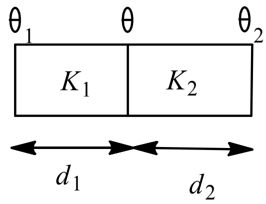
339 **(b)**

Because of uneven surfaces of mountains, most of it's parts remain under shadow. So, most of the mountains, land is not heated up by sun rays. Besides this, sun rays fall slanting on the mountains and are spread over a larger area. So, the heat received by the mountains top per unit area is less and they are less heated compared to planes (Foot)

340 **(c)**

For first slab,

Heat current, $H_1=\frac{K_1(\theta_1-\theta)A}{d_1}$



For second slab,

Heat current, $H_2=\frac{K_2(\theta-\theta_2)A}{d_2}$

As slabs are in series

$$H_1=H_2$$

$$\therefore \quad \frac{K_1(\theta_1-\theta)A}{d_1}=\frac{K_2(\theta-\theta_2)A}{d_2}$$

$$\Rightarrow \quad \theta=\frac{K_1\theta_1d_2+K_2\theta_2d_1}{K_2d_1+K_1d_2}$$

341 **(a)**

According to Newton's law of cooling we have, rate of cooling ∝ temperature difference between the liquid and surrounding.

As temperature difference decreases gradually, time taken to cool increases

ie., $t_1<t_2<t_3$

342 **(c)**

According toNewtons's law of cooling

$$\frac{d\theta}{dt}=\frac{\sigma A(T^4-T_0^4)}{ms}$$

$\therefore$ Specific heat $s=\frac{\sigma A(T^4-T_0^4)}{m\left(\frac{d\theta}{dt}\right)}$

Substituting the values

$$\therefore s=\frac{(5.73\times10^{-8})(19.2\times10^{-4})[(4)^4-(3)^4]\times10^8}{(34.38\times10^{-3})(4\times10^{-2})}=1400$$

343 **(d)**

According to Wien's displacement law,

$$\lambda_m T=b \vee \lambda_m \propto \frac{1}{T}$$

Where b is Wien's constant whose value is 29×10^{-3} mK

¿¿¿¿

Or $T_F=T_S\times$¿¿¿¿ = 5500 K$\times\frac{(5.5\times10^{-7}m)}{(11\times10^{-7}m)}$

= 2750 K

344 **(c)**

$\frac{E_2}{E_1}=\left(\frac{T_2}{T_1}\right)^4 \Rightarrow T_2=\left(\frac{E_2}{E_1}\right)^{1/4} \times T_1=(16)^{1/4} \times (273+12$

$\Rightarrow T_2=800\,K=527℃$

345 **(c)**

$\lambda_m T = constant$

From the graph $T_3 > T_2 > T_1$

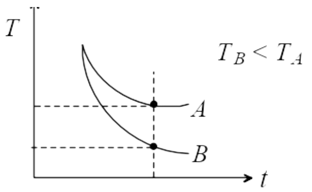
Temperature of sun will be maximum

346 **(b)**

As we know, Rate of cooling $\propto \frac{1}{specific\,heat\,(c)}$

$\because c_{oil} < c_{Water}$

$\Rightarrow (Rate\ of\ cooling)_{oil} > (Rate\ of\ cooling)_{Water}$



It is clear that, at a particular time after start cooling, temperature of oil will be less than that of water

So graph B represents the cooling curve of oil and A represents the cooling curve of water

347 **(a)**

$\frac{C}{5}=\frac{F-32}{9} \Rightarrow \frac{t}{5}=\frac{t-32}{9} \Rightarrow t=-40^o$

348 **(b)**

Since the curved surface of the conductor is thermally insulated, therefore, in steady state, the rate of flow of heat at every section will be the same. Hence the curve between H and x will be straight line parallel to x-axis

349 **(b)**

$\lambda_{m_2}=\frac{T_1}{T_2} \times \lambda_{m_1}=\frac{1500}{2500} \times 5000=3000\,Å$

350 **(a)**

From Stefan's law

$$E=\sigma T^4 A$$

Given, $T=727\,℃=(727+273)=1000$ K

$$A=5\times 10^{-4} m^2$$

$\therefore Energy=(5.67\times 10^{-8})(1000)^4(5\times 10^{-4})60$

$\therefore E=1.7\times 10^3$ J

352 **(b)**

Rate of cooling ¿ $\frac{-d\theta}{dt} \propto \left(\frac{\theta_1+\theta_2}{2}-\theta_0\right)$

In second case average temperature will be less hence rate of cooling will be less. Therefore time taken will be more than 4 minutes

353 **(a)**

$536\,\frac{cal}{gm}=\frac{536\times 4.2\,J}{10^{-3}\,kg}=2.25\times 10^6\,J/kg$

354 **(b)**

$\theta_{mix}=\frac{m_1 c_1 \theta_1+m_2 c_2 \theta_2}{m_1 c_1+m_2 c_2}=\frac{ms(2t)+1.5(ms)\times \frac{t}{3}}{ms+1.5(ms)}=t$

355 **(c)**

$\Delta L=\alpha L(\Delta T)=\frac{F}{A}\frac{L}{Y}$

$\therefore F=\alpha(\Delta T)AY$

$= 1.1\times 10^{-5}\times(50-30)\times 2\times 10^{-6}\times 2\times 10^{11}$

=88 N

356 **(c)**

Let m gram of water, whose temperature is θ(> 30 ℃ ¿, be added to 20 g of water at 30℃. If

$m\times 1(\theta-\theta_0)=20\times 1(\theta_0-30)$

$(m+20$ ¿ $\theta_0=60+m\theta$

$\theta_0=\frac{600+m\theta}{20+m}$

For θ_0 ¿ be maximum m should be small and θ should be large

357 **(d)**

According to Newton's law of cooling the rate of loss of heat of a body is directly proportional to the difference in temperature of the body, *ie*,

$$\frac{-dQ}{dt} \propto (\Delta\theta)$$

…(i)

Given, $\frac{-dQ}{dt} \propto (\Delta\theta)^n$ …

(ii)

Comparing Eqs. (i) and (ii), we get

$$n=1$$

358 **(c)**

According to Kirchoff's law, the ratio of emissive power to absorptive power is same for all bodies is equal to the emissive power of a perfectly black body *i.e.*,

$\left(\frac{e}{a}\right)_{body}=E_{¿body}$ for a particular wave length

$\left(\frac{e_\lambda}{a_\lambda}\right)_{body}=(E_\lambda)_{¿body} \Rightarrow e_\lambda=a_\lambda E_\lambda$

359 **(c)**

Radiation is the fastest mode of heat transfer

360 **(d)**

$(Q)_{¿body} = A\sigma T^4 t \Rightarrow Q \propto T^4$

$\Rightarrow Q_2 = Q_1\left(\frac{T_2}{T_1}\right)^4 = 10\left(\frac{273+327}{273+27}\right)^4 = 10\left(\frac{600}{300}\right)^4 = 16$

361 **(c)**

As $\frac{dQ}{dt}=KA\frac{dT}{dx}$, therefore, when

$dt\rightarrow\frac{1}{2}, A\rightarrow(2)^2=4, K\rightarrow\frac{1}{4}$

$\frac{dQ}{dt}$ becomes twice ; m would become twice

Mass of ice melted/s= 2× 0.1g=0.2g

362 **(c)**

In winter, the temperature of surrounding is low compared to the body temperature $(37.4℃)$. Since woolen clothes are bad conductors of heat, so they keep the body warm

363 **(d)**

When element and surrounding have same temperature there will be no temperature difference, hence heat will not flow from the filament and it's temperature remains constant

364 **(b)**

At low temperature short wavelength radiation is emitted. As the temperature rises colour of emitted radiations are in the following order

Red → Yellow → Blue → White (at highest temperature)

365 **(c)**

$\because \lambda_m T=\lambda_m' T' \Rightarrow \lambda_0 T=\lambda' \times 2T \Rightarrow \lambda'=\frac{\lambda_0}{2}$

366 **(a)**

Rapidly changing temperature is measured by thermocouple thermometers

367 **(b)**

Here , $K_A=2K_B (dx)_A=d(dx)_B . If\, \theta$ is temperature of junction,

$(dT)_A=\theta_A-\theta, (dT)_B=(\theta-\theta_B)$

As $\left(\frac{dQ}{dt}\right)_A=\left(\frac{dQ}{dt}\right)_B$

$\therefore K_A A\frac{(dT)_A}{(dx)_A}=K_B\frac{A(dT)_B}{(dx)_B}$

$2K_B(\theta_A-\theta)=K_B(\theta-\theta_B)$

$2\theta_A-2\theta=\theta-\theta_B$

$2\theta_A+\theta_B=3\theta$

As $\theta_A-\theta_B=48°;$ ….(i)

$\theta_A=48+\theta_B$

Put in Eq. (i)

2(48+θ_B¿+$\theta_B=3\theta$

96+3$\theta_B=3\theta$

96 = 3($\theta-\theta_B$¿

$\therefore \theta-\theta_B=96/3$ =32℃

368 **(b)**

For parallel combination of two rods of equal length and equal area of cross-section.

$K=\frac{K_1+K_2}{2}=\frac{K_1+\frac{4K_1}{3}}{2}$

$=\frac{7K_1}{6}$

Hence , $\frac{K}{K_1}=\frac{7}{6}$

369 **(a)**

$\frac{Q_2}{Q_1}=\frac{T_2^4}{T_1^4}=\left(\frac{273+527}{273+127}\right)^4=\left(\frac{800}{400}\right)^4\Rightarrow Q_2=16\frac{cal}{cm^2\times s}$

370 **(a)**

According to Wien's displacement law

$\lambda_m\propto\frac{1}{T}\Rightarrow\lambda_{m_2}<\lambda_{m_1}[\because T_1<T_2]$

There fore $I-\lambda$ graph for T_2 has lesser wavelength (λ_m) and so curve for T_2 will shift towards left side

372 **(b)**

$Q=mL=KA\frac{(\theta_1-\theta_2)}{l}t\Rightarrow m=\frac{1}{L}\times KA\frac{(\theta_1-\theta_2)}{l}\times t$

¿ $\frac{1}{80}\times 0.2\times 4\times\frac{(100-0)}{\sqrt{4}}\times 10\times 60[\because l^2=4\Rightarrow l=\sqrt{}$

¿ $\frac{0.2\times 4\times 100\times 600}{80\times 2}=300\, gm$

374 **(a)**

Language of question is slightly wrong. As heat capacity and specific heat are two different physical quantities. Unit of heat capacity is Jkg^{-1}, not $Jkg^{-1}℃^{-1}$. The heat capacity given in the question is really the specific heat. Now applying the heat exchange equation:

$420=(m\times 10^{-3})(2100)(5)+(1\times 10^{-3})(3.36\times 10^5)$

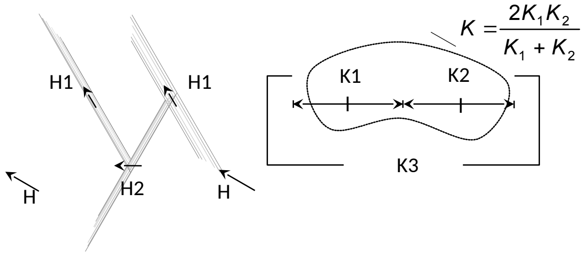
Solving this equation, we get

$m=8g$

∴ The correct answer is 8.

375 **(c)**

The given arrangement of rods can be redrawn as follows



It is given that $H_1 = H_2$

$$\Rightarrow \frac{KA(\theta_1-\theta_2)}{2l} = \frac{K_3 A(\theta_1-\theta_2)}{l} \Rightarrow K_3 = \frac{K}{2} = \frac{K_1 K_2}{K_1+K}$$

376 **(b)**

Temperature of interface $\theta = \frac{K_1\theta_1 + K_2\theta_2}{K_1+K_2}$

Where $K_1 = 2K$ and $K_2 = 3K\left[\because \frac{K_1}{K_2} = \frac{2}{3}\right]$

$$\Rightarrow \theta = \frac{2K \times 100 + 3K \times 0}{2K+3K} = \frac{200K}{5K} = 40℃$$

377 **(b)**

From Wien's law

$$\lambda_m T = constant$$

Where λ_m is maximum wavelength and T the absolute temperature.

Given, $\lambda_1 = 140, \lambda_2 = 4200\,Å$

$\therefore \quad \frac{\lambda_1}{\lambda_2} = \frac{T_2}{T_1} = \frac{140}{4200}$

$\Rightarrow \quad \frac{T_2}{T_1} = \frac{1}{30}$

$\Rightarrow \quad \frac{T_1}{T_2} = \frac{30}{1}$

378 **(d)**

The degree Celsius (℃) scale was devised by dividing the range of temperature between the freezing and boiling temperature of pure water at standard atmospheric conditions into 100 equals parts.

For Fahrenheit scale.

Boiling point=212 ℉,

Freezing point=32 °

∴ Difference of

$100℃ = difference\,of\,(212° - 32°) = 180℉$

$\therefore$ Difference of $30° = \frac{180}{100} \times 30 = 54°$

379 **(a)**

If temperature of surrounding is considered, then net loss of energy of a body by radiation

$$Q = Ae\sigma(T^4 - T_0^4)$$

$\Rightarrow \quad Q \propto (T^4 - T_0^4)$

$\therefore \quad \frac{Q_1}{Q_2} = \frac{T_1^4 - T_0^4}{T_2^4 - T_0^4}$

$$= \frac{(273+327)^4 - (273+27)^4}{(273+427)^4 - (273+27)^4}$$

$$¿ \frac{(600)^4 - (300)^4}{(700)^4 - (300)^4} = 0.52$$

380 **(c)**

$$\frac{F-32}{9} = \frac{K-273}{5} \Rightarrow \frac{F-32}{9} = \frac{0-273}{5}$$

$\Rightarrow F = -459.4^o F = -460° F$

381 **(a)**

$\frac{C}{5} = \frac{F-32}{9} \Rightarrow C = \left(\frac{5}{9}\right)F - \frac{20}{3}$. Hence graph between ℃ and ℉ will be a straight line with positive slope and negative intercept

382 **(b)**

According to Newton's law of cooling, rate of cooling is given by

$$\left(\frac{-dT}{dt}\right) = \frac{eA\sigma}{mc}(T^4 - T_0^4)$$

where c is specific heat of material.

or $\quad \left(\frac{-dT}{dt}\right) \propto \frac{1}{c}$

$ie.$,rate of cooling varies inversely as specific heat. From the graph, for A rate of cooling is larger. Therefore, specific heat of A is smaller.

383 **(a)**

$$\alpha = \frac{\Delta L}{L_0(\Delta\theta)} = \frac{0.19}{100(100-0)} = 1.9 \times 10^{-5}/℃$$

Now $\gamma = 3\alpha = 3 \times 1.9 \times 10^{-5}/℃ = 5.7 \times 10^{-5}/℃$

384 **(b)**

$Y = \frac{FL}{Al}$ where Y is Young's modulus, A is area

$\Rightarrow F = \frac{YAl}{L} \quad \ldots(i)$

From the formula for linear expansion

$\alpha = \frac{l}{L \times 100} \quad \ldots(ii)$

According to the condition the bar should not bend or expand

Now from equations (i) and (ii)

$F = YA \times 100\alpha$

Hence, force is independent of length L

385 **(b)**

Heat taken by ice to raise its temperature to 100 °C

$Q_1 = 1 \times 80 + 1 \times 1 \times 100 = 180$ cal

Heat given by steam when condensed

$Q_2 = m_2 L_2 = 1 \times 540 = 540$ cal

As $Q_2 > Q_1$, hence, temperature of mixture will remain $100°C$.

386 **(d)**

Thermostat is used in electric apparatus like refrigerator, iron *etc* for automatic cut off. Therefore for metallic strips to bend on heating their coefficient if linear expansion should be different

387 **(b)**

For resistance thermometers

$$t = \frac{R_t - R_0}{R_{100} - R_0} \times 100\,°C$$

Here $R_t = 5.5\Omega$, $R_o = 5\Omega$, $R_{100} = 5.25\,\Omega$

$$\therefore t = \frac{5.5 - 5}{5.25 - 5} \times 100$$

$$¿ \frac{0.5}{0.25} \times 100 = 200\,°C$$

388 **(c)**

$\lambda_m T = ¿$ constant

389 **(a)**

$$\lambda_m \propto \frac{1}{T}$$

$$\therefore \frac{\lambda_A}{\lambda_B} = \frac{T_B}{T_A} = \frac{500}{1500} = \frac{1}{3}$$

$E \propto T^4 (where\ A = surface\ area = 4\pi R^2)$

$\therefore E \propto T^4 R^2$

$$\frac{E_A}{E_B} = \left(\frac{T_A}{T_B}\right)^4 \left(\frac{R_A}{R_B}\right)^2$$

$$¿ (3)^4 \left(\frac{16}{18}\right)^2 = 9$$

391 **(c)**

The volume of the metal at 30 °C is

$$V_{30} = \frac{loss\ of\ weight}{Specific\ gravity \times g} = \frac{(45 - 25) g}{1.5 \times g} = 13.33\, cn$$

Similarly, Volume of metal at 40 °C is

$$V_{40} = \frac{(45 - 27) g}{1.25 \times g} = 14.40\, cm^3$$

Now, $V_{40} = V_{30} [1 + \gamma (t_2 - t_1)]$

$$\Rightarrow \gamma = \frac{V_{40} - V_{30}}{V_{30}(t_2 - t_1)} = \frac{14.40 - 13.33}{13.33(40 - 30)} = 8.03 \times 10^{-3} / ^{\circ}$$

$\therefore$ Coefficient of linear expansion of the metal is

$$\alpha = \frac{\gamma}{3} = \frac{8.03 \times 10^{-3}}{3} = 2.6 \times 10^{-3} / °C$$

393 **(a)**

Heat is lost by steam in two stages (i) for change of state from steam at 100 °C to water at 100 °C is $m \times 540$ (ii) to change water at 100 °C to water at 80 °C is $m \times 1 \times (100 - 80)$, where m is the mass of steam condensed

Total heat lost by is $m \times 540 + m \times 20 = 560\, m (cals)$.

Heat gained by calorimeter and its contents is

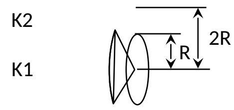
$¿ (1.1 + 0.02) \times (80 - 15) = 1.12 \times 65\, cals$

Using Principle of calorimetery, Heat gained = heat lost

$\therefore 560\, m = 1.12 \times 65,\ m = 0.130\, g$

394 **(c)**

Both the cylinders are in parallel, for the heat flow from one end as shown



Hence $K_{eq} = \dfrac{K_1 A_1 + K_2 A_2}{A_1 + A_2}$

Where $A_1 = ¿$ Area of cross-section of inner cylinder $\propto \pi R^2$ and $A_2 = ¿$ Area of cross-section of cylindrical shell

$¿ \pi \{(2R)^2 - (R)^2\} = 3\pi R^2$

$$\Rightarrow K_{eq} = \frac{K_1 (\pi R^2) + K_2 (3\pi R^2)}{\pi R^2 + 3\pi R^2} = \frac{K_1 + 3K_2}{4}$$

395 **(b)**

$$\frac{E_1}{E_2} = \left(\frac{T_1}{T_2}\right)^4 = \left(\frac{727 + 273}{127 + 273}\right)^4 = \frac{(1000)^4}{(400)^4} = \frac{10^4}{4^4} = \frac{625}{16}$$

396 **(b)**

Work done to raise the temperature of 100 *gm* water through 10 °C is

$W = JQ = 4.2 \times (100 \times 10^{-3} \times 1000 \times 10) = 4200\, J$

397 **(a)**

Here, $t_1 = 0\,°C = 273\,K,\ t_2 = 473\,K$

$\gamma_r = 0.18 \times 10^{-3}\,°C^{-1};\ d_1 = 13.6\, g/cc$

$$d = \frac{d_1}{1 + \gamma_r (\Delta T)}$$

$$= \frac{13.6}{1 + 0.18 \times 10^{-3} \times (473 - 273)}$$

$$d_2 = \frac{13.6}{1.036} = 13.127\, g/cc$$

398 **(a)**

From $T=2\pi\sqrt{\frac{1}{g}}$

$$\frac{\Delta T}{T}=\frac{1}{2}\frac{\Delta l}{l}=\frac{\alpha\Delta T}{2}$$

$$=\frac{1}{2}\times 2\times 10^{-6}\times 10=10^{-3}\%$$

399 **(b)**

Heat lost in $t\ sec$ ¿ mL or heat lost per sec ¿ $\frac{mL}{t}$. This must be the heat supplied for keeping the substance in molten state per sec.

$$\therefore \frac{mL}{t}=P\vee L=\frac{Pt}{m}$$

400 **(a)**

$$W=JQ\Rightarrow\frac{1}{2}I\omega^2=J(MS\Delta\theta)$$

$$\Rightarrow\frac{1}{2}\left(\frac{2}{5}MR^2\right)\omega^2=J(MS\Delta\theta)\Rightarrow\Delta\theta=\frac{1}{5}\frac{R^2\omega^2}{JS}$$

401 **(b)**

Stefan's law states that the rate of emission of radiant energy by unit area of perfectly black body is directly proportional to the fourth power of its absolute temperature.

$$E\propto AT^4$$

¿ $E\propto r^2$

($\because A=\pi r^2\wedge T$ is same for both the spheres where r is radius of sphere.)

$$\frac{E_1}{E_2}=\frac{r_1^2}{r_2^2}=\left(\frac{2}{1}\right)^2=\frac{4}{1}=4:1$$

402 **(d)**

$$(¿)^2=(PR)^2-(PO)^2=l^2-\left(\frac{l}{2}\right)^2$$

$$¿\left[l(1+\alpha_2 t)\right]^2-\left[\frac{l}{2}(1+\alpha_1 t)\right]^2$$

$$l^2-\frac{l^2}{4}=l^2(1+\alpha_2^2t^2+2\alpha_2 t)-\frac{l^2}{4}(1+\alpha_1^2t^2+2\alpha_1 t)$$

Neglecting $\alpha_2^2t^2$ and $\alpha_1^2t^2$

$$0=l^2(2\alpha_2 t)-\frac{l^2}{4}(2\alpha_1 t)\Rightarrow 2\alpha_2=\frac{2\alpha_1}{4}\Rightarrow\alpha_1=4\alpha_2$$

403 **(b)**

A person with dark skin absorbs more heat radiation and feels more heat. It also radiates more heat and feels more cold

404 **(b)**

We know that heat lost ¿ $mc\theta$

For a given quantity of heat, we must need a minimum mass of water for cooling the radiators due to a high value of specific heat

406 **(c)**

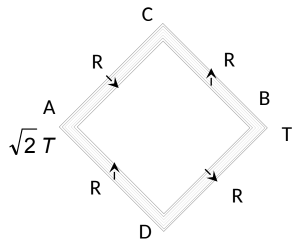
$$\frac{Q}{t}=\frac{KA\Delta\theta}{l}=\frac{mL}{t}=\frac{K(\pi r^2)\Delta\theta}{l}$$

$\Rightarrow$ Rate of melting of ice $\left(\frac{m}{t}\right)\propto\frac{Kr^2}{l}$

Since for second rod K becomes $\frac{1}{4}thr$ becomes double and length becomes half, so rate of melting will to twice

$$i.e.\left(\frac{m}{t}\right)_2=2\left(\frac{m}{t}\right)_1=2\times 0.1=0.2\,g/s$$

Temperature difference between C and D is zero



407 **(a)**

Since, $t=\frac{\rho L}{2k\theta}(x_2^2-x_1^2)$

$$\therefore t=\frac{\rho L}{2k\theta}(x^2-y^2)=\frac{\rho L(x+y)(x-y)}{2K\theta}$$

408 **(b)**

Suppose $m\,kg$ if ice melts then by using

$$\underset{(Joules)}{W}=\underset{(Joules)}{H}$$

$$\Rightarrow Mgh=mL\Rightarrow 3.5\times 10\times 2000=m\times 3.5\times 10^5$$

$$\Rightarrow m=0.2\,kg=200\,gm$$

409 **(b)**

$$W=JQ=4.18\times 400=1672\,joule$$

410 **(b)**

$$\frac{\theta_1-\theta_2}{l}=80\Rightarrow\frac{30-\theta_2}{0.5}=80\Rightarrow\theta_2=-10\,℃$$

411 **(a)**

According to Stefan's law

$$E\propto T^4$$

$$\frac{E'}{E}=\left(\frac{3T}{T}\right)^4\vee E'=81E$$

412 **(c)**

$$L=L_0(1+\alpha\Delta\theta)\Rightarrow\frac{L_1}{L_2}=\frac{1+\alpha(\Delta\theta)_1}{1+\alpha(\Delta\theta)_2}$$

$$\Rightarrow\frac{10}{L_2}=\frac{1+11\times 10^{-6}\times 20}{1+11\times 10^{-6}\times 19}\Rightarrow L_2=9.99989$$

$\Rightarrow$ Length is shorten by

$$10-9.99989=0.00011=11\times10^{-5}\,cm$$

413 **(c)**

When we increase the temperature of a liquid, the liquid will expand. So, the volume of the liquid will increase and hence, the density of the liquid will decrease.

414 **(c)**

Given, $\Delta l_1 = \Delta l_2$

Or $l_1 \alpha_a t = l_2 \alpha_s t$

$\therefore \quad \frac{l_1}{l_2} = \frac{\alpha_s}{\alpha_a}$

Or $\frac{l_1}{l_1 + l_2} = \frac{\alpha_s}{\alpha_a + \alpha_s}$

415 **(d)**

Let θ *be the* temperature of the mixture.

Heat gained by water at $0\,℃$ = Heat lost by water at $10℃$

$c m_1 (\theta - 0) = c m_2 (10 - \theta)$

$\theta = \frac{400}{60} = 6.66\,℃$

416 **(b)**

$Q \propto T^4 \Rightarrow \frac{Q_1}{Q_2} = \frac{T_1^4}{T_2^4} \Rightarrow T_2^4 = \left(\frac{E_2}{E_1}\right) T_1^4$

$\Rightarrow T_2^4 = \frac{1}{16} \times (1000)^4 = \left(\frac{1000}{2}\right)^4$

$\Rightarrow T_2 = 500\,K$

417 **(d)**

$T_1 = 277\,℃ = 277 + 273 = 550\,K$

$T_2 = 67\,℃ = 67 + 273 = 340\,K$

Temperature of surrounding

$T = 27\,℃ = 27 + 273 = 300\,K$

Ratio of loss of heat=$\frac{T_1^4 - T^4}{T_2^4 - T^4}$

$¿ \frac{\left(\frac{T_1}{T}\right)^4 - 1}{\left(\frac{T_2}{T}\right)^4 - 1} = \frac{\left(\frac{550}{300}\right)^4 - 1}{\left(\frac{340}{300}\right)^4 - 1} = \frac{9.5}{0.5} = \frac{19}{1}$

418 **(d)**

$W = JQ \Rightarrow W = 4.2 \times 200 = 840\,J$

419 **(b)**

Heat released by 5 kg of water when its temperature falls from $20\,℃ ¿ 0\,℃ is$,

$Q_1 = m_1 c_1 \Delta\theta_1 = (5)(10^3)(20 - 0) = 10^5\,cal$

When 2 kg ice at $-¿20℃$ comes to a temperature of $0℃$, it takes an energy

$Q_2 = m_2 c_2 \Delta\theta_2 = (2)(500)(20) = 0.2 \times 10^5\,cal$

The remaining heat

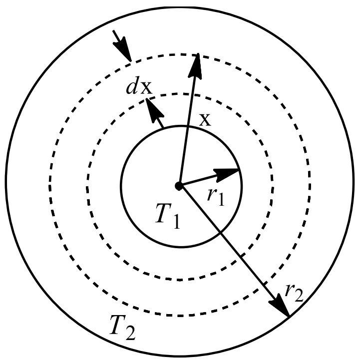
$Q = Q_1 - Q_2 = 0.8 \times 10^5\,cal$ will melt a mass m of the ice, thus

$m = \frac{Q}{L} = \frac{0.8 \times 10^5}{80 \times 10^3} = 1$ kg

So, the temperature of the mixture will be $0℃$, mass of water in it is 5+¿1=6 kg and mass of ice is 2−¿1=1 kg

420 **(c)**

To measure the radial rate of heat flow, we have to go for integration technique as here the area of the surface through which heat will flow is not constant.



Let us consider an element (spherical shell) of thickness dx and radius x as shown in figure. Let us first find the equivalent thermal resistance between inner and outer sphere.

Resistance of shell=$dR = \frac{dx}{K \times 4\pi x^2}$

$\left(¿ R = \frac{l}{KA}\ where, \quad K = thermal\ conductivity \right)$

$\Rightarrow \quad \int dR = R = \int_{r_1}^{r_2} \frac{dx}{4\pi K x^2}$

$= \frac{1}{4\pi K}\left[\frac{1}{r_1} - \frac{1}{r_2}\right] = \frac{r_2 - r_1}{4\pi K (r_1 r_2)}$

Rate of heat flow = H

$= \frac{T_1 - T_2}{R}$

$= \frac{T_1 - T_2}{r_2 - r_1} \times 4\pi K (r_1 r_2)$

$\propto \frac{r_1 r_2}{r_2 - r_1}$

421 **(c)**

Power $P \propto A T^4 \propto r^2 T^4$

$\Rightarrow \frac{P_2}{P_1} = \left(\frac{r_2}{r_1}\right)^2 \times \left(\frac{T_2}{T_1}\right)^4 = \left(\frac{4r}{r}\right)^2 \times \left(\frac{T/2}{T}\right)^4 = 1$

422 **(a)**

Heat absorbed by 540 g of ice at $0°C$ to melt out = 540×80 cal. This is exactly what is available in 540 g of water at $80°C$ to cool down to $0°C$

423 **(a)**

The latent heat of vaporization is always greater than latent heat of fusion because in liquid to vapour phase change there is a large increase in volume. Hence more heat is required as compared to solid to liquid phase change

424 **(c)**

When pressure increases boiling point also increases

425 **(a)**

$Q=m.c.\Delta\theta=5\times(1000\times 4.2)\times(100-20)$

$¿1680\times 10^3 J=1680\,kJ$

426 **(c)**

From ideal gas equation $PV=\mu RT\Rightarrow P=\frac{\mu RT}{V}$

Given

$PT^2=K\Rightarrow\frac{\mu RT}{V}.T^2=K\Rightarrow\mu RT^3=KV\ldots(i)$

Differentiating both sides, we get

$3\mu RT^2 dT=K\,dV\ldots(ii)$

Dividing equation (ii) by (i), we get $\frac{3}{T}dT=\frac{dV}{V}$

Coefficient of volume expansion $¿\frac{dV}{V\,dT}=\frac{3}{T}$

427 **(b)**

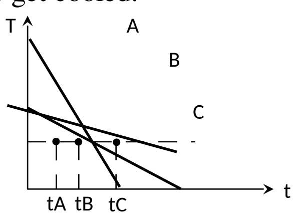
Water has maximum density at $4°C$ so at this temperature, it has minimum volume.

428 **(c)**

Newton's law of cooling is used for the determination of specific heat of liquids

429 **(c)**

Substances having more specific heat take longer time to get heated to a higher temperature and longer time to get cooled.



If we draw a line parallel to the time axis then it cuts the given graphs at three different points. Corresponding points on the times axis shows that $t_C>t_B>t_A\Rightarrow C_C>C_B>C_A$

430 **(d)**

Rate of cooling $R_C=\frac{d\theta}{dt}=\frac{A\varepsilon\sigma(T^4-T_0^4)}{mc}$

$\Rightarrow\frac{d\theta}{dt}\propto\frac{A}{V}\propto\frac{r^2}{r^3}\Rightarrow\frac{d\theta}{dt}\propto\frac{1}{r}$

431 **(d)**

$\lambda_m T=¿$ constant $\Rightarrow\frac{T_1}{T_2}=\frac{\lambda_2}{\lambda_1}\Rightarrow\frac{10^{-4}}{0.5\times 10^{-5}}=200$

432 **(d)**

$\frac{X-LFP}{UFP-LFP}=constant$

Where $X=¿$ Any given temperature on that scale

$L.F.P.=¿$ Lower fixed point (Freezing point)

$U.F.P.=¿$ Upper fixed point (Boiling point)

$\frac{W-39}{239-39}=\frac{39-0}{100-0}$

$\Rightarrow\frac{W-39}{200}=\frac{39}{100}\Rightarrow W=78+39\Rightarrow W=117^o W$

433 **(b)**

Rate of cooling of a body $R=\frac{\Delta\theta}{t}=\frac{A\varepsilon\sigma(T^4-T_0^4)}{mc}$

$\Rightarrow R\propto\frac{A}{m}\propto\frac{Area}{Volume}$

$\Rightarrow$ For the same surface area, $R\propto\frac{1}{Volume}$

$\because$ Volume of cube < Volume of sphere

$\Rightarrow R_{Cube}>R_{Sphere}\,i.e.$ cube, cools down with faster rate

435 **(b)**

$Q=\frac{KA(\theta_1-\theta_2)}{l}t\Rightarrow K_1t_1=K_2t_2\Rightarrow\frac{K_1}{K_2}=\frac{t_2}{t_1}=\frac{35}{20}=\cdot$

[As Q, l, A and $(\theta_1-\theta_2)$ are same]

436 **(c)**

Water will overflow, both when heated or cooled because water has maximum density at $4°C$ or minimum volume at $4°C$

437 **(c)**

Heat absorbed by water = Heat produced

$mc\,\Delta T=\frac{mgh}{J}$

$\Delta T=\frac{gh}{Jc}=\frac{980\times 500\times 100}{4.2\times 10^7\times 1}=\frac{900}{420}=1.16\,°C$

438 **(b)**

The rate of radiated energy $\frac{Q}{t}=P=A\varepsilon\sigma T^4$

$\Rightarrow 1134=5.67\times 10^{-8}\times(0.1)^2 T^4\Rightarrow T=1189\,K$

439 **(a)**

If the room temperature becomes equal to the dew point, the relative humidity of the room is 100%.

440 **(d)**

Temperature of mixture $\theta = \frac{m_1 c_1 \theta_1 + m_2 c_2 \theta_2}{m_1 c_1 + m_2 c_2}$

$\Rightarrow 32 = \frac{m_1 \times 0.2 \times 40 + 100 \times 0.5 \times 20}{m_1 \times 0.2 + 100 \times 0.5} \Rightarrow m_1 = 375\, gm$

441 **(b)**

Since $102.2^o F \rightarrow 39\,℃$ and $98.6^o F \rightarrow 37\,℃$

Hence $\Delta Q = m.\, s.\, \Delta \theta = 80 \times 1000 \times (39 - 37)$

¿ $16 \times 10^4\, cal = 160\, kcal$

442 **(b)**

$$\frac{4\pi}{3}r^3\rho c\left(\frac{-dT}{dt}\right)=\sigma 4\pi r^2(T^4-T_0^4)$$

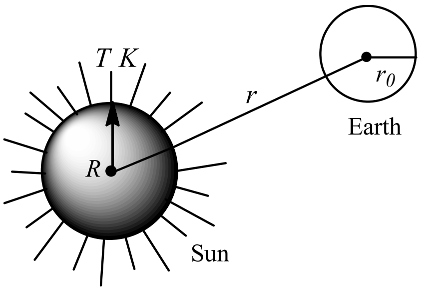
$$\therefore\left(\frac{-dT}{dt}\right)=\frac{3\sigma}{\rho rc}(T^4-T_0^4)=H \qquad \text{(say)}$$

Ratio of rates of fall of temperature

$$\frac{H_A}{H_B}=\frac{r_B}{r_A}$$

443 **(b)**

From Stefan's law, the rate at which energy is radiated by sun at its surface is $P=\sigma\times 4\pi r^2 T^4$



[Sun is a perfectly black body as it emits radiations of all wavelengths and so for it e=1.]

The intensity of this power at earth's surface(under the assumption $r>>r_0$¿ is

$$I=\frac{P}{4\pi R^2}=\frac{\sigma\times 4\pi r^2T^4}{4\pi R^2}=\frac{\sigma R^2\sigma T^4}{r^2}$$

The area of earth which receives this energy is only one-half of total surface area of earth, whose projection would be πr_0^2.

∴ Total radiant power as received by earth

$$¿\pi r_0^2\times I$$

$$=\frac{\pi r_0^2\times\sigma R^2T^4}{r^2}=\frac{\pi r_0^2R^2\sigma T^4}{r^2}$$

444 **(b)**

$$\frac{Q}{t}=\frac{KA(\theta_1-\theta_2)}{l}=\frac{0.2\times 10\times 20}{2\times 10^{-3}}=2\times 10^4\,J/s$$

445 **(b)**

$$\left(\frac{Q}{t}\right)_1=\frac{K_1A_1(\theta_1-\theta_2)}{l} \text{ and } \left(\frac{Q}{t}\right)_2=\frac{K_2A_2(\theta_1-\theta_2)}{l}$$

Given $\left(\frac{Q}{t}\right)_1=\left(\frac{Q}{t}\right)_2\Rightarrow K_1A_1=K_2A_2$

446 **(a)**

$$\frac{h_1}{h_2}=\frac{\rho_2}{\rho_1}=\frac{(1+\gamma\theta_1)}{(1+\gamma\theta_2)}\left[\because \rho=\frac{\rho_0}{(1+\gamma\theta)}\right]$$

$$\Rightarrow\frac{50}{60}=\frac{1+\gamma\times 50}{1+\gamma\times 100}\Rightarrow\gamma=0.005/°C$$

447 **(b)**

Rate of heat flow $\left(\frac{Q}{t}\right)=\frac{k\pi r^2(\theta_1-\theta_2)}{L}\propto\frac{r^2}{L}$

$$\therefore\frac{Q_1}{Q_2}=\left(\frac{r_1}{r_2}\right)^2\left(\frac{l_2}{l_1}\right)=\left(\frac{1}{2}\right)^2\times\left(\frac{2}{1}\right)=\frac{1}{2}\Rightarrow Q_2=2Q_1$$

448 **(a)**

According to Wien's law $\lambda_m T=$¿ constant, on heating up to ordinary temperatures, only long wavelength (red) radiation is emitted. As the temperature rises, shorter wavelengths are also emitted in more and more quantity. Hence the colour of radiation emitted by the hot wire shifts from red to yellow, then to blue and finally to white

449 **(d)**

Pressure at $0\,°C, p_0=40\,cm$

Pressure at $100\,°C, p_{100}=60$cm

Pressure at unknown temperature *t*,

p_t=100 cm of mercury. Then

$$t=100\left(\frac{p_t-p_0}{p_{100}-p_0}\right)$$

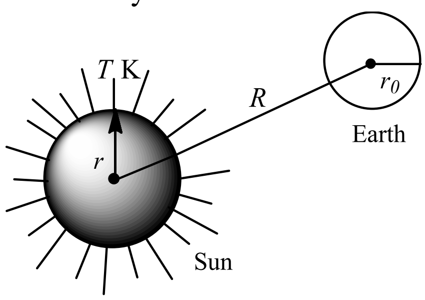
$$¿100\left(\frac{100-40}{60-40}\right)=300^o C$$

450 **(d)**

$$\alpha=\frac{\beta}{2}=\frac{2\times 10^{-5}}{2}=10^{-5}/°C$$

451 **(d)**

From Stefan's law, the rate at which energy is radiated by sun at its surface is



$P=\sigma\times 4\pi r^2T^4$

(Sun is a perfectly black body as it emits radiations of all wavelengths and so for it e=1)

The intensity of this power at earth's surface(under the assumption R>>r_0¿ is

$$I=\frac{P}{4\pi R^2}=\frac{\sigma\times 4\pi r^2T^4}{4\pi R^2}$$

$$¿\frac{\sigma r^2T^4}{R^2}=\frac{\sigma r^2(t+273)^4}{R^2}$$

452 **(a)**

Density of water is maximum at $4\ ℃$ and is less on either side of this temperature

453 **(a)**

$$\frac{K_1}{K_2}=\frac{l_1^2}{l_2^2}\therefore K_2=\frac{K_1 l_2^2}{l_1^2}\approx\frac{0.92\times(4.2)^2}{(8.4)^2}=0.23$$

454 **(c)**

Mud is bad conductor of heat. So it prevents the flow of heat between surroundings and inside

455 **(a)**

The temperature at the contact of the surface

$$¿\frac{K_1 d_2 \theta_1+K_2 d_1 \theta_2}{K_1 d_2+K_2 d_1}$$

$$¿\frac{2K_2 d_2\times 100+2d_2\times K_2\times 25}{2K_2 d_2+K_2 2d_2}$$

$$¿\frac{200+50}{4}=62.6\ ℃$$

456 **(d)**

$$\frac{Q_1}{Q_2}=\left(\frac{T_1}{T_2}\right)^4=\left(\frac{273+27}{273+927}\right)^4=\left(\frac{1}{4}\right)^4=\frac{1}{256}$$

457 **(a)**

Here, $\frac{50}{100}¿$ of rotation) $= c\,m\theta$

$$\frac{1}{2}\left(\frac{1}{2}I\omega^2\right)=cm\theta\frac{1}{4}\left(\frac{2}{5}Ir^2\right)(2\pi n)^2=cm\theta$$

$$\theta=\frac{2}{5}\frac{\pi^2 n^2 r^2}{c}$$

458 **(b)**

$$J=\frac{W}{Q}=\frac{Joule}{cal}$$

459 **(b)**

Due to volume expansion of both liquid and vessel, the change in volume of liquid relative to container is given by $\Delta V=V_0[\gamma_L-\gamma_g]\Delta\theta$

Given $V_0=1000\,cc,\alpha_g=0.1\times 10^{-4}/℃$

$\therefore\gamma_g=3\alpha_g=3\times 0.1\times 10^{-4}/℃=0.3\times 10^{-4}/℃$

$\therefore\Delta V=1000\left[1.82\times 10^{-4}-0.3\times 10^{-4}\right]\times 100=15.2$

460 **(b)**

$$\Delta t=\frac{\Delta Q(\Delta x)}{KA(\Delta T)}$$

When two rods of same length are joined in parallel,

$A\rightarrow 2\wedge(\Delta x)\rightarrow\frac{1}{2}\times¿$

$\therefore\Delta t\ becomes\frac{1}{4}\times ie,\frac{1}{4}\times 12s=3s$

461 **(c)**

$E\propto T^4$ (Stefan's law)

462 **(c)**

Because Planck's law explains the distribution of energy correctly at low temperature as well as at high temperature

463 **(c)**

Since in the region B temperature is constant therefore at this temperature phase of the material changes from solid to liquid and (H_2-H_1) heat will be absorb by the material. This heat is known as the heat of melting of the solid.

Similarly in the region CD temperature is constant therefore at this temperature phase of the material changes from liquid to gas and (H_4-H_3) heat will be absorbed by the material. This heat as known as the heat of vaporisation of the liquid

464 **(c)**

Infinite thermal capacity implies that there would be practically no change in temperature whether heat is taken in or given out.

465 **(b)**

Heat passes quickly from the body into the metal which leads to a cold feeling

466 **(b)**

$$\frac{dQ}{dt}=\frac{KA\Delta T}{x}$$

$$\frac{1.56\times 10^5}{3600}=\frac{K\times 2\times 20}{12\times 10^{-2}}$$

$$K=\frac{1.56\times 10^5\times 12\times 10^{-2}}{3600\times 2\times 10}$$

$$¿\frac{1.56}{12}=0.13$$

467 **(a)**

$$\left(\frac{\Delta Q}{\Delta t}\right)_P=\left(\frac{\Delta Q}{\Delta t}\right)_Q$$

$$K_1 A_1\frac{(T_1-T_2)}{l}=K_2 A_2\frac{(T_1-T_2)}{l}$$

Or $K_1 A_1=K_2 A_2\vee\frac{A_1}{A_2}=\frac{K_2}{K_1}$

468 **(c)**

When light incident on pin hole, enters into the box and suffers successive reflection at the inner wall. At each reflection some energy is absorbed. Hence the ray once it enters the box can never come out and pin hole acts like a perfect black body

469 **(b)**

In the given graph CD represents liquid state

470 **(b)**

For θt plot, rate of cooling ¿ $\frac{d\theta}{dt}$ =¿ slope of the curve

At $P, \frac{d\theta}{dt}=\tan\phi_2=k(\theta_2-\theta_0)$, where $k=$¿ constant

At $Q, \frac{d\theta}{dt}=\tan\phi_1=k(\theta_1-\theta_0)\Rightarrow\frac{\tan\phi_2}{\tan\phi_1}=\frac{\theta_2-\theta_0}{\theta_1-\theta_0}$

471 **(b)**

Here, $\gamma_{ag}=10.30\times10^{-4}°C^{-1}$

$\gamma_{am}=10.06\times10^{-4}°C^{-1}$

$\alpha_a=9\times10^{-6}°C^{-1}, \alpha_m=?$

Now, $\gamma_r=\gamma_{ag}+g_{glass}=\gamma_{am}+g_m$

$\therefore 10.30\times10^{-4}+3\times9\times10^{-6}=10.06\times10^{-4}+g_m[\because$

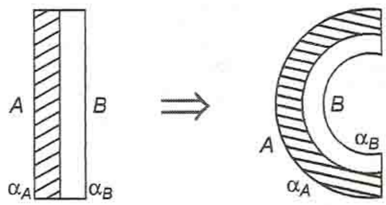
$\therefore g_m=(10.30+0.27-10.06)10^{-4}=0.51\times10^{-4}$

$\alpha_m=\frac{1}{3}g_m=\frac{0.50\times10^{-4}}{3}$

$=0.17\times10^{-4}=17\times10^{-6}°C^{-1}$

472 **(c)**

A bimetallic strip on being heated bends in from of an arc with more expandable metal (A) outside (as shown)



474 **(c)**

When state is not changing $\Delta Q=mc\Delta\theta$

475 **(b)**

Energy received per second $i.e.$, power

$P\propto(T^4-T_0^4)$

$\Rightarrow P\propto T^4(\because T_0<$¿$T)$

Also energy received per sec $(P)\propto\frac{1}{d^2}$

(inverse square law)

$\Rightarrow P\propto\frac{T^4}{d^2}\Rightarrow\frac{P_1}{P_2}=\left(\frac{T_1}{T_2}\right)^4\times\left(\frac{d_2}{d_1}\right)^2$

$\Rightarrow\frac{P}{P_2}=\left(\frac{T}{2T}\right)^4\times\left(\frac{2d}{d}\right)^2=\frac{1}{4}\Rightarrow P_2=4P$

476 **(a)**

If mass of the bullet is $m\,gm$,

Then total heat required for bullet to just melt down

$Q_1=mc\Delta\theta+mL=m\times0.03(327-27)+m\times6$

¿$15m\,cal=(15m\times4.2)J$

Now when bullet is stopped by the obstacle, the loss in its mechanical energy ¿$\frac{1}{2}(m\times10^{-3})v^2J$

(As $m\,g=m\times10^{-3}kg$)

As 25% of this energy is absorbed by the obstacle,

The energy absorbed by the bullet

$Q_2=\frac{75}{100}\times\frac{1}{2}mv^2\times10^{-3}=\frac{3}{8}\times10^{-3}J$

Now the bullet will melt if $Q_2\geq Q_1$

$i.e., \frac{3}{8}mv^2\times10^{-3}\geq15m\times4.2\Rightarrow v_{min}=410\,m/s$

477 **(a)**

The velocity of heat radiation in vacuum is equal to that of light

478 **(c)**

Equivalent thermal conductivity of the compound, slab,

$$K_{eq}=\frac{l_1+l_2}{\frac{l_1}{K_1}+\frac{l_2}{K_2}}=\frac{l+l}{\frac{l}{K}+\frac{l}{2K}}$$

$$=\frac{2l}{\frac{3l}{2K}}=\frac{4}{3}\text{K}$$

479 **(a)**

$\frac{C_P}{C_V}=\gamma\Rightarrow C_P=C_V.\gamma\ But\ C_P-C_V=R$

$\Rightarrow C_P=R+C_V$

$\therefore\gamma C_V=C_V+R\Rightarrow C_V(\gamma-1)=R\Rightarrow C_V=\frac{R}{\gamma-1}$

480 **(a)**

$\theta=\frac{\Delta L}{L_0\Delta\alpha}=\frac{(1-0.9997)}{0.9997\times12\times10^{-6}}=25°C$

481 **(c)**

$\frac{Q}{t}=\frac{KA(\theta_1-\theta_2)}{l}\Rightarrow\frac{Q}{t}\propto\frac{A}{l}\propto\frac{r^2}{l}$

[As $(\theta_1-\theta_2)$ and K are constant]

$\Rightarrow\frac{\left(\frac{Q}{t}\right)_1}{\left(\frac{Q}{t}\right)_2}=\frac{r_1^2}{r_2^2}\times\frac{l_2}{l_1}=\frac{4}{9}\times\frac{2}{1}=\frac{8}{9}$

482 **(d)**

$\frac{C}{5}=\frac{F-32}{9}\Rightarrow\frac{C}{5}=\frac{140-32}{9}\Rightarrow C=60°C$

484 **(c)**

Pyrometer can measure temperature from 800 $°C$ to 6000 $°C$. Hence temperature of sun is measured with pyrometer

485 **(c)**

The heat radiation emitted by the human body is the infrared radiation. Their wavelength is of the order of 7.9×10^{-7}m to 10^{-3} m which is of course the range of infrared region. Hence, human body emits radiation in infrared region.

486 **(a)**

$v'^2 \propto T\left(\because T \propto K.E.=\frac{1}{2}mv^2\right)$

487 **(b)**

Change in length of brass rod

$\Delta l_B=\alpha_B l_B(T_2-T_1)$

$= 2.5\times10^{-5}\times500\times(200-50)$

= 1.875 mm

Similarly change in length of the steel rod

$\Delta i l_s=\alpha_B l_S(T_2-T_1)$

$= 1.25\times10^{-5}\times500\times(200-50)$

= 0.9375 mm

Therefore, change in length of the combined rod

$=\Delta l_B+\Delta l_S=1.875+0.9375$

= 2.8175 mm =2.8 mm

488 **(b)**

If the ball is heated then it will expand at free surface, so the ball will expand at outer and inner both surfaces. Hence, the volume of cavity which is inside the ball, decreases.

489 **(c)**

Heat required to convert 10 g of ice at $0°C$ to water at $0°C$

$Q_1 mL=10\times80$ cal

Heat required to raise the temperature of water from $0°C$ to $20°C$

$Q_1=cm\theta=1\times10\times20=200$ cal

Total heat required

$=Q_1+Q_2=800+200=1000$ cal

490 **(b)**

For parallel combination of two rods of equal lengths and equal areas of cross-section,

$K=\frac{K_1+K_2}{2}$

¿ $\frac{K_1+\frac{4K_1}{3}}{2}$

¿ $\frac{7K_1}{6K_1}=\frac{7}{6}$

491 **(d)**

Rate of loss of heat $\left(\frac{\Delta Q}{t}\right)\propto$ temperature difference

$\Delta\theta$

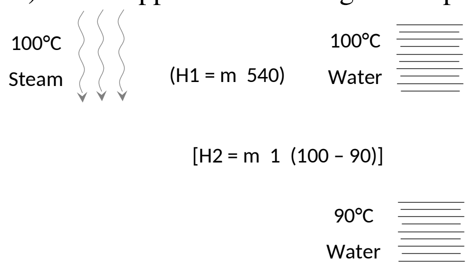
$\frac{\left(\frac{\Delta Q}{t}\right)_1}{\left(\frac{\Delta Q}{t}\right)_2}=\frac{\Delta\theta_2}{\Delta\theta_1}\Rightarrow\frac{60}{\left(\frac{\Delta Q}{t}\right)_2}=\frac{80-20}{40-20}\Rightarrow\left(\frac{\Delta Q}{t}\right)_2=\frac{20c}{s}$

492 **(c)**

$\frac{F-32}{9}=\frac{K-273}{5}\Rightarrow\frac{x-32}{9}=\frac{x-273}{5}\Rightarrow x=574.25$

493 **(a)**

Let $m\,gm$ of steam get condensed into water (By heat loss). This happens in following two steps.



Heat gained by water $(20\,°C)$ to raise it's temperature upto $90^o=22\times1\times(90-20)$

Hence, in equilibrium heat lost = Heat gain

$\Rightarrow m\times540+m\times1\times(100-90)=22\times1\times(90-20)$

$\Rightarrow m=2.8g$

The net mass of the water present in the mixture

¿ $22+2.8=24.8g$

494 **(d)**

$Q\propto T^4\Rightarrow\frac{Q_1}{Q_2}=\left(\frac{T_1}{T_2}\right)^4$

$\Rightarrow\frac{Q_1}{Q_2}=\left(\frac{T}{T+T/2}\right)^4=\frac{16}{81}\Rightarrow Q_2=\frac{81}{16}Q_1$

% increase in energy ¿ $\frac{Q_2-Q_1}{Q_1}\times100=400\%$

495 **(b)**

$\frac{C}{100}=x-lower$ ¿ $point\,\frac{¿}{upper\,¿}\,point-lower\,poi$

$C=\frac{700}{10}=70°$

496 **(c)**

According to Newton's law of cooling

Rate of cooling ∝ mean temperature difference

Initially, mean temperature difference

¿ $\left(\frac{70+60}{2}-\theta_0\right)=(65-\theta_0)$

Finally, mean temperature difference

¿ $\left(\frac{60+50}{2}-\theta_0\right)=(55-\theta_0)$

In second case mean temperature difference decreases, so rate of fall of temperature decreases, so it takes more time to cool through the same range

497 **(b)**

Change in resistance $3.70-2.71=0.99\,\Omega$ corresponds to interval of temperature $90\,℃$

So change in resistance $3.26-2.71=0.55\,\Omega$

Corresponds to change in temperature

¿ $\frac{90}{0.99}\times 0.55=50\,℃$

498 **(d)**

A	B	C

$$K_B=\frac{K_A}{2}$$

$K_B=3K_C$

$K_C=\frac{K_A}{6}$

$\frac{l}{K_s}=\frac{l_1}{K_A}+\frac{l_2}{K_B}+\frac{l_3}{K_C}$

$\frac{3l}{K_S}=\frac{l}{K_A}+\frac{l}{\frac{K_A}{2}}+\frac{l}{\frac{K_A}{6}}$

$\frac{3l}{K_S}=\frac{9l}{K_A}$

$K_S=\frac{K_A}{3}$

499 **(d)**

Fall in temperature of copper block when it is placed on the ice block $=\Delta T=425-0=425\,℃$.

Heat lost by copper block when it is placed on the ice block.

$Q_1=m_1 s\Delta T$

$= 4\times 500\times 425=850\,kJ$

Heat gained by ice in melting into m_2 kg of water.

$Q_2=m_2 L$

¿ $m_2\times 336$

¿ $336\,m_2\,kJ$

According to Calorimetry principle,

Heat lost=Heat gained

ie, $850=336\,m_2$

$\therefore \quad m_2=\frac{850}{336}=2.5\,kg$

501 **(a)**

Cubical expansion

$\Delta V=\gamma V\Delta T$

$\Delta V=3\alpha V\Delta T$

$= 3\times 23\times 10^{-6}\times\left(\frac{4}{3}\pi\times 10^3\right)\times 100$

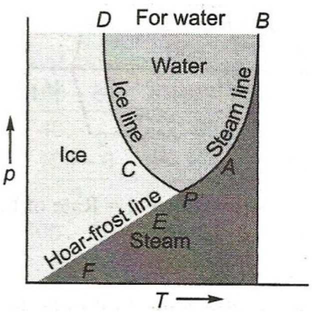
$= 28.9$cc

502 **(c)**

In the $p-T$ diagram of water, if the three curves AB, CD and EF are extended, they came to meet at a point *P*, called the triple point.

Therefore, triple point of a substance is a point in the phase diagram representing a particular set of pressure and temperature at which the solid, liquid and vapour phases of the substance can coexist.

For water, the values of pressure and temperature corresponding to triple point P are 0.46 cm of mercury and 273.16 K (or $0.01℃$) respectively.



504 **(c)**

For a black body $\frac{Q}{t}=P=A\sigma T^4$

$\Rightarrow\frac{P_2}{P_1}=\left(\frac{T_2}{T_1}\right)^4\Rightarrow\frac{P_2}{20}=\left(\frac{273+727}{273+227}\right)^4$

$\Rightarrow\frac{P_2}{20}=(2)^4\Rightarrow P_2=320\,W$

506 **(a)**

$c=\frac{\Delta Q}{m.\Delta T}=\frac{\Delta Q}{m\times 0}=0$

507 **(c)**

Heat energy always flow from higher temperature to lower temperature. Hence, temperature difference $w.r.t.$ length (temperature gradient) is required to flow heat from one part of a solid to other part

508 **(d)**

In conducting rod given heat transmits so burning temperature does not reach soon. In wooden rod heat doesn't conducts

509 **(d)**

Let final temperature be θ

Now heat taken by ice$=m_1 L+m_1 c_1 \theta_1$

$¿ 5\times 80+5\times 1(\theta-0)$

$=400+5\theta$

…(i)

Heat given by water at 40 ℃

$¿ m_2 C_2 \theta_2=20\times 1\times(40°-\theta)$ …(ii)

Heat given=Heat taken

$800-¿ 20\theta=400+¿ 5\theta$

or $25\theta = 400$,

or $\theta=\frac{400}{25}=16℃$

510 **(a)**

Heat current $H=\frac{KA\Delta\theta}{l}$

$\therefore \quad \Delta\theta=\frac{Hl}{KA}$

$¿ \frac{30\times 1\times 10^{-2}}{0.76\times 100\times 10^{-4}}=39.47$

$¿ 40℃(¿.)$

511 **(a)**

For black body, $P=A\varepsilon\sigma T^4$. For same power $A\propto\frac{1}{T^4}$

$\Rightarrow\left(\frac{r_1}{r_2}\right)^2=\left(\frac{T_2}{T_1}\right)^4\Rightarrow\frac{r_1}{r_2}=\left(\frac{T_2}{T_1}\right)^4$

512 **(a)**

When the temperature of an object is equal to that of human body, no heat is transferred from the object to body and vice versa. Therefore block of wood and block of metal feel equally cold and hot if they have same temperature as human body

513 **(b)**

$\frac{C}{5}=\frac{F-32}{9}\Rightarrow\frac{-183}{5}=\frac{F-32}{9}\Rightarrow F=-297^o F$

514 **(a)**

$\frac{Q}{t}=\frac{KA\Delta\theta}{l}\Rightarrow\frac{\Delta\theta}{(l/KA)}=\frac{\Delta\theta}{R}¿$ Thermal resistance]

$\Rightarrow t\propto R¿$ and $\Delta\theta$ are same]

$\Rightarrow\frac{t_p}{t_s}=\frac{R_P}{R_S}=\frac{R/2}{2R}=\frac{1}{4}\Rightarrow t_P=\frac{t_S}{4}=\frac{4}{4}=1\,min$

[Series resistance $R_S=R_1+R_2$ and parallel resistance

$R_P=\frac{R_1 R_1}{R_2+R_2}$]

515 **(a)**

Moment of inertia of a rod,

$I=\frac{1}{12}ML^2 \quad \ldots(i)$

Where M is the mass of the rod and L is the length of the rod

$\therefore \Delta I=\frac{1}{12}2ML\Delta L(\because M \, is \, a \, constant) \quad \ldots(ii)$

Divide (ii) by (i), we get

$\frac{\Delta I}{I}=2\frac{\Delta L}{L} \quad \ldots(iii)$

As $\Delta L=L\alpha\Delta t$

Or $\frac{\Delta L}{L}=\alpha\Delta t$

Substituting the value of $\frac{\Delta L}{L}$ in (iii), we get

$\frac{\Delta I}{I}=2\alpha\Delta t$

516 **(c)**

Relative humidity at a given temperature (R)

$$¿\frac{\partial \, pressure \, of \, water \, vapour}{Vapour \, pressure \, of \, water}$$

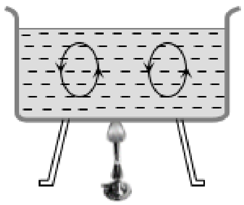
$$¿\frac{0.012\times10^5}{0.016\times10^5}=0.75=75\%$$

517 **(d)**

Since, the coefficient of linear expansion of brass is greater than that of steel. On cooling, the brass contracts more, so, it get loosened

519 **(c)**

In convection hot particles move upward (due to low density) and light particle move downward (due to high density)



520 **(c)**

Energy radiated per unit time

$$E=\sigma AT^4$$

Where $\sigma=Stefan's constant$

$\therefore$ For sun $E_{sun}=\sigma A_{sun}T^4_{sun}$

According to question

$$E_{star}=10000\,E_{sun}$$

$$\sigma A_{star}\times T^4_{star}=10000\times\sigma A_{sun}\times T^4_{sun}$$

$$\pi R^2_{star}T^4_{star}=10000\times\pi R^2_{sun}\times T^4_{sun}$$

$$\left(\frac{R_{star}}{R_{sun}}\right)^2=10000\left(\frac{T_{sun}}{T_{star}}\right)^4$$

$$¿10000\left(\frac{6000}{2000}\right)^4$$

$$\Rightarrow\frac{R_{star}}{R_{sun}}=\sqrt{10000\times(3)^4}$$

$$¿100\times3^2=900$$

$$R_{star}:R_{sun}=900:1$$

521 **(b)**

The change in length Δl is proportional to l and ΔT. Stated mathematically

$$\Delta l=\alpha l\Delta T$$

Where α is called the coefficient of linear thermal expansion for the material.

Given, $\alpha=10\times10^{-6}/°C$, $\quad \Delta T=100\,°C$

$l=10$m

$\therefore \quad \Delta l=10\times100\times10\times10^{-6}$

$= 10^{-2}$m=1 cm

522 **(a)**

As $V=L^3$

$\therefore\frac{\Delta V\times100}{V}=3\frac{\Delta L\times100}{L}$

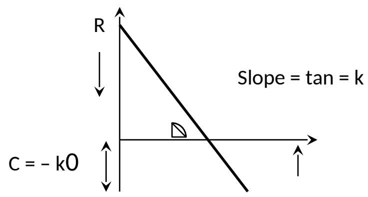
$= 3\times0.2\%=0.6\%$

523 **(c)**

Rate of loss of heat $(R)\propto$ temperature difference

$\Rightarrow R\propto(\theta-\theta_0)\Rightarrow R=k(\theta-\theta_0)=k\theta-k\theta_0¿$ constant]

On comparing it with $y=mx+c$ it is observed that, the graph between R and θ will be straight line with slope $¿k$ and intercept $¿-k\theta_0$



524 **(c)**

According to Stefan's law

$$E=\sigma T^4$$

Where σ is Stefan's constant.

Given, $T=2T_s$

$\therefore \quad E'=\sigma(2T_s)^4=16\sigma T_s^4=16E_s$

Hence, total energy radiated by star is sixteen times as that of the sun.

525 **(a)**

$$\frac{365-361}{2}=K\left[\frac{365+361}{2}-293\right]=70K\Rightarrow K=\frac{1}{35}$$

Again $\frac{344-342}{t}=\frac{1}{35}\left[\frac{344+342}{2}-293\right]=\frac{10}{7}$

$\Rightarrow t=\frac{14}{10}min=\frac{14}{10}\times 60=84\,s$

526 **(a)**

The temperature of ice will increases from $-10\,℃$ ¿ $0\,℃$.

Heat supplied in this process will be

$$Q=m s_i(10)$$

Here, m=mass of ice

s_i=specific heat of ice

Then ice starts melting. Temperature during melting will remain constant (0℃ ¿. Heat supplied in this process will be

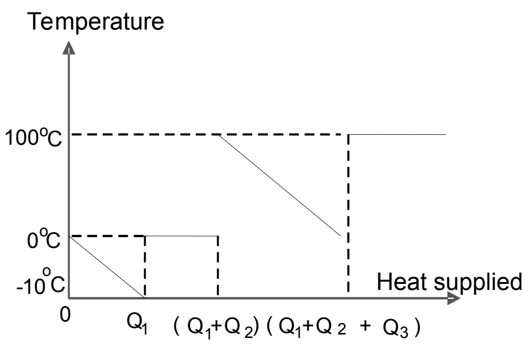
$$Q_2=mL\,where\,,L=latent\,heat\,of\,melting$$

Now, the temperature of water will increase from $0\,℃$ ¿ $100\,℃$. Heat supplied will be $Q_3=m s_w(100)$

where $s_w=specific\,heat\,of\,water$.

Finally water at 100℃ will be converted into steam at 100℃ and during this process temperature again remains constant.

Temperature $versus$ heat supplied graph will be as follows



528 **(b)**

For a black body rate of energy $\frac{Q}{t}=P=A\sigma T^4$

$\Rightarrow P\propto T^4\Rightarrow\frac{P_1}{P_2}=\left(\frac{T_1}{T_2}\right)^4=\left\{\frac{(273+7)}{(273+287)}\right\}^4=\frac{1}{16}$

529 **(a)**

For the two sheets, shown in figure, rate of heat transfer is same, ie,

$\frac{dQ_1}{dt}=\frac{dQ_2}{dt}$

$\therefore\frac{dT_1}{R_1}=\frac{dT_2}{R_2}$

$\frac{\theta_1-\theta}{R_1}=\frac{\theta-\theta_2}{R_2}$

$\theta_1 R_2-\theta R_2=\theta R_1-\theta_2 R_1,\theta\frac{\theta_1 R_2+\theta_2 R_1}{R_1+R_2}$

530 **(a)**

According to Wien's displacement law

$\lambda_m=\frac{b}{T}\Rightarrow T=\frac{b}{\lambda_m}=\frac{2.93\times 10^{-3}}{4000\times 10^{-10}}=7325$ K

531 **(c)**

Wien's displacement law

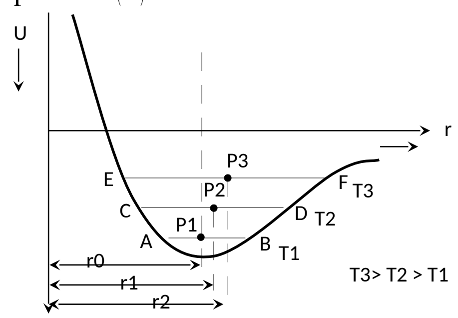
$\lambda_{max}.T=b$ where b =Wien's constant

$\therefore\lambda_{max}\propto\frac{1}{T}$

Thus, λ_{max} is inversely proportional to absolute temperature (T).

532 **(d)**

The expansion of solids can be well understood by potential energy curve for two adjacent atoms in a crystalline solid as a function of their intermolecular separation (r).



At ordinary temperature: Each molecule of the solid vibrates about it's equilibrium position P_1 between A and B (r_0 is the equilibrium distance of it from some other molecule)

At high temperature: Amplitude of vibration increases $(C\leftrightarrow D\wedge E\leftrightarrow F)$. Due to asymmetry of the curve, the equilibrium positions $(P_2\wedge P_3)$ of molecule is displaced. Hence it's distance from other molecules increses $(r_2>r_1>r_0)$.

Thus, on raising the temperature, the average equilibrium between the molecules increases and the solid as a whole expands

533 **(d)**

Zero kelvin ¿ $-273\,℃$ (absolute temperature). As no matter can attain this temperature, hence temperature can never be negative on Kelvin scale

534 **(a)**

Let the final temperature of the mixture be t.

Heat lost by water

at $80°C = ms\Delta t$

$= 0.1 \times 10^3 \times s_{water} \times (80° - t)$

¿)

Heat against by water at $60°C$

$= 0.3 \times 10^3 \times s_{water} \times (t - 60°)$

According to principle of Calorimetry,

Heat lost = Heat against

$0.1 \times 10^3 \times S_{water} \times (80° - t) = 0.3 \times 10^3 \times S_{water} \times (t -$

or $(80° - t) = 3 \times (t - 60°)$

or $4t = 260 °C$

or $t = 65 °C$

535 **(c)**

Rate of loss of heat is directly proportional to the temperature difference between water and the surroundings

536 **(b)**

$\frac{C}{5} = \frac{F-32}{9} \Rightarrow \frac{25}{5} = \frac{F-32}{9} = F = 77^o F$

537 **(d)**

According to Wien's displacement law,

$\lambda_m T = constant$

or $\lambda_m \propto \frac{1}{T}$

or $\frac{(\lambda_m)_1}{(\lambda_m)_2} = \frac{T_2}{T_1}$

$\therefore$ $\frac{5000}{(\lambda_m)_2} = \frac{2227+273}{1227+273}$

or $\frac{5000}{(\lambda_m)_2} = \frac{2500}{1500}$

$\therefore$ $(\lambda_m)_2 = 3000\, Å$

538 **(d)**

$A \propto L^2 \Rightarrow \frac{\Delta A}{A} = 2.\frac{\Delta L}{L} \Rightarrow \frac{\Delta A}{A} = 2 \times 2 = 4\%$

539 **(b)**

In first case $\frac{50-40}{5} = K\left[\frac{50+40}{2} - \theta_0\right]$ …(i)

In second case $\frac{40-33.33}{5} = K\left[\frac{40+33.33}{2} - \theta_0\right]$

…(ii)

By solving $\theta_0 = 20 °C$

540 **(d)**

$n = 8\, mole, \Delta t = 30 °C$

$\theta = n c_p \Delta t$

$\theta = 8 \times \frac{5}{2} \times 8.31 \times 30 = 5000$

541 **(d)**

The polished surface reflects all the radiation

542 **(a)**

The energy emitted by a body, in the form of radiation on account of its temperature, is called thermal radiation. These radiations are heat radiations and travel along straight lines with the speed of light.

543 **(a)**

$\gamma_{app.} = \frac{Mass\ expelled}{Mass\ remained \times \Delta T}$

¿ $\frac{x/100}{x \times 80} = \frac{1}{8000} = 1.25 \times 10^{-4}/°C$

544 **(b)**

We know that $\frac{dQ}{dt} = kA\frac{d\theta}{dx}$

In steady state flow of heat

$d\theta = \frac{dQ}{dt} \cdot \frac{1}{kA} dx$

$\Rightarrow$ $\theta_H - \theta = k'x$

$\Rightarrow$ $\theta = \theta_H - k'x$

Equation $\theta = \theta_H - k'x$ represents a straight line.

545 **(d)**

$\theta_{mix} = \frac{m_W \theta_W - \frac{m_i L_i}{S_W}}{m_i + m_W} = \frac{300 \times 25 - \frac{100 \times 80}{1}}{100 + 300} = -1.2$

Which is not possible. Hence $\theta_{mix} = 0 °C$

546 **(d)**

$E \propto T^4$

547 **(b)**

$\frac{\Delta T_C}{100} = \frac{\Delta T_F}{180} = \frac{212 - 140}{180}$

$i.e., \Delta T_C = 100 \times \frac{72}{180} = 40 °C$

$\therefore$ Fall in temperature ¿40^o

548 **(b)**

When salt crystals dissolve, crystal lattice is destroyed. The process requires a certain amount of energy (latent heat) which is taken from the water. In vessel (B), a part of intermolecular bonds has already been destroyed in crushing the crystal. Hence less energy is required to dissolve the powder and the water will be at higher temperature

549 **(c)**

For brass rod A

Volume $V_1 = \pi(2r)^2 \times l \quad \ldots$(i)

For volume expansion

$V'_1 = V_1$¿

$\Rightarrow \quad V'_1 - V_1 \propto V_1$

Or $\quad \Delta V_1 \propto V_1 \quad \ldots$(ii)

Similarly, for brass rod B

Volume $\quad V_2 = \pi(r)^2 \times 2l \quad \ldots$(iii)

and $\quad \Delta V_2 \propto V_2 \quad \ldots$(iv)

Dividing Eq. (i) by Eq. (ii), we get

$$\frac{V_1}{V_2} = \frac{\pi 4r^2 l}{\pi r^2 2l} = \frac{2}{1}$$

From eqs. (ii) and (iv),

$$\frac{\Delta V_1}{\Delta V_2} = \frac{2}{1}$$

550 **(a)**

Heat current $H = \frac{\Delta\theta}{R} \Rightarrow \frac{H_P}{H_S} = \frac{R_S}{R_P}$

In first case : $R_S = R_1 + R_2 = \frac{l}{(3K)A} + \frac{l}{KA} = \frac{4}{3}\frac{l}{KA}$

In second case :

$$R_P = \frac{R_1 R_2}{R_1 + R_2} = \frac{\frac{1}{(3K)A} \times \frac{l}{KA}}{\left(\frac{l}{(3K)A} + \frac{l}{KA}\right)} = \frac{l}{4KA}$$

$$\therefore \frac{H_P}{H_S} = \frac{\frac{4l}{3KA}}{\frac{l}{4KA}} = \frac{16}{3}$$

551 **(b)**

Calorimeters are made by conducting materials

553 **(a)**

As for a black body rate of absorption of heat is more. Hence thermometer A shows faster rise in temperature but finally both will acquire the atmosphere temperature

554 **(b)**

Wien's displacement law is given by

$$\lambda_m T = constant$$

(say b)

Given, b=Wien's constant=$2.93 \times 10^{-3} m - K$

$$\lambda_m = 2.93 \times 10^{-10} m$$

Substituting the values, we obtain

$$T = \frac{b}{\lambda_m}$$

¿ $\frac{2.93 \times 10^{-3}}{2.93 \times 10^{-10}} = 10^7 K$

555 **(b)**

$Q = m.c.\Delta\theta$;if $\Delta\theta = 1K$ then $Q = mc =$¿ Thermal capacity

556 **(c)**

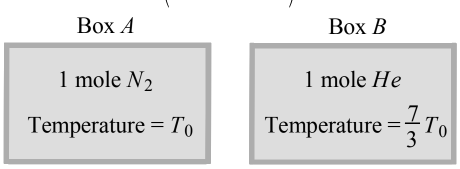
A lake cools from the surface to bottom. Above $4\ ℃$ the cooled water at the surface flows to the bottom because of it's greater density. But when the surface temperature drops below $4\ ℃$ (here it is $2\ ℃$), the water near the surface is less dense than the warmer water below. Hence the downward flow ceases, the water at the bottom remains at $4\ ℃$ until nearly the entire lake, is frozen

557 **(b)**

When two gases are mixed together then

Heat lost by the Helium gas = Heat gained by the Nitrogen gas

$$\mu_B \times (C_v)_{He} \times \left(\frac{7}{3}T_0 - T_f\right) = \mu_A \times (C_v)_{N_2} \times (T_f - T_0)$$



$$\Rightarrow 1 \times \frac{3}{2}R \times \left(\frac{7}{3}T_0 - T_f\right) = 1 \times \frac{5}{2}R \times (T_f - T_0)$$

By solving we get $T_f = \frac{3}{2}T_0$

558 **(b)**

$\frac{dQ}{dt} = KA\frac{d\theta}{dl} \Rightarrow \frac{dQ}{dt} \propto \frac{d\theta}{dl}$ [Temperature gradient]