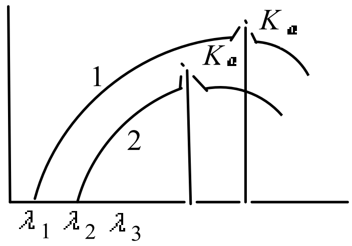
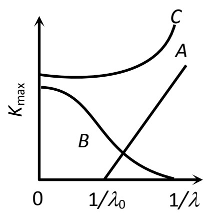
11.DUAL NATURE OF RADIATION AND MATTER

Single Correct Answer Type

1. The ratio of the energy of an X-ray photon of wavelength 1 Å to that of visible light of wavelength 5000 Å is
   a) 1 :5000 b) 5000 :1 c) $1: 25 \times 10^6$ d) 25×10^6
2. If light of wavelength λ_1 is allowed to fall on a metal, then kinetic energy of photoelectrons emitted is E_1. If wavelength of light changes to λ_2 then kinetic energy of electrons changes to E_2. Then work function of the metal is
   a) $\frac{E_1E_2(\lambda_1-\lambda_2)}{\lambda_1\lambda_2}$ b) $\frac{E_1\lambda_1-E_2\lambda_2}{(\lambda_1-\lambda_2)}$ c) $\frac{E_1\lambda_1-E_2\lambda_2}{(\lambda_2-\lambda_1)}$ d) $\frac{\lambda_1\lambda_2E_1E_2}{(\lambda_2-\lambda_1)}$
3. When two different materials A and B having atomic number Z_1 and Z_2 are used as the target in Coolidge γ-ray tube at different operating voltage V_1 and V_2 respectively their spectrums are found as below.



   The correct relation is
   a) $V_1 > V_2$ and $Z_1 > Z_2$ b) $V_1 < V_2$ and $Z_1 < Z_2$ c) $V_1 < V_2$ and $Z_1 > Z_2$ d) $V_1 > V_2$ and $Z_1 < Z_2$
4. If the linear momentum of a particle is 2.2×10^4 kg-ms^{-1}, then what will be its de-Broglie wavelength? (Take $h = 6.6 \times 10^{-34}\ Js$)
   a) 3×10^{-29}m b) 3×10^{-29}nm c) 6×10^{-29}m d) 6×10^{-29}nm
5. The rest mass of the photon is
   a) 0 b) ∞
   c) Between 0 and ∞ d) Equal to that of an electron
6. The value of Plank energy is
   a) $\frac{nhc}{\lambda}$ b) $nh\lambda$ c) $nhc\lambda$ d) $\frac{nh\lambda}{c}$
7. The ratio of specific charge of an α-particle to that of a proton is
   a) 2 :1 b) 1 :1 c) 1 :2 d) 1 :3
8. The correct graph between the maximum energy of a photoelectron and the inverse of wavelength of the incident radiation is given by the curve



   a) A b) B c) C d) None of the above
9. Two identical metal plates shown photoelectric effect by a light of wavelength λÅ falls on plate A and λ_B on plate $B(\lambda_A = 2\lambda_B)$. The maximum kinetic energy is
   a) $2\ K_A = K_B$ b) $K_A < K_B/2$ c) $K_A = 2K_B$ d) $K_A = K_B/2$
10. Quantum nature of light is explained by which of the following phenomenon
    a) Huygen wave theory b) Photoelectric effect
    c) Maxwell electromagnetic theory d) De-Broglie theory
11. Energy from the sun is received on earth at the rate of 2 cal per cm^2 per min. if average wavelength of solar light be taken at 5500 A then how many photons are received on the earth per cm^2 per min?

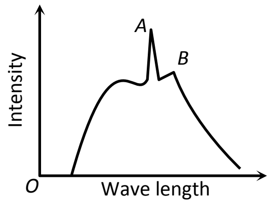
(Take $h = 6.6 \times 10^{-34}$Js, 1cal=4.2 J).

a) 1.5×10^{13} b) 2.9×10^{13} c) 2.3×10^{19} d) 1.75×10^{19}

12. Which phenomenon best supports the theory that matter has a wave nature

a) Electron momentum b) Electron diffraction c) Photon momentum d) Photon diffraction

13. The figure represents the observed intensity of X-rays emitted by an X-ray tube as a function of wavelength. The sharp peaks A and B denote



a) Band spectrum b) Continuous spectrum

c) Characteristic radiations d) White radiations

14. The frequency of a photon, having energy 100 eV is ($h = 6.6 \times 10^{-34} J\text{-}s$)

a) $2.42 \times 10^{26} Hz$ b) $2.42 \times 10^{16} Hz$ c) $2.42 \times 10^{12} Hz$ d) $2.42 \times 10^{9} Hz$

15. Which of the following have highest specific charge

a) Positron b) Proton c) He d) None of these

16. Planck's constant has the dimensions of

a) Energy b) Mass c) Frequency d) Angular momentum

17. The de-Broglie wavelength is proportional to

a) $\lambda \propto \frac{1}{v}$ b) $\lambda \propto \frac{1}{m}$ c) $\lambda \propto \frac{1}{p}$ d) $\lambda \propto p$

18. A parallel beam of light is incident normally on a plane surface absorbing 40% of the light and reflecting the rest. If the incident beam carries 60 W of power, the force exerted by it on the surface is

a) 3.2×10^{-8}N b) 3.2×10^{-7}N c) 5.12×10^{-7}N d) 5.12×10^{-8}N

19. Given below is a list of electromagnetic spectrum and its mode of production. Which one does not match

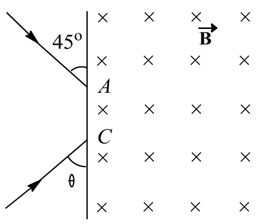
a) Gamma rays – Radioactive of the nucleus

b) Ultraviolet – Magnetron valve

c) Infrared – Vibration of atoms and molecules

d) Radiowave – Rapid acceleration and decelaration of electrons in conducting wires

20. A proton of mass 1.67×10^{-27} kg enters a uniform magnetic field of 1 T at point A as shown in figure, with a speed of 10^7 ms^{-1}. The magnetic field is directed normal to the plane of paper downwards. The proton emerges out of the magnetic field at point C, then the distance AC and the value of angle θ will respectively be



a) 0.7 m, 45° b) 0.7 m, 90° c) 0.14 m, 90° d) 0.14 m, 45°

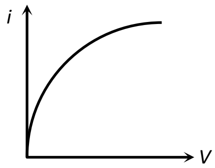
21. The uncertainty in the position of a particle is equal to the de-Broglie wavelength. The uncertainty in its momentum will be

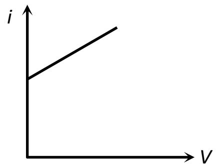
a) h/λ b) $2h/3\lambda$ c) λ/h d) $3\lambda/2h$

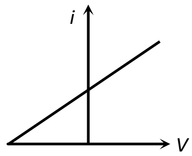
22. The work functions for sodium and copper are $2eV$ and $4eV$. Which of them is suitable for a photocell with 4000 Å light

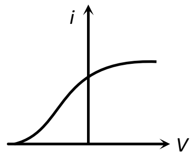
a) Copper b) Sodium c) Both d) Neither of them

23. The curve between current (i) and potential difference (V) for a photo cell will be

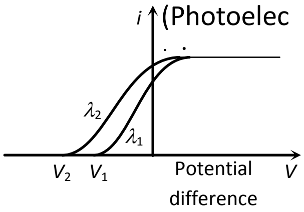
a) 

b) 

c) 

d) 

24. What will be the number of photons emitted per second by a 10 W sodium vapour lamp assuming that 90% of the consumed energy is converted into light? Wavelength of sodium light is 590 nm, $h = 6.63 \times 10^{-34}$J-s.
a) 0.267×10^{18} b) 0.267×10^{19} c) 0.267×10^{20} d) 0.267×10^{17}
25. For the Bohr's second orbit of circumference $2\pi r$, the de-Broglie wavelength of revolving electron will be
a) $2\pi r$ b) πr c) $\frac{1}{2\pi r}$ d) $\frac{1}{4\pi r}$
26. The work function of a metal is
a) The energy for the electron to enter into the metal
b) The energy for producing X-ray
c) The energy is required for an electron to come out from metal surface
d) None of these
27. If the uncertainty in the position of proton is 6×10^{8}m, then the minimum uncertainty in its speed will be
a) 1 cms^{-1} b) 1 ms^{-1} c) 1 mms^{-1} d) 100 ms^{-1}
28. The work function for metals A, B and C are respectively 1.92 eV, 2.0 eV and 5 eV. According to Einstein's equation, the metals which will emit photo electrons for a radiation of wavelength 4100 Å is/are
a) None of these b) A only c) A and B only d) All the three metals
29. Among the following four spectral regions, the photons has the highest energy in
a) Infrared b) Violet c) Red d) Blue
30. Kinetic energy of emitted cathode rays is dependent on
a) Only voltage b) Only work function
c) Both (a) and (b) d) It does not depend upon any physical quantity
31. An electron is accelerated under a potential difference of 182 V. The maximum velocity of electron will be (Charge of an electron is 1.6×10^{-19} C and its mass is 9.1×10^{-31} kg)
a) 5.65×10^{6} m/s b) 4×10^{6} m/s c) 8×10^{6} m/s d) 16×10^{6} m/s
32. If the voltage of X-rays tube is doubled, the intensity of X-rays will become
a) Half b) Unchanged c) Double d) Four times
33. Bragg's law for X-rays is
a) $d \sin\theta = 2n\lambda$ b) $2d \sin\theta = n\lambda$ c) $n \sin\theta = 2\lambda d$ d) None of these
34. An electron of charge $'e'$ coulomb passes through a potential difference of V $volts$. Its energy in $'joules'$ will be
a) V/e b) eV c) e/V d) V
35. When cathode-rays strike a metal target of high melting point with a very high velocity, then which of the following are produced
a) α-rays b) X-rays c) Ultraviolet rays d) γ-waves
36. A photon of energy 8 eV is incident on a metal surface of threshold frequency $1.6 \times 10^{15} Hz$, then the maximum kinetic energy of photoelectrons emitted is ($h = 6.6 \times 10^{-34} Js$)
a) 4.8 eV b) 2.4 eV c) 1.4 eV d) 0.8 eV
37. The kinetic energy of an electron is 5 eV. Calculate the de-Broglie wavelength associated with it ($h = 6.6 \times 10^{-34} Js, m_e = 9.1 \times 10^{-31} kg$)
a) 5.47 Å b) 10.9 Å c) 2.7 Å d) None of these
38. Order of q/m ratio of proton, α-particle and electron is
a) $e > p > \alpha$ b) $p > \alpha > e$ c) $e > \alpha > p$ d) None of these
39. In the following diagrams if $V_2 > V_1$ then



a) $\lambda_1 = \sqrt{\lambda_2}$ b) $\lambda_1 < \lambda_2$ c) $\lambda_1 = \lambda_2$ d) $\lambda_1 > \lambda_2$

40. Ultraviolet radiations of 6.2 eV falls on an aluminium surface. KE of fastest electron emitted is (work function = 4.2 eV)
a) 3.2×10^{-21}J b) 3.2×10^{-19}J c) 7×10^{-25} J d) 9×10^{-32} J

41. Which of the following is incorrect statement regarding photon
a) $E = \frac{hc}{\lambda}$ b) $E = \frac{1}{2}mu^2$ c) $p = \frac{E}{2v}$ d) $E = \frac{1}{2}mc^2$

42. If intensity of incident light is increased in PEE then which of the following is true
a) Maximum $K.E.$ of ejected electron will increase
b) Work function will remain unchanged
c) Stopping potential will decrease
d) Maximum $K.E.$ of ejected electron will decrease

43. The wavelength of K_a X-rays produced by an X-ray tube is 0.76 Å. The atomic number of the anode material of the tube is
a) 20 b) 60 c) 40 d) 80

44. In X-ray tube when the accelerating voltage V is halved, the difference between the wavelength of K_α line and minimum wavelength of continuous X-ray spectrum
a) Remains constant b) Becomes more than two times
c) Becomes half d) Becomes less than two times

45. Which of the following wavelength fall in X-ray region
a) 10000 Å b) 1000 Å c) 1 Å d) 10^{-2} Å

46. A tiny spherical oil drop carrying a net charge q is balanced in still air with vertical uniform electric field of strength $\frac{81\pi}{7} \times 10^5 \text{Vm}^{-1}$.When the field is switched off, the drop is observed to fall with terminal velocity $2 \times 10^{-3}\text{ms}^{-1}$. Given g = 9.8 ms^{-2}, viscosity of the air =1.8×10^{-5}Ns m^{-2} and the density of oil = 900 kg m^{-3}, the magnitude of q is
a) 1.6×10^{-19} C b) 3.2×10^{-19} C c) 4.8×10^{-19} C d) 8.0×10^{-19} C

47. The potential energy of a particle of mass m is given by
$$U(x) = \begin{cases} E_0; & 0 \le x \le 1 \\ 0; & x > 1 \end{cases}$$
λ_1 and λ_2 are the de-Broglie wavelengths of the particle, when $0 \le x \le 1$ and $x > 1$ respectively. If the total energy of particle is $2E_0$, the ratio $\frac{\lambda_1}{\lambda_2}$ will be
a) 2 b) 1 c) $\sqrt{2}$ d) $\frac{1}{\sqrt{2}}$

48. Which of the following metal thermionically emits an electron at a relatively lowest temperature among them
a) Platinum b) Copper c) Aluminium d) Molybdenum

49. A particle A has a charge q and particle B has charge$+4q$ with each of them having the mass m. When they are allowed to fall from rest through same potential difference, the ratio of their speeds v_A: v_B will be
a) 4:1 b) 1:4 c) 1:2 d) 2:1

50. Velocity ratio of the two cathode rays 1.2. They are applied to the same electric field. What is the deflection ratio of the two cathode rays
a) 1 :2 b) 1 :4 c) 4 :1 d) 8 :1

51. The maximum wavelength of radiation that can produce photoelectric effect in certain metal is 200 nm. The maximum kinetic energy acquired by electron due to radiation of wavelength 100 nm will be

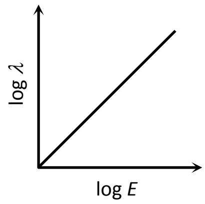
a) 12.4 eV b) 6.2 eV c) 100 eV d) 200 eV

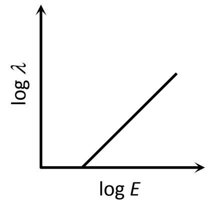
52. J. J. Thomson's cathode ray tube experiment demonstrated that
a) Cathode rays are streams of negatively charged ions
b) All the mass of an atom is essentially in the nucleus
c) The e/m of electrons is much greater than the e/m of protons
d) The e/m ratio of the cathode ray particles changes when a different gas is placed in the discharge tube

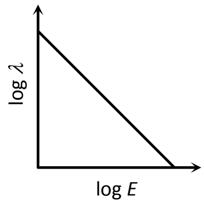
53. If $\lambda = 10$Å, then it corresponds to
a) Infra-red b) Microwave c) Ultra-violet d) X-rays

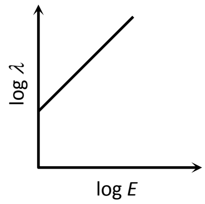
54. Light of wavelength 4000 Å is incident on a metal plate whose work function is 2 eV. The maximum KE of the emitted photoelectron would be
a) 0.5 eV b) 1.1 eV c) 1.5 eV d) 2.0 eV

55. The log-log graph between the energy E of an electron and its de-Broglie wavelength λ will be

a) 

b) 

c) 

d) 

56. Which one of the following statement is wronge in the context of X-rays generated from X-ray tube?
a) Wavelength of characteristic X-rays decreases when the atomic number of the target increases
b) Cut-off wavelength of the continuous X-rays depends on the atomic number of the target
c) Intensity of the characteristic X-rays depends on the electrical power given to the X-ray tube
d) Cut-off wavelength of the continuous X-rays depends on the energy of the electrons in X-ray tube

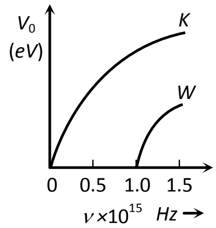
57. If f_1, f_2 and f_3 are the frequencies of corresponding K_α, K_β and $L_\alpha X$-rays of an element, then
a) $f_1 = f_2 = f_3$ b) $f_1 - f_2 = f_3$ c) $f_2 = f_1 + f_3$ d) $f_2^2 = f_1 f_3$

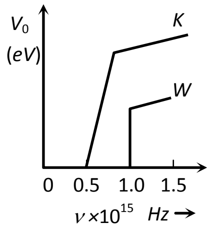
58. A radio transmitter operates at a frequency of 880 kHz and a power of 10 kW. The number of photons emitted per second are
a) 1.72×10^{31} b) 1327×10^{34} c) 13.27×10^{34} d) 0.075×10^{-34}

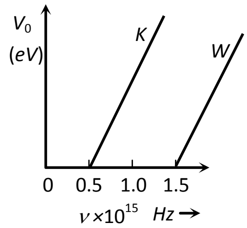
59. A photon of wavelength 4400 Å is passing through vacuum. The effective mass and momentum of the photon are respectively
a) $5 \times 10^{-36} kg, 1.5 \times 10^{-27} kg\text{-}m/s$ b) $5 \times 10^{-35} kg, 1.5 \times 10^{-26} kg\text{-}m/s$
c) Zero, $1.5 \times 10^{-26} kg\text{-}m/s$ d) $5 \times 10^{-36} kg, 1.67 \times 10^{-43} kg\text{-}m/s$

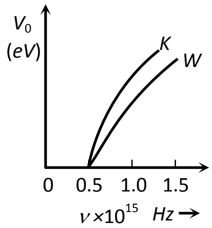
60. The de-Broglie wavelength associated with the particle of mass m moving with velocity v is
a) h/mv b) mv/h c) mh/v d) m/hv

61. The figure showing the correct relationship between the stopping potential V_0 and the frequency v of light for potassium and tungsten is

a) 

b) 

c) 

d) 

62. The de-Broglie wavelength of a proton (charge $=1.6\times 10^{-19}$ C, mass$=1.6 \times 10^{-27}$ kg) accelerated through a potential difference of 1kV is
a) 600 Å b) 0.9×10^{-12} m c) 7 Å d) o.9 nm

63. The potential difference applied to an X-ray tube is $5kV$ and the current through it is 3.2 mA. Then the number of electrons striking the target per second is
a) 2×10^{16} b) 5×10^{16} c) 1×10^{17} d) 4×10^{15}

64. Which is not true with respect to the cathode rays
a) A stream of electrons b) Charged particles
c) Move with speed same as that of light d) Can be deflected by magnetic fields

65. If in a photoelectric experiment, the wavelength of incident radiation is reduced from 6000 Å to 4000 Å then
a) Stopping potential will decrease
b) Stopping potential will increase
c) Kinetic energy of emitted electrons will decrease
d) The value of work function will decrease

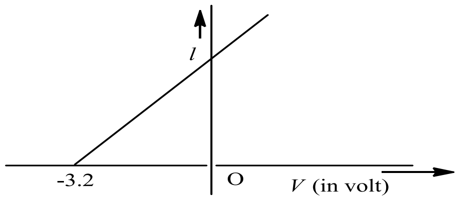
66. Photon of frequency v has a momentum associated with it. If c is the velocity of light, the momentum is
a) v/c
b) hvc
c) hv/c^2
d) hv/c

67. Air becomes conducting when the pressure ranges between
a) 76 cm and 10 cm
b) 10 cm and 1 cm
c) 1 cm and 10^{-3} cm
d) 10^{-4}cm and 10^{-7}cm

68. The specific charge of a proton is 9.6×10^7 Ckg^{-1}.The specific charge of an alpha particle will be
a) 9.6×10^7 Ckg^{-1}
b) 19.2×10^7 Ckg^{-1}
c) 4.8×10^7 Ckg^{-1}
d) 2.4×10^7 Ckg^{-1}

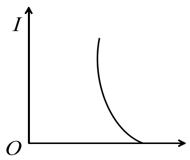
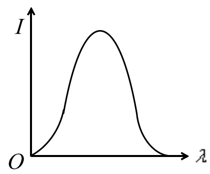
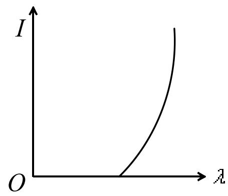
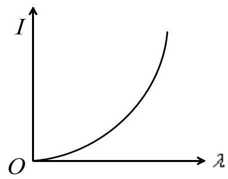
69. What should be the velocity of an electron so that its momentum becomes equal to that of a photon of wavelength 5200Å ?
a) 10^3ms^{-1}
b) 1.2×10^3ms^{-1}
c) 1.4×10^3ms^{-1}
d) 2.8×10^3ms^{-1}

70. In a photoelectric experiment the relation between applied potential difference between cathode and anode V and the photoelectric current I was found to be shown in graph below. If Planck's constant $h = 6.6 \times 10^{-34}$Js, the frequency of incident radiation would be nearly (in s^{-1})



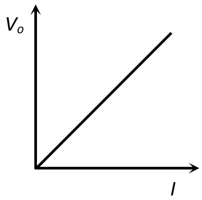
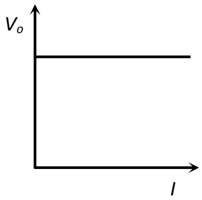
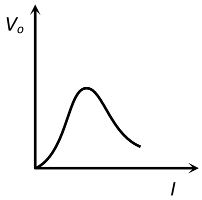
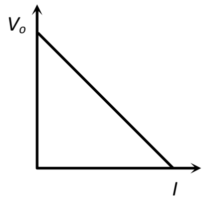
a) 0.436×10^{18}
b) 0.436×10^{17}
c) 0.775×10^{15}
d) 0.775×10^{16}

71. The anode voltage of a photocell is kept fixed. The wavelength λ of the light falling on the cathode is gradually changed. The plate current 1 of the photocell varies as follows

a) 
b) 
c) 
d) 

72. If an electron and proton are propagating in the form of waves having the same wavelength, it implies that they have the same
a) Energy
b) Momentum
c) Velocity
d) Angular momentum

73. The correct curve between the stopping potential (V) and intensity of incident light (I) is

a) 
b) 
c) 
d) 

74. While doing his experiment, Millikan one day observed the following charges on a single drop
(i) $6.563 \times 10^{-19}C$ (ii) $8.204 \times 10^{-19}C$
(iii)$11.50 \times 10^{-19}C$ (iv)$13.13 \times 10^{-19}C$
(v) $16.48 \times 10^{-19}C$ (vi)$18.09 \times 10^{-19}C$
From this data the value of the elementary charge (e) was found to be
a) $1.641 \times 10^{-19}C$
b) $1.630 \times 10^{-19}C$
c) $1.648 \times 10^{-19}C$
d) $1.602 \times 10^{-19}C$

75. Which of the following shows particle nature of light
a) Refraction
b) Interference
c) Polarization
d) Photoelectric effect

76. When an inert gas is filled in place of vacuum in a photo cell, then
a) Photo-electric current is decreased
b) Photo-electric current is increased
c) Photo-electric current remains the same

d) Decrease or increase in photo-electric current does not depend upon the gas filled

77. Momentum of a photon of wavelength λ is

a) h/λ b) $h\lambda/c^2$ c) $h\,\lambda/c$ d) Zero

78. Molybdenum is used as a target element for production of X-rays because it is

a) A heavy element and can easily absorb high velocity electrons
b) A heavy element with a high melting point
c) An element having high thermal conductivity
d) Heavy and can easily deflect electrons

79. In Millikan's oil drop experiment, an oil drop of mass 16×10^{-6} kg is balanced by an electric field of 10^6 $\mathrm{Vm^{-1}}$. The charge in coulomb on the drop is (assuming $\mathrm{g} = 10\ \mathrm{ms^{-2}}$)

a) 6.2×10^{-11} b) 16×10^{-9} c) 16×10^{-11} d) 16×10^{-13}

80. The X-ray beam coming from an X-ray tube will be

a) Monochromatic
b) Having all wavelengths smaller than a certain maximum wavelength
c) Having all wavelengths larger than a certain minimum wavelength
d) Having all wavelengths lying between a minimum and a maximum wavelength

81. In photoelectric effect, the threshold wavelength of sodium is 5000 Å. Find its work function($h = 6.6 \times 10^{-34}\ Js, c = 3 \times 10^8\ ms^{-1}, 1\ eV = 1.6 \times 10^{-19}\ J$)

a) 7.5 eV b) 2.5 eV c) 10 eV d) 5.0 eV

82. An X-ray has a wavelength of 0.010 Å. Its momentum is

a) $2.126 \times 10^{-23} kg\text{-}m/s$ b) $6.626 \times 10^{-22} kg\text{-}m/s$
c) $3.456 \times 20^{-25} kg\text{-}m/s$ d) $3.313 \times 10^{-22} kg\text{-}m/s$

83. In the Davission and Germer experiment, the velocity of electrons emitted from the electron gun can be increased by

a) Decreasing the potential difference between the anode and filament
b) Increasing the potential difference between the anode and filament
c) Increasing the filament current
d) Decreasing the filament current

84. If an electron and a photon propagate in the form of waves having the same wavelength, it implies that they have the same

a) Energy b) Momentum c) Velocity d) Angular momentum

85. When a high energy UV photon beam enters an electric field, it will be

a) Accelerated b) Retarded c) Undeflected d) None of these

86. A metal surface of work function 1.07 eV is irradiated with light of wavelength 332 nm. The retarding potential required to stop the escape of photoelectrons is

a) 1.07 eV b) 2.66 eV c) 3.7 eV d) 4.81 eV

87. When light falls on a metal surface, the maximum kinetic energy of the emitted photo-electrons depends upon

a) The time for which light falls on the metal
b) Frequency of the incident light
c) Intensity of the incident light
d) Velocity of the incident light

88. An X-ray tube is operated at 50 kV. The minimum wavelength produced is

a) 0.5 Å b) 0.75 Å c) 0.25 Å d) 1 Å

89. The K_a X-ray emission line of tungsten occurs at $\lambda = 0.021 nm$. The energy difference between K and L levels in this atom is about

a) 0.51 MeV b) 1.2 MeV c) 59 KeV d) 13.6 eV

90. A photon of energy 3.4 eV is incident on a metal having work function 2 eV. The maximum KE of photoelectrons is equal to

a) 1.4 eV b) 1.7 eV c) 5.4 eV d) 6.8 eV

91. A beam of 35.0 keV electrons strikes a molybdenum target, generating the X-rays. What is the cut-off wavelength?
a) 35.5 pm b) 40.0 pm c) 15.95 pm d) 18.2 pm

92. The energy that should be added to an electron to reduce its de-Broglie wavelength from 1 nm to 0.5 nm is
a) Four times the initial energy
b) Equal to the initial energy
c) Twice the initial energy
d) Thrice the initial energy

93. A charged oil drop of mass $2.5 \times 10^{-7} kg$ is in space between the two plates, each of area $2 \times 10^{-2} m^2$ of a parallel plate capacitor. When the upper plate has a charge of $5 \times 10^{-7} C$ and the lower plate has an equal negative charge, the oil remains stationary. The charge of the oil drop is [Take $g = 10\ m/s^2$]
a) $9 \times 10^{-1} C$ b) $9 \times 10^{-6} C$ c) $8.85 \times 10^{-13} C$ d) $1.8 \times 10^{-14} C$

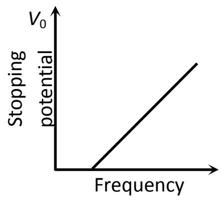
94. The photoelectric effect can be understood on the basis of
a) The principle of superposition
b) The electromagnetic theory of light
c) The special theory of relativity
d) Line spectrum of the atom

95. The ratio of the de Broglie wavelengths of an electron of energy 10 eV to that of person of mass 66 kg travelling at a speed of 100 km/hr is of the order of
a) 10^{34} b) 10^{27} c) 10^{17} d) 10^{-10}

96. By photoelectric effect, Einstein, proved
a) $E = hv$ b) $K.E. = \frac{1}{2}mv^2$ c) $E = mc^2$ d) $E = \frac{Rhc^2}{n^2}$

97. A particle with rest mass m_0 is moving with speed of light c. The de-Broglie wavelength associated with it will be
a) Infinite b) Zero c) $m_0 c/h$ d) $hv/m_0 c$

98. In the graph given below. If the slope is $4.12 \times 10^{-15} V\text{-}s$, then value of $'h'$ should be



a) $6.6 \times 10^{-31} J\text{-}s$ b) $6.6 \times 10^{-34} J\text{-}s$ c) $9.1 \times 10^{-31} J\text{-}s$ d) None of these

99. The wavelength of X-rays is
a) 2000 Å b) 2 Å c) 1 mm d) 1 cm

100. If a cathode ray tube has a potential difference V volt between the cathode and anode, then the speed v of cathode rays is given by
a) $v \propto V^2$ b) $v \propto \sqrt{V}$ c) $v \propto V^{-1}$ d) $v \propto V$

101. The ratio of the energy of a photon with $\lambda = 150$ nm to that with $\lambda = 300$ nm is
a) 2 b) $\frac{1}{4}$ c) 4 d) $\frac{1}{2}$

102. Photoelectric emission is observed from a metallic surface for frequencies v_1 and v_2 of the incident light rays $(v_1 > v_2)$. If the maximum values of kinetic energy of the photoelectrons emitted in the two cases are in the ratio of $1 : k$, then the threshold frequency of the metallic surface is
a) $\frac{v_1 - v_2}{k - 1}$ b) $\frac{kv_1 - v_2}{k - 1}$ c) $\frac{kv_2 - v_1}{k - 1}$ d) $\frac{v_2 - v_1}{k}$

103. The cathode rays have particle nature because of the fact that
a) They can propagate in vacuum
b) They are deflected by electric and magnetic fields
c) They produced fluorescence
d) They cast shadows

104. The light rays having photons of energy 1.8 eV are falling on a metal surface having a work function 1.2 eV. What is the stopping potential to be applied to stop the emitting electrons
a) 3 eV b) 1.2 eV c) 0.6 eV d) 1.4 eV

105. The cathode of a photoelectric cell is changed such that the work function changes from W_1 to $W_2 (W_2 > W_1)$. If the current before and after change are I_1 and I_2, all other conditions remaining unchanged, then (assuming $hv > W_2$)

a) $I_1 = I_2$ b) $I_1 < I_2$ c) $I_1 > I_2$ d) $I_1 < I_2 < 2I_1$

106. The magnitude of saturation photoelectric current depends upon

a) Frequency b) Intensity c) Work function d) Stopping potential

107. In Thomson mass spectrograph, singly and doubly ionised particles from similar parabola corresponding to magnetic fields of 0.8 T and 1.2 T for a constant electric field. The ratio of masses f ionised particles will be

a) 3 : 8 b) 2 : 9 c) 8 : 3 d) 9 : 2

108. The energy of a photon of light with wavelength 5000 Å is approximately 2.5 eV. This way the energy of an X-ray photon with wavelength 1Å would be

a) $2.5/5000\ eV$ b) $2.5/(5000)^2 eV$ c) $2.5 \times 5000\ eV$ d) $2.5 \times (5000)^2 eV$

109. Which of the following event, support the quantum nature of light?

a) Diffraction b) Polarization c) Interference d) Photoelectric effect

110. For photoelectric emission, tungsten requires light of 2300 Å. If light of 1800 Å wavelength is incident then emission

a) Takes place b) Doesn't take place
c) May or may not take place d) Depends on frequency

111. The ratio of de-Broglie wavelength of a α-particle to that of a proton being subjected to the same magnetic field so that the radii of their path are equal to each other assuming the field induction vector $\vec{B}$ is perpendicular to the velocity vectors of the α-particle and the proton is

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

112. Light of wavelength 4000 Å incident on a sodium surface for which the threshold wavelength of photoelectrons is 5420 Å. The work function of sodium is

a) 0.57 eV b) 1.14 eV c) 2.29 eV d) 4.58 eV

113. What is the difference between soft and hard X-rays

a) Velocity b) Intensity c) Frequency d) Polarization

114. An electron of mass m when accelerated through a potential difference V has de-Broglie wavelength λ. The de-Broglie wavelength associated with a proton of mass M accelerated through the same potential difference will be

a) $\lambda \frac{m}{M}$ b) $\lambda \sqrt{\frac{m}{M}}$ c) $\lambda \frac{M}{m}$ d) $\lambda \sqrt{\frac{M}{m}}$

115. When a beam of accelerated electrons hits a target, a continuous X-ray spectrum is emitted from the target. Which of the following wavelength is absent in the X-ray spectrum, if the X-ray tube is operating at 40,000 $volts$

a) 0.25 Å b) 0.5 Å c) 1.5 Å d) 1.0 Å

116. The mass of a photo electron is

a) $9.1 \times 10^{-27} kg$ b) $9.1 \times 10^{-29} kg$ c) $9.1 \times 10^{-31} kg$ d) $9.1 \times 10^{-34} kg$

117. In a region, steady and uniform electric magnetic fields are present. These two fields are parallel to each other. A charged particle is released from rest in this region. The path of the particle will be a

a) Helix b) Straight line c) Ellipse d) Circle

118. The photoelectric effect represents that

a) Light has a particle nature b) Electron has a wave nature
c) Proton has a wave nature d) None of the above

119. Consider the following two statements A and B and identify the correct choice in the given answer

A: The characteristic X-ray spectrum depends on the nature of the material of the target

B: The short wavelength limit of continuous X-ray spectrum varies inversely with the potential difference applied to the X-rays tube

a) A is true and B is false
b) A is false and B is true
c) Both A and B are true
d) Both A and B are false

120. During X-ray production from coolidge tube if the current in increased, then
a) The penetration power increases
b) The penetration power decreases
c) The intensity of X-rays increases
d) The intensity of X-rays decreases

121. De-Broglie wavelength of a body of mass 1 kg moving with velocity of 2000 m/s is
a) 3.32×10^{-27}Å
b) 1.5×10^{7}Å
c) 0.55×10^{-22}Å
d) None of these

122. If threshold wavelength for a certain metal is 2000Å , then the work function of metal is
a) 6.2 MeV
b) 6.2 keV
c) 6.2 J
d) 6.2 eV

123. Four particles have same momentum. Which has maximum kinetic energy?
a) Proton
b) Electron
c) Deuteron
d) α- particle

124. Cathode rays are
a) Positive rays
b) Neutral rays
c) He rays
d) Electron waves

125. A photon collides with a stationary hydrogen atom in ground state inelastically. Energy of the colliding photon is 10.2 eV. After a time interval of the order of micro second another photon collides with same hydrogen atom inelastically with an energy of 15 eV. What will be observed by the detector?
a) 2 photons of energy 10.2 eV
b) 2 photons of energy of 1.4 eV
c) One photon of energy 10.2 eV and an electron of energy 1.4 eV
d) One photon of energy 10.2 eV and another photon of 1.4 eV

126. Which of the following statement about photon is incorrect?
a) Photons exert no pressure
b) Momentum of photon is $h\nu/c$
c) Photon's rest mass is zero
d) Photon's energy is $h\nu$

127. A metal surface is illuminated by a light of given intensity and frequency to cause photoemission. If the intensity of illumination is reduced to one-fourth of its original value, then the maximum kinetic energy of the emitted photoelectrons would become
a) Four times the original value
b) Twice the original value
c) 1/6th of the original value
d) unchanged

128. K_α and K_β X-rays are emitted when there is a transition of electron between the levels
a) n=2 to n=1 and n=3 to n=1 respectively
b) n=2 to n=1 and n=3 to n=2 respectively
c) n=3 to n=2 and n=4 to n=2 respectively
d) n=3 to n=2 and n=4 to n=3 respectively

129. Dual nature of radiation is shown by
a) Diffraction and reflection
b) Refraction and diffraction
c) Photoelectric effect alone
d) Photoelectric effect and diffraction

130. The momentum of a photon is 2×10^{-16} gm-cm/sec. Its energy is
a) $0.61 \times 10^{-26} erg$
b) $2.0 \times 10^{-26} erg$
c) $6 \times 10^{-6} erg$
d) $6 \times 10^{-8} erg$

131. A photon of wavelength 6630 Å is incident on a totally reflecting surface. The momentum delivered by the photon is equal to
a) $6.63 \times 10^{-27} kg$-m/s
b) 2×10^{-27} kg-m/s
c) $10^{-27} kg$-m/s
d) None of these

132. A beam of light of wavelength λ and with illumination L falls on a clean surface of sodium. If N photoelectrons are emitted each with kinetic energy E, then
a) $N \propto L$ and $E \propto L$
b) $N \propto L$ and $E \propto \frac{1}{\lambda}$
c) $N \propto \lambda$ and $E \propto L$
d) $N \propto \frac{1}{\lambda}$ and $E \propto \frac{1}{L}$

133. An electron and a neutron can have same (1) kinetic energy, (2) momentum, or (3) speed. Which particle has a shorter de-Broglie wavelength?
a) Neutron, same, neutron
b) Neutron, electron, same
c) Electron, same, neutron
d) Electron, neutron, electron

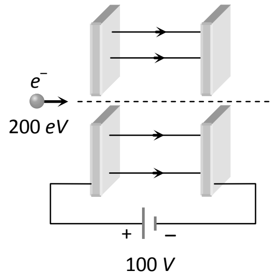
134. A proton and an α-particle are accelerated through the same potential difference. The ratio of their de-Broglie wavelength $(\lambda_p/\lambda_\alpha)$ is
a) $1/2\sqrt{2}$
b) 1
c) 2
d) $2\sqrt{2}$

135. A charged dust particle of radius 5×10^{-7}m is located in a horizontal electric field having an intensity of

$6.28 \times 10^5\ Vm^{-1}$. The surrounding medium in air with coefficient of viscosity $\eta = 1.6 \times 10^{-15} Nsm^{-2}$. If this particle moves with a uniform horizontal speed of $0.01\ ms^{-1}$, the number of electrons on it will be

a) 20 b) 15 c) 25 d) 30

136. Two large parallel plates are connected with the terminal of 100 v power supply. These plates have a fine hole at the centre. An electron having energy 200 eV is so directed that it passes through the holes. When if comes out it's de-Broglie wavelength is



a) 1.22 Å b) 1.75 Å c) 2 Å d) None of these

137. What will be the ratio of de-Broglie wavelengths of proton and α-particle of same energy

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

138. Rest mass energy of an electron is 0.51 MeV. If this electron is moving with a velocity 0.8 c (where c is velocity of light in vacuum), then kinetic energy of the electron should be

a) 0.28 MeV b) 0.34 MeV c) 0.39 MeV d) 0.46 MeV

139. A photoelectric cell is illuminated by a point source of light 1 m away. When the source is shifted to 2 m then

a) Each emitted electron carries half the initial energy
b) Number of electrons emitted is a quarter of the initial number
c) Each emitted electron carries one quarter of the initial energy
d) Number of electrons emitted is half the initial number

140. An electromagnetic radiation has an energy of 13.2 keV. Then the radiation belongs to the region of

a) Visible light b) Ultraviolet c) Infrared d) X-ray

141. Positive rays are very identical to

a) α-particle rays b) β-rays c) γ-rays d) None of above

142. When a piece of metal is illuminated by a monochromatic light of wavelength λ, then stopping potential is $3V_S$. When same surface is illuminated by light of wavelength 2λ, then stopping potential becomes V_S. The value of threshold wavelength for photoelectric emission will be

a) 4λ b) 8λ c) $\frac{4}{3}\lambda$ d) 6λ

143. In photoelectric effect if the intensity of light is doubled, then maximum kinetic energy of photoelectrons will become

a) Double b) Half c) Four times d) No change

144. The energy of a photon is equal to the kinetic energy of a photon. The energy of a the photon is E. Let λ_1 be the de-Broglie wavelength of the photon and λ_2 be the wavelength of the photon. The ratio $\frac{\lambda_1}{\lambda_2}$ proportional to

a) E^0 b) $E^{1/2}$ c) E^{-1} d) E^{-2}

145. Light of frequency v is incident on a certain photoelectric substance with threshold frequency v_0. The work function for the substance is

a) hv b) hv_0 c) $h(v - v_0)$ d) $h(v + v_0)$

146. The momentum of a photon of energy hv will be

a) hv b) hv/c c) $h\ vc$ d) h/v

147. Consider the following statements concerning electrons :

I. Electrons are universal constituents of mater.
II. J J Thomson received the very first Nobel prize in Physics for discovering the electron.
III. The mass of the electron is about 1/2000 of a neutron.

IV. According to Bohr the linear momentum of the electron is quantised in the hydrogen atom. Which of the above statements are not correct?

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

148. In a photoemissive cell with exciting wavelength λ, the fastest electron has speed v. If the exciting wavelength is changed to $3\lambda/4$, the speed of the fastest emitted electron will be

a) $v(3/4)^{1/2}$ b) $v(4/3)^{1/2}$

c) Less than $v(4/3)^{1/2}$ d) Greater than $v(4/3)^{1/2}$

149. The curve drawn between velocity and frequency of photon in vacuum will be a

a) Straight line parallel to frequency axis

b) Straight line parallel to velocity axis

c) Straight line passing through origin and making an angle of 45° with frequency axis

d) Hyperbola

150. If a voltage applied to an X-ray tube is increased to 1.5 times the minimum wavelength ($\lambda_{\min}$) of an X-ray continuous spectrum shifts by $\Delta\lambda = 26\ pm$. The initial voltage applied to the tube is

a) $\approx 10\ kV$ b) $\approx 16\ kV$ c) $\approx 50\ kV$ d) $\approx 75\ kV$

151. The characteristic X-rays radiation is emitted, when

a) The electrons are accelerated to a fixed energy

b) The source of electrons emits a monoenergetic beam

c) The bombarding electrons knock out electrons from the inner shell of the target atoms and one of the outer electrons falls into this vacancy

d) The valence electrons in the target atoms are removed as a result of the collision

152. The minimum wavelength of X-rays produced in a coolidge tube operated at potential difference of 40 kV is

a) 0.31 Å b) 3.1 Å c) 31 Å d) 311 Å

153. If m is the mass of an electron and c is the speed of light, the ratio of the wavelength of a photon of energy E to that of the electron of the same energy is

a) $c\sqrt{\frac{2m}{E}}$ b) $\sqrt{\frac{2m}{E}}$ c) $\sqrt{\frac{2m}{cE}}$ d) $\sqrt{\frac{m}{E}}$

154. A photon of 1.7×10^{-13} $Joules$ is absorbed by a material under special circumference. The correct statement is

a) Electrons of the atom of absorbed material will go the higher energy states

b) Electron and positron pair will be created

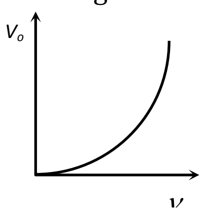
c) Only positron will be produced

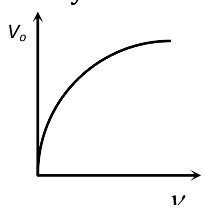
d) Photoelectric effect will occur and electron will be produced

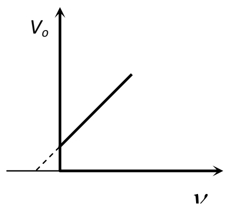
155. The velocity of photon is proportional to (where v is frequency)

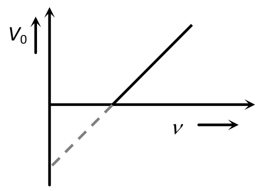
a) $\frac{v^2}{2}$ b) $\frac{1}{\sqrt{v}}$ c) $\sqrt{v}$ d) v

156. For a photoelectric cell the graph showing the variation of cut off voltage (V_o) with frequency (v) of incident light is best represented by

a) 

b) 

c) 

d) 

157. Hydrogen atom does not emit X-rays because

a) Its energy levels are too close to each other b) Its energy levels are too apart

c) It is too small in size d) It has a single electron

158. A particle of charge -16×10^{-18} C moving with velocity 10 ms^{-1} along the x-axis enters a region where a magnetic field of induction B is along the y-axis and an electric field of magnitude 10^4 Vm^{-1} is along the

negative z-axis. If the charged particle continues moving along the x-axis, the magnitude of B is

a) 10^3Wbm^{-2} b) 10^5Wbm^{-2} c) 10^{16}Wbm^{-2} d) 10^{-3}Wbm^{-2}

159. An important spectral emission line has a wavelength of 21cm. The corresponding photon energy is ($h = 6.62 \times 10^{-34}$ Js and $c = 3 \times 10^8$ ms^{-1})

a) 5.9×10^{-8} eV b) 5.9×10^{-4} eV c) 5.9×10^{-6} eV d) 11.8×10^{-6} eV

160. A charge of magnitude $3e$ and mass $2m$ is moving in an electric field **E**. The acceleration imparted to the charge is

a) $2\ Ee/3m$ b) $3\ Ee/2m$ c) $2\ m/3Ee$ d) $3\ m/2Ee$

161. X-ray will travel minimum distance in

a) Air b) Iron c) Wood d) Water

162. When cathode rays strike a metal target of high melting point with very high velocity, then

a) X-rays are produced b) Alpha-rays are produced c) UV waves are produced d) Ultrasonic waves are produced

163. X-ray of wavelength $\lambda = 2$Å is emitted from the metal target. The potential difference applied across the cathode and the metal target is

a) 5525 V b) 320 V c) 6200 V d) 3250 V

164. X-rays are produced in laboratory by

a) Radiation b) Decomposition of the atom c) Bombardment of high energy electron on heavy metal d) None of these

165. The current conduction in a discharged tube is due to

a) Electrons only b) $+ve$ ions and electrons c) $-ve$ ions and electrons d) $+ve$ ions, $-ve$ ions and electrons

166. Light of wavelength λ strikes a photo-sensitive surface and electrons are ejected with kinetic energy E. If the kinetic energy is to be increased to $2E$, the wavelength must be changed to λ' where

a) $\lambda' = \frac{\lambda}{2}$ b) $\lambda' = 2\lambda$ c) $\frac{\lambda}{2} < \lambda' < \lambda$ d) $\lambda' > \lambda$

167. An oil drop with charge q is held stationary between two plates with an external potential difference of 400 V. If the size of the drop is doubled without any change of charge, the potential difference required to keep the drop stationary will be

a) 400 V b) 1600 V c) 3200 V d) 4000 V

168. A beam of cathode rays is subjected to crossed Electric (E) and Magnetic field (B). The fields are adjusted such that the beam is not deflected. The specific charge of the cathode rays is given by

a) $\frac{E^2}{2VB^2}$ b) $\frac{B^2}{2VE^2}$ c) $\frac{2VB^2}{E^2}$ d) $\frac{2VE^2}{B^2}$

169. A charged oil drop falls with terminal velocity v_0 in the absence of electric field. An electric field E keeps it stationary. The drop acquires charge $3q$, it starts moving upwards with velocity v_0. The initial charge on the drop is

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

170. Light of wavelength 4000Å is incident on a metal surface. The maximum kinetic energy of emitted photoelectron is 2 eV. What is the work function of the metal surface ?

a) 4 eV b) 1 eV c) 2 eV d) 6 eV

171. A charged particle is moving in a uniform magnetic field in a circular path. The energy of the particle is tripled. If the initial radius of the circular path was R, the radius of the new circular path after the energy is tripled will be

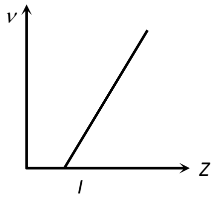
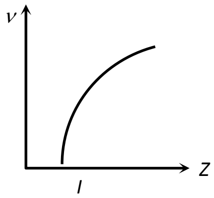
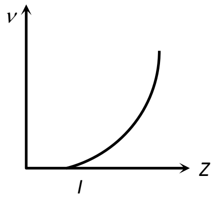
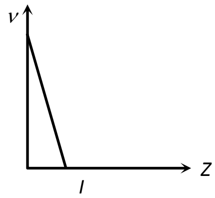
a) $\frac{R}{3}$ b) $\sqrt{3}\ R$ c) $3\ R$ d) $R/\sqrt{3}$

172. Cathode rays enter a magnetic field making oblique angle with the lines of magnetic induction. What will be the nature of the path followed?

a) Parabola b) Helix c) Circle d) Straight line

173. The graph that correctly represents the relation of frequency v of a particular characteristic X-ray with the

atomic number Z of the material is

a) 
b) 
c) 
d) 

174. Einstein's photoelectric equation states that $Ek = hv - \phi$. In this equation E_k refers to
a) Kinetic energy of all the emitted electrons
b) Mean kinetic energy of the emitted electrons
c) Maximum kinetic energy of the emitted electrons
d) Minimum kinetic energy of the emitted electrons
175. Let $\lambda_\alpha, \lambda_\beta$ and λ'_α denote the wavelengths of the X-rays of the K_α, K_β and L_α lines in the characteristic X-rays for a metal. Then
a) $\lambda_\alpha > \lambda'_\alpha > \lambda_\beta$ b) $\lambda'_\alpha > \lambda_\beta > \lambda_\alpha$ c) $\frac{1}{\lambda_\beta} = \frac{1}{\lambda_\alpha} + \frac{1}{\lambda'_\alpha}$ d) $\frac{1}{\lambda_\alpha} + \frac{1}{\lambda_\beta} = \frac{1}{\lambda'_\alpha}$
176. Monochromatic radiation emitted when electron on hydrogen atom jumps from first excited to the ground state irradiates a photosensitive material. The stopping potential is measured to be 3.57 V. the threshold frequency of the material is
a) $4 \times 10^{15} Hz$ b) $5 \times 10^{15} Hz$ c) $1.6 \times 10^{15} Hz$ d) $2.5 \times 10^{15} Hz$
177. Who discovered the charge on an electron for the first time?
a) Millikan b) Thomson c) Kelvin d) Coulomb
178. An electron microscope is used to probe the atomic arrangement to a resolution of 5 Å. What should be the electric potential to which the electrons need to be accelerated
a) 2.5 V b) 6 V c) 2.5 kV d) 5 kV
179. A light of wavelength 4000 Å is allowed to fall on a metal surface having work function 2 eV. The maximum velocity of the emitted electrons is ($R = 6.6 \times 10^{-34}$Js)
a) 1.35×10^5 ms^{-1} b) 2.7×10^5 ms^{-1} c) 6.2×10^5 ms^{-1} d) 8.1×10^5 ms^{-1}
180. The wavelength λ of the K_α line of characteristic X-rays spectra varies with atomic number approximately
a) $\lambda \propto Z$ b) $\lambda \propto \sqrt{Z}$ c) $\lambda \propto \frac{1}{Z^2}$ d) $\lambda \propto \frac{1}{\sqrt{Z}}$
181. There are n_1 photons of frequency v_1 in a beam of light. In an equally energetic beam there are n_2 photons of frequency v_2. Then the correct relation
a) $\frac{n_1}{n_2} = \frac{v_1}{v_2}$ b) $\frac{n_1}{n_2} = 1$ c) $\frac{n_1}{n_2} = \frac{v_2}{v_1}$ d) $\frac{n_1}{n_2} = \frac{v_2^2}{v_1^2}$
182. The photosensitive surface is receiving light of wavelength Å at the rate of 10^{-8} Js^{-1}. The number of photons received per second is
a) 2.5×10^{10} b) 2.5×10^{11} c) 2.5×10^{12} d) 2.5×10^9
183. When radiation is incident on a photoelectron emitter, the stopping potential is found to be 9 V. I e/m for the electron is 1.8×10^{11} C Kg^{-1},the maximum velocity the ejected electron is
a) 6×10^5 ms^{-1} b) 8×10^5 ms^{-1} c) 1.8×10^6 ms^{-1} d) 1.8×10^5 ms^{-1}
184. In Millikans oil drop experiment, a charged drop of mass $1.8 \times 10^{-14} kg$ is stationary between its plates. The distance between its plates is 0.90 cm and potential difference is 2.0 $kilo\ volts$. The number of electrons on the drop is
a) 500 b) 50 c) 5 d) 0
185. X-rays beam can be deflected by
a) Magnetic field b) Electric field c) Both (a) and (b) d) None of these
186. The minimum wavelength of X-ray emitted by X-rays tube is 0.4125 Å. The accelerating voltage is
a) 30 kV b) 50 kV c) 80 kV d) 60 kV
187. If the wavelength of incident light changes from 400 nm to 300 nm, the stopping potential for photoelectrons emitted from a surface becomes approximately

a) 1.0 V greater b) 1.0 V smaller c) 0.5 V greater d) 0.5 V smaller

188. If n_R and n_V denote the number of photons emitted by a red bulb and violet bulb of equal power in a given time, then

a) $n_R = n_V$ b) $n_R > n_V$ c) $n_R < n_V$ d) $n_R \geq n_V$

189. Mosley measured the frequency (f) of the characteristic X-rays from many metals of different atomic number (Z) and represented his results by a relation known as Mosley's law. This law is (a, b are constants)

a) $f = a(Z-b)^2$ b) $Z = a(f-b)^2$ c) $f^2 = a(Z-b)$ d) $f = a(Z-b)^{1/2}$

190. The minimum energy required to remove an electron is called

a) Stopping potential b) Kinetic energy c) Work function d) None of these

191. In Millikan's oil drop experiment, a charged drop falls with terminal velocity V. if an electric field E is applied in vertically upward direction then it starts moving in upward direction with terminal velocity $2V$. if magnitude of electric field is decreased to $E/2$, then terminal velocity will becomes

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

192. X-rays are

a) Stream of electrons b) Stream of positively charged particles

c) Electromagnetic radiantions of high frequency d) Stream of uncharged particles

193. X-rays are used in determining the molecular structure of crystalline because its

a) Energy is high

b) It can penetrate the material

c) Its wavelength is comparable to interatomic distance

d) Its freqency is low

194. For an electron in the second orbit of Bohr's hydrogen atom, the moment of linear momentum is

a) πh b) $2\pi h$ c) $\frac{h}{\pi}$ d) $\frac{2h}{\pi}$

195. The potential difference applied to an X-ray tube is 5 kV and the current through it is 3.2 mA. The number of electrons striking the target per second is (Take e =1.6 × 10^{-19} C)

a) 1.6×10^6 b) 2×10^{-6} c) 4×10^{16} d) 2×10^{16}

196. What is the de-Broglie wavelength of the α-particle accelerated through a potential difference V

a) $\frac{0.287}{\sqrt{V}}$Å b) $\frac{12.27}{\sqrt{V}}$Å c) $\frac{0.101}{\sqrt{V}}$Å d) $\frac{0.202}{\sqrt{V}}$Å

197. In the phenomenon of electron discharge through gases at low pressure, the coloured glow in the tube appears as a result of

a) Collisions between the charged particles emitted from the cathode and the atoms of the gas

b) Collision between different electrons of the atoms of the gas

c) Excitation of electrons in the atoms

d) Collision between the atoms of the gas

198. An electron is moving with constant velocity along x-axis. If a uniform electric field is applied along $y-$axis, then its path in the $x-y$ plane will be

a) A straight line b) A circle c) A parabola d) An ellipse

199. Choose the correct answer

a) Photoelectric effect can take place from bound electron

b) Photoelectric effect can take place from free electron

c) Photoelectric effect can take place from bounded or free electron

d) Nothing can be said

200. An electron with (rest mass m_0) moves with a speed of $0.8c$. Its mass when it moves with this speed is

a) m_0 b) $m_0/6$ c) $5m_0/3$ d) $3m_0/5$

201. Two metallic plates A and B, each of area $5 \times 10^{-4} m^2$ are placed parallel to each other at a separation of 1 cm. plate B carries a positive charge of 33.7 pc. A monochromatic beam of light. With photons of energy 5 eV each, starts falling on plate A at $t = 0$, so that 10^{16} photons fall on it per square meter per second. Assume that one photoelectron is emitted for energy 10^6 incident photons. Also assume that all the

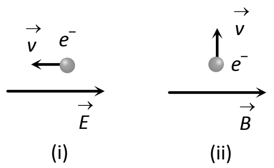
emitted photoelectrons are collected by plate B and the work function of plate A remains constant at the value 2 eV. Electric field between the plates at the end of 10 seconds is

a) $2 \times 10^3 N/C$ b) $10^3 N/C$ c) $5 \times 10^3 N/C$ d) Zero

202. If the operating potential of an X-ray tube is 50 kV, the velocity of X-rays coming out of it is

a) $4 \times 10^4 m/s$ b) $3 \times 10^8 m/s$ c) $10^8 m/s$ d) $3m/s$

203. An electron is moving through a field. It is moving (i) opposite an electric field (ii) perpendicular to a magnetic field as shown. For each situation the de-Broglie wave length of electron



a) Increasing, increasing b) Increasing, decreasing
c) Decreasing, same d) Same, Same

204. Sodium and copper have work functions 2.3 eV and 4.5 eV respectively. Then the ratio of their threshold wavelengths is nearest to

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

205. Ultraviolet light of wavelength 300 nm and intensity 1.0 Wm^{-2} falls on the surface on photoelectric metal. If one percent of incident photons produce photoelectrons, then the number of photoelectrons emitted from an area of 1.0 cm^2 of the surface is nearly

a) 2.13×10^{11} s^{-1} b) 1.5×10^{12} s^{-1} c) 3.02×10^{12} s^{-1} d) None of these

206. According to Mosely's law, the frequency of a spectral line in X-ray spectrum varies as

a) Atomic number of the element
b) Square of the atomic number of the element
c) Square ropot of the atomic number of the element
d) Fourth power of the atomic number of the element

207. In a photoelectric experiment for 4000 Å incident radiation, the potential difference to stop the ejection is $2V$. If the incident light is changed to 3000 Å, then the potential required to stop the ejection of electrons will be

a) 2 V b) Less than $2V$ c) Zero d) Greater than 2 V

208. An α-particle of mass 6.4×10^{-27}kg and charge 3.2×10^{-19} C is situated in a uniform electric field of 1.6×10^5 Vm^{-1}. The velocity of the particle at the end of 2×10^{-2} m path when it starts from rest is

a) $2\sqrt{3} \times 10^5$ms^{-1} b) 8×10^5 ms^{-1} c) 16×10^5 ms^{-1} d) $4\sqrt{2} \times 10^5$ ms^{-1}

209. The wavelength of de-Broglie wave is 2μm, then its momentum is
$(h = 6.63 \times 10^{-34} Js)$

a) 3.315×10^{-28} kg – ms^{-1} b) 1.66×10^{-28} kg – ms^{-1}
c) 4.97×10^{-28} kg – ms^{-1} d) 9.9×10^{-28} kg – ms^{-1}

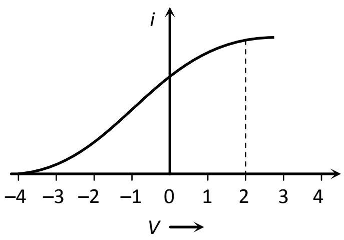
210. In a Thomson set-up for the determination of e/m, electrons accelerated by 2.5 kV enter the region of crossed electric and magnetic fields of strengths $3.6 \times 10^4 Vm^{-1}$ and $1.2 \times 10^{-3} T$ respectively and go through undeflected. The measured value of e/m of the electron is equal to

a) $1.0 \times 10^{11} C$-kg^{-1} b) $1.76 \times 10^{11} C$-kg^{-1} c) $1.80 \times 10^{11} C$-kg^{-1} d) $1.85 \times 10^{11} C$-kg^{-1}

211. A 5 W source emits monochromatic light of wavelength 5000Å. When placed 0.5 m away, it liberates photoelectrons from a photosensitive metallic surface. When the source is moved to a distance of 1.0m, the number of photoelectrons liberated will be reduced by a factor of

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

212. Figure represents a graph of photo current I versus applied voltage (V). The maximum energy of the emitted photoelectrons is



a) $2eV$ b) $4\ eV$ c) $0\ eV$ d) $4\ J$

213. Millikan's oil-drop experiment established that
a) Electric charge depends on velocity
b) Specific charge of electron is 1.76×10^{11} Ckg^{-1}
c) Electron has wave nature
d) Electric charge is quantized

214. The energy that should be added to an electron, to reduce its de-Broglie wavelength from $10^{-10}m$ to $0.5 \times 10^{-10}m$, will be
a) Four times the initial energy
b) Thrice the initial energy
c) Equal to the initial energy
d) Twice the initial energy

215. If λ_1 and λ_2 are the wavelengths of characteristic X-rays and gamma rays respectively, then the relation between them is
a) $\lambda_1 = \frac{1}{\lambda_2}$ b) $\lambda_1 = \lambda_2$ c) $\lambda_1 > \lambda_2$ d) $\lambda_1 < \lambda_2$

216. If energy of K-shell electron is $-40000\ eV$ and If $60000\ V$ potential is applied at coolidge tube then which of the following X-ray will from?
a) Continuous
b) White X-rays
c) Continuous and all series of characteristic
d) None of these

217. The energy of a photon of characteristic X-rays from a Coolidge tube comes from
a) The kinetic energy of the striking electron
b) The kinetic energy of the free electrons of the target
c) The kinetic energy of the ions of the target
d) An electronic transition of the target atom

218. Light of wavelength 5000Å is falling on a sensitive surface.If the surface has received 10^{-7} J of energy, then the number of photons falling on the surface will be
a) 5×10^{11} b) 2.5×10^{11} c) 3×10^{11} d) None of these

219. The wavelength of a 1 keV photon is 1.24 nm. The frequency of 1 MeV photon is
a) 1.24×10^{15}Hz b) 2.4×10^{20} Hz c) 1.24×10^{18} Hz d) 2.4×10^{24} Hz

220. An electron and a proton are moving in the same direction with same kinetic energy. The ratio of the de-Broglie wavelength associated with these particles is
a) $\frac{m_e}{m_p}$ b) $\frac{m_p}{m_e}$ c) $\sqrt{\frac{M_p}{M_e}}$ d) $m_p.m_e$

221. What is the work function (in eV) of a substance if photoelectrons are just ejected for a monochromatic light of wavelength $\lambda = 3300$Å?
a) 3.75 b) 3.25 c) 1.63 d) 0.75

222. A photon of energy 8 eV is incident on metal surface of threshold frequency 1.6×10^{15} Hz. The kinetic energy of the photoelectrons emitted (in eV)
$(Take\ h = 6 \times 10^{-34}\ Js)$
a) 1.6 b) 6 c) 2 d) 1.2

223. The stopping potential (V_0)
a) Depends upon the angle of incident light
b) Depends upon the intensity of incident light
c) Depends upon the surface nature of the substances
d) Is independent of the intensity of the incident light

224. When X rays pass through a strong uniform magnetic field. Then they

a) Do not get deflected at all
b) Get deflected in the direction of the field
c) Get deflected in the direction opposite to the field
d) Get deflected in the direction perpendicular to the field

225. The photoelectric threshold wavelength for potassium (work function being 2 eV) is
a) 310 nm b) 620 nm c) 1200 nm d) 2100 nm

226. In an ionisation experiment it is found that a doubly ionised particle enters a magnetic field of 1 T and moves in a circular path of radius 1 m with a speed of 1.6×10^7 ms^{-1}. The particle must be
a) C^{++} b) Be^{++} c) Li^{++} d) He^{++}

227. Consider the two following statements I and II, and identify the correct choice given in the answers
I. In photovoltaic cells the photoelectric current produced is not proportional to the intensity of incident light.
II. In gas filled photoemissive cells, the velocity of photoelectrons depends on the wavelength of the incident radiation.
a) Both I and II are true b) Both I and II are false c) I is true but II is false d) I is false but II is true

228. A proton and an α-particle are accelerated through a potential difference of 100 V. The ratio of the wavelength associated with the proton to that associated with an α-particle is
a) $\sqrt{2} : 1$ b) 2 :1 c) $2\sqrt{2} : 1$ d) $\frac{1}{2\sqrt{2}} : 1$

229. The energy of an X-ray photon of wavelength 1Å is
($h = 6.6 \times 10^{-34}\text{J} - \text{s}$)
a) 24.6 keV b) 6.1 keV c) 12.3 keV d) 1.2 keV

230. If the energy of a photon corresponding to a wavelength of 6000 Å is $3.32 \times 10^{-19} J$, the photon energy for a wavelength of 4000 Å will be
a) 1.4 eV b) 4.9 eV c) 3.1 eV d) 1.6 eV

231. The average energy of the Planck oscillator is
a) hv b) $\frac{hv}{(e^{hv/kT} - 1)}$ c) $\frac{hv}{(e^{hv/kT} + 1)}$ d) kT

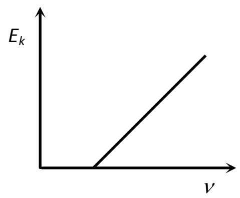
232. In a discharge tube ionization of enclosed gas is produced due to collisions between
a) Photons and neutral atoms/molecules
b) Neutral gas atoms/molecules
c) Positive ions and neutral atoms/molecules
d) Negative electrons and neutral atoms/molecules

233. Which of the following statements is not correct
a) Photographic plates are sensitive to infrared rays
b) Photographic plates are sensitive to ultraviolet rays
c) Infra-red rays are invisible but can cast shadows like visible light
d) Infrared photons have more energy than photons of visible light

234. Electrons ejected from the surface of a metal, when light of certain frequency is incident on it, are stopped fully by a retarding potential of 3 V. Photoelectric effect in this metallic surface begins at a frequency 6×10^{14} s^{-1}. The frequency of the incident light in s^{-1} is
[Planck's constant $= 6.4 \times 10^{-34}$ Js, charge on the electron $= 1.6 \times 10^{-19}$C]
a) 7.5×10^{13} b) 13.5×10^{13} c) 13.5×10^{14} d) 7.5×10^{15}

235. The momentum of a photon is 3.3×10^{-29} $kg\text{-}m/sec$. Its frequency will be
a) $3 \times 10^3 Hz$ b) $6 \times 10^3 Hz$ c) $7.5 \times 10^{12} Hz$ d) $1.5 \times 10^{13} Hz$

236. For the photoelectric effect, the maximum kinetic energy E_k of the emitted photoelectrons is plotted against the frequency v of the incident photons as shown in the figure. The slope of the curve gives



a) Charge of the electron
b) Work function of the metal
c) Plank's constant
d) Ratio of the Plank's constant to electronic charge

237. The frequency and intensity of a light source are doubled. Consider the following statements
III. Saturation photocurrent remains almost the same.
IV. Maximum kinetic energy of the photoelectrons is doubled.
a) Both I and II are true
b) I is true but II is false.
c) I is false but II is true.
d) Both I and II are false.

238. The frequency of a photon having energy 100eV is
(Take $h = 6.67 \times 10^{-34}$ Js, 1 eV $= 1.6 \times 10^{-19}$ J)
a) 2.4×10^{-16}
b) 2.4×10^{16}
c) 2.4×10^{17}
d) 10.54×10^{16}

239. A photon, an electron and a uranium nucleus all have the same wavelength. The one with the most energy
a) Is the photon
b) Is the electron
c) Is the uranium nucleus
d) Depends upon the wavelength and the properties of the particle

240. The wavelength of the photoelectric threshold for silver is λ_0. The energy of the electron ejected from the surface of silver by an incident light of wavelength $\lambda(\lambda < \lambda_0)$ will be
a) $hc(\lambda_0 - \lambda)$
b) $\frac{hc}{\lambda_0 - \lambda}$
c) $\frac{h}{c}\left(\frac{1}{\lambda} - \frac{1}{\lambda_0}\right)$
d) $hc\left(\frac{\lambda_0 - \lambda}{\lambda_0 \lambda}\right)$

241. Penetrating power of X-rays can be increased by
a) Increasing the potential difference between anode and cathode
b) Decreasing the potential difference between anode and cathode
c) Increasing the cathode filament current
d) Decreasing the cathode filament current

242. The minimum wavelength of X-ray emitted from X-ray machine operating at an accelerating potential of V volts is
a) $\frac{hc}{eV}$
b) $\frac{Vc}{eh}$
c) $\frac{eh}{Vc}$
d) $\frac{eV}{hc}$

243. The correctness of velocity of an electron moving with velocity 50 ms^{-1} is 0.005%. The accuracy with which its position can be measured will be
a) 4634×10^{-3}m
b) 4634×10^{-5}m
c) 4634×10^{-6}m
d) 4634×10^{-8}m

244. If an electron and a proton have the same de-Broglie wavelength, then the kinetic energy of the electron is
a) Zero
b) Less than that of a proton
c) More than that of a proton
d) Equal to that of a proton

245. A electron moving with a variable linear velocity v in a variable magnetic field B will remain rotating in a circle of constant radius r only when
a) B is held constant
b) v is held constant
c) Both v and B are constant
d) None of the above

246. When a point source of light is 1m away from a photoelectric cell, the photoelectric current is found to be I mA. If the same source is placed at 4 m from the same photoelectric cells, the photoelectric current (in mA) will be
a) $I/16$
b) $I/4$
c) $4I$
d) $16\,I$

247. The work function of a substance is 4.0 eV. The longest wavelength of light that can cause photoelectron emission from this substance is approximately
a) 540 nm
b) 400 nm
c) 310 nm
d) 220 nm

248. A particle of mass M at rest decays into two masses m_1 and m_2 with non-zero velocities. The ratio of de-Broglie wavelengths of the particles $\frac{\lambda_1}{\lambda_2}$ is

a) $\frac{m_2}{m_1}$ b) $\frac{m_1}{m_2}$ c) $\frac{\sqrt{m_1}}{\sqrt{m_2}}$ d) 1:1

249. In Thomsons experiment of finding e/m for electrons, beam of electron is replaced by that of muons (particles with same charge as of electrons but mass 208 times that of electrons). No deflection condition in this case is satisfied if

a) B is increased 208 times b) E is increased 208 times

c) B is increased 14.4 times d) None of these

250. The temperature at which protons in proton gas would have enough energy to overcome Coulomb barrier of 4.14×10^{-14} J is (Boltzmann constant $=1.38\times 10^{-23}$ JK^{-1})

a) 2×10^9 K b) 10^9 K c) 6×10^9 K d) 3×10^9 K

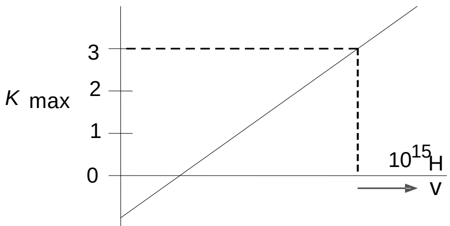
251. In an experiment on photoelectric emission from a metallic surface, wavelength of incident light is 2×10^{-7}m and stopping potential is 2.5 V. The threshold frequency of the metal (in Hz) approximately (charge on electron $e = 1.6 \times 10^{-19}$ C, Planck's constant $h = 6.6 \times 10^{-34}$J-s)

a) 12×10^{15} b) 9×10^{15} c) 9×10^{14} d) 12×10^{13}

252. The de-Broglie wavelength of the electron in the ground state of the hydrogen atom is (Radius of the first orbit of hydrogen atom =0.53Å)

a) 1.67 Å b) 3.33 Å c) 1.06 Å d) 0.53 Å

253. Figure represents a graph of kinetic energy of most energetic photoelectrons, K_{max} (in eV), and frequency (v) for a metal used as cathode in photoelectric experiment. The threshold frequency of light for the photoelectric emission from the metal is



a) $1 \times 10^{14} Hz$ b) $1.5 \times 10^{14} Hz$ c) $2.1 \times 10^{14} Hz$ d) $2.7 \times 10^{14} Hz$

254. If V be the accelerating voltage, then the maximum frequency of continuous X-rays is given by

a) $\frac{eh}{V}$ b) $\frac{hV}{e}$ c) $\frac{eV}{h}$ d) $\frac{h}{eV}$

255. If the uncertainty in the position of an electron is 10^{-10}m, then the value of uncertainty in its momentum (in kg-ms^{-1}) will be

a) 3.33×10^{-24} b) 1.03×10^{-24} c) 6.6×10^{-24} d) 6.6×10^{-24}

256. Energy of characteristic X-ray is a consequence of

a) Energy of projectile electron b) Thermal energy of target

c) Transition in target atoms d) None of the above

257. Electrons with de-Broglie wavelength λ fall on the target in an X-ray tube. The cut-off wavelength of the emitted X-rays is

a) $\lambda_0 = \frac{2mc\lambda^2}{h}$ b) $\lambda_0 = \frac{2h}{mc}$ c) $\lambda_0 = \frac{2m^2c^2\lambda^2}{h^2}$ d) $\lambda_0 = \lambda$

258. The work function of metal is 1 eV. Light of wavelength 3000 Å is incident on this metal surface. The velocity of emitted photo-electrons will be

a) 10 m/s b) 1×10^3 m/s c) 1×10^4 m/s d) 1×10^6 m/s

259. For moving ball of cricket, the correct statement about de-Broglie wavelength is

a) It is not applicable for such big particle b) $\frac{h}{\sqrt{2mE}}$

c) $\sqrt{\frac{h}{2mE}}$ d) $\frac{h}{2mE}$

260. X-ray beam of intensity I_0 passes through an absorption plate of thickness d. If absorption coefficient of material of plate is μ, the correct statement regarding the transmitted intensity I of X-ray is

a) $I = I_0(1 - e^{-\mu d})$ b) $I = I_0 e^{-\mu d}$ c) $I = I_0(1 - e^{-\mu/d})$ d) $I = I_0 e^{-\mu/d}$

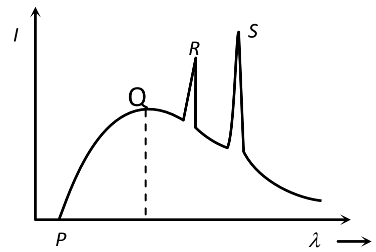
261. A direct X-ray photograph of the intestines is not generally taken by the radiologists because

a) Intestines would burst on exposure to X-rays
b) The X-rays would not pass through the intensities
c) The X-rays will pass though the intestines without causing a good shadow for any useful diagnosis
d) A very small exposure of X-rays causes cancer in the intestines

262. When intensity of incident light increases

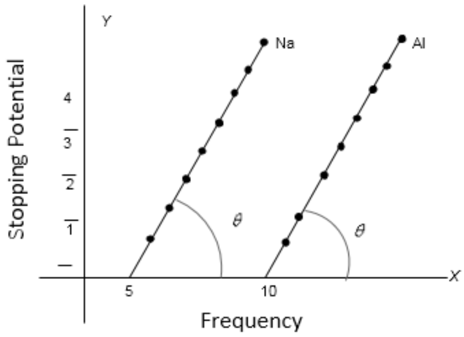
a) Photo-current increases
b) Photo-current decreases
c) Kinetic energy of emitted photoelectrons increases
d) Kinetic energy of emitted photoelectrons decreases

263. If the potential difference between the anode and cathode of the X-ray tube is increase



a) The peaks at R and S would move to shorter wavelength
b) The peaks at R and S would remain at the same wavelength
c) The cut off wavelength at P would increase
d) (b) and (c) both are correct

264. From the figure describing photoelectric effect we may infer correctly that



a) Na and Al both have the same threshold frequency
b) Maximum kinetic energy for both the metals depend linearly on the frequency
c) The stopping potentials are different for Na and Al for the same change in frequency
d) Al is a better photo sensitive material than Na

265. The material used for making thermionic cathode must have

a) Low work function and low melting point b) Low work function and high melting point
c) High work function and high melting point d) High work function and low melting point

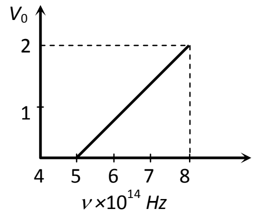
266. Mosley's law relates the frequencies of line X-rays with the following characteristics of the target element

a) Its density b) Its atomic weight
c) Its atomic number d) Interplaner spacing of the atomic planes

267. The speed of an electron having a wavelength of $10^{-10} m$ is

a) $7.25 \times 10^6 m/s$ b) $6.26 \times 10^6 m/s$ c) $5.25 \times 10^6 m/s$ d) $4.24 \times 10^6 m/s$

268. The stopping potential (V_0) versus frequency (v) plot of a substance is shown in figure the threshold wave length is



a) $5 \times 10^{14} m$
b) 6000 Å
c) 5000 Å
d) Cannot be estimated from given data

269. For harder X-rays
a) The wavelength is higher
b) The intensity is higher
c) The frequency is higher
d) The frequency is higher

270. Momentum of a photon is p. The corresponding wavelength is
a) $h/\sqrt{p}$
b) p/h
c) ph
d) h/p

271. Which one of the following statements regarding photo-emission of electrons is correct?
a) Kinetic energy of electrons increases with the intensity of incident light.
b) Electrons are emitted when the wavelength of the incident light is above a certain threshold wavelength.
c) Photoelectric emission is instantaneous with the incidence of light.
d) Photoelectrons are emitted whenever a gas is irradiated with ultraviolet light.

272. A photon and an electron have an equal energy$E$.
a) $\sqrt{E}$
b) $1/\sqrt{E}$
c) $1/E$
d) Does not depend upon E

273. If the wavelength of light is 4000 Å, then the number of waves in 1 mm length will be
a) 25
b) 0.25
c) 0.25×10^4
d) 25×10^4

274. A photosensitive metallic surface has work function $h\nu_0$. If photons of energy $2h\nu_0$ fall on this surface the electrons come out with a maximum velocity of $4 \times 10^6 m/s$. When the photon energy is increases to $5h\nu_0$ then maximum velocity of photo electron will be
a) $2 \times 10^6 m/s$
b) $2 \times 10^7 m/s$
c) $8 \times 10^5 m/s$
d) $8 \times 10^6 m/s$

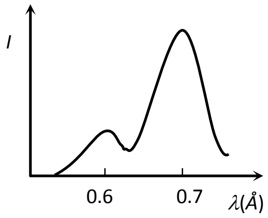
275. An electron of mass $m_e$and a proton of mass m_p are moving with the same speed. The ratio of their de-Brolie wavelength λ_e/λ_p is
a) 918
b) $\frac{1}{1836}$
c) 1836
d) 1

276. If the work function of a photometal is 6.825 eV. Its threshold wavelength will be ($c = 3 \times 10^8\ m/s$)
a) 1200 Å
b) 1800 Å
c) 2400 Å
d) 3600 Å

277. An atom of mass Mwhich is in the state of rest emits a photon of wavelength λ. As a result, the atom will deflect with the kinetic energy equal to (h is Planck's constant)
a) $\frac{h^2}{M\lambda^2}$
b) $\frac{1}{2}\frac{h^2}{M\lambda^2}$
c) $\frac{h}{M\lambda}$
d) $\frac{1}{2}\frac{h}{M\lambda}$

278. A photon will have less energy, if its
a) Amplitude is higher
b) Frequency is higher
c) Wavelength is longer
d) Wavelength is shorter

279. In the diagram a graph between the intensity of X-rays emitted by a molybdenum target and the wavelength is shown, when electrons of 30 keV are incident on the target. In the graph one peak is of K_α line and the other peak is of K_β line



a) First peak is of K_α line at 0.6 Å

b) Highest peak is of K_α line at 0.7 Å
c) If the energy of incident particles is increased, then the peaks will shift towards left
d) If the energy of incident particles is increased, then the peaks will shift towards right

280. X-rays of wavelength 0.140 nm are scattered from a block of carbon. What will be the wavelenghts of X-rays scattered at 90^0?
a) 0.140 nm b) 0.142 nm c) 0.144 nm d) 0.146 nm

281. Ultraviolet radiation of 6.2eV falls on an aluminium surface (work function 4.2eV). The kinetic energy in joule of the fastest electron emitted is approximately
a) 3×10^{-21} b) 3.2×10^{-19} c) 3×10^{-17} d) 3×10^{-15}

282. Which of the following is not the property of the photons?
a) Momentum b) Energy c) Charge d) Velocity

283. For the structural analysis of crystals, X-rays are used because
a) X-rays have wavelength of the order of interatomic spacing
b) X-rays are highly penetrating radiations
c) Wavelength of X-rays is of the order of nuclear size
d) X-rays are coherent radiations

284. The wavelength of most energetic X-rays emitted when a metal target is bombarded by $40KeV$ electrons, is approximately
$(h = 6.62 \times 10^{-34} J\text{-}sec, 1\ eV = 1.6 \times 10^{-19} J; c = 3 \times 10^8 m/s)$
a) 300 Å b) 10 Å c) 4 Å d) 0.31 Å

285. When a cathode ray tube is operated at 2912 V, the velocity of electrons is 3.2×10^7 m/s. Find the velocity of cathode ray if the tube is operated at 5824 V
a) 2.4×10^7 m/s b) 5.2×10^7 m/s c) 4.525×10^7 m/s d) 2.4×10^6 m/s

286. Work function of a metal is 2.51 eV. Its threshold frequency
a) $5.9 \times 10^{14} cycles/s$ b) $6.5 \times 10^{14} cycles/s$ c) $9.4 \times 10^{14} cycles/s$ d) $6.08 \times 10^{14} cycles/s$

287. The energy of a photon is $E = hv$ and the momentum of photon $p = \frac{h}{\lambda}$, then the velocity of photon will be
a) E/p b) Ep c) $\left(\frac{E}{p}\right)^2$ d) $3 \times 10^8 m/s$

288. If the mass of neutral $= 1.7 \times 10^{-27}$kg, then the de-Broglie wavelength of neutral of energy 3eV is $(h = 6.6 \times 10^{-34} \text{J} - \text{s})$
a) 1.6×10^{-16}m b) 1.6×10^{-11}m c) 1.4×10^{-10}m d) 1.4×10^{-11}m

289. Electric field and magnetic field in Thomson mass spectrograph are applied
a) Simultaneously, perpendicular b) Perpendicular but not simultaneously
c) Parallel but not simultaneously d) Parallel simultaneously

290. The retarding potential for having zero photo-electron current
a) Is proportional to the wavelength of incident light
b) Increases uniformly with the increase in the wavelength of incident light
c) Is proportional to the frequency of incident light
d) Increases uniformly with the increase in the frequency of incident light waves

291. If the potential difference applied across X-ray tube is V volts, then approximately minimum wavelength of the emitted X-rays will be
a) $\frac{1227}{\sqrt{V}}$Å b) $\frac{1240}{V}$Å c) $\frac{2400}{V}$Å d) $\frac{12400}{V}$Å

292. X-rays when incident on a metal
a) Exert a force on it b) Transfer energy to it
c) Transfer pressure to it d) All of the above

293. Electron volt is a unit of
a) Potential b) Charge c) Power d) Energy

294. In Millikan's oil drop experiment a drop of charge Q and radius r is kept constant between two plates of potential difference of 800 V. Then charge on other drop of radius 2 r which is kept constant with a

potential difference of 3200 V is

a) $Q/2$ b) $2\,Q$ c) $4\,Q$ d) $Q/4$

295. When the photons of energy $h\nu$ fall on a photosensitive metallic surface (work function $h\nu_0$), electrons are emitted from the metallic surface. The electrons coming out of the surface have some kinetic energy. The most energetic ones have the kinetic energy equal to

a) $h\nu_0$ b) $h\nu$ c) $h\nu - h\nu_0$ d) $h\nu + h\nu_0$

296. Penetrating power of X-rays depends on

a) Current flowing in the filament b) Applied potential difference
c) Nature of the target d) All the above

297. In Millikan's oil drop experiment, a charged drop of mass 1.8×10^{-14} kg is stationary between the plates. The distance between the plates 0.9 cm and potential difference between the plates is 2000 V. The number of electrons on the oil drop is

a) 10 b) 5 c) 50 d) 20

298. An oil drop of mass 50 mg and of charge$-5\mu C$ is just balanced in air against the force of gravity. Calculate the strength of the electric field required to balance is, ($g = 9.8\ ms^{-2}$)

a) 98 NC^{-1} upwards b) 98 NC^{-1} downwards
c) 9.8 NC^{-1} towards north d) 9.8 NC^{-1} towards south

299. An α-particle moves in a circular path of radius 0.83 cm in the presence of a magnetic field of 0.25 Wb/m^2. The de Broglie wavelength associated with the particle will be

a) 1 Å b) 0.1 Å c) 10 Å d) 0.01 Å

300. If source of power 4 kW produces 10^{20} photon/ second, the radiation belong to a part of the spectrum called

a) X-rays b) Ultraviolet rays c) Microwaves d) γ-rays

301. The wavelength of X-rays decreases, when

a) Temperature of target is increased
b) Intensity of electron beam is increased
c) K.E. of electrons striking the target is increased
d) K.E. of electrons striking the target is decreased

302. If wavelength of photon and electron is same then ratio of total energy of electron to total energy of photon would be

a) $\frac{\text{Velocity of electron}}{\text{Light's speed}}$ b) $\frac{\text{Light's speed}}{\text{Electron's speed}}$ c) $\frac{\text{Light'sspeed}}{\text{Velocity of electron}}$ d) $\frac{\text{Electron's speed}}{\text{Light's speed}}$

303. Light of wavelength 5000 Å falls on a sensitive plate with photoelectric work functional of 1.9 eV. The kinetic energy of the photoelectron emitted will be

a) 0.58 eV b) 2.48 eV c) 1.24 eV d) 1.16 eV

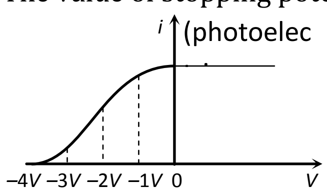
304. On increasing the number of electrons striking the anode of an X-ray tube, which one of the following parameters of the resulting X-rays would increase?

a) Penetration b) Frequency c) Wavelength d) Intensity

305. Work function of lithium and copper are respectively 2.3 eV and 4.0 eV. Which one of the metal will be useful for the photoelectric cell working with visible light ($h = 6.6 \times 10^{-34} J\text{-}s, c = 3 \times 10^8 m/s$)

a) Lithium b) Copper c) Both d) None of these

306. The value of stopping potential in the following diagram



a) $-4V$ b) $-3\ V$ c) $-2V$ d) $-1\ V$

307. A ratio transmitter operates at a frequency 880 kHz and a power of 10 kW. The number of photons emitted per second is

a) 1.72×10^{31} b) 1.327×10^{25} c) 1.327×10^{37} d) 1.327×10^{45}

308. According to photon theory of light which of the following physical quantities associated with a photon do not/does not change as it collides with an electron in vacuum
a) Energy and momentum b) Speed and momentum
c) Speed only d) Energy only

309. Five elements A, B, C, D and E have work functions $1.2\ eV, 2.4\ eV, 3.6\ eV, 4.8\ eV$ and $6\ eV$ respectively. If light of wavelength 4000 Å is allowed to fall on these elements, then photoelectrons are emitted by
a) A, B and C b) A, B, C, D and E c) A and B d) Only E

310. The ratio transmitter operates on a wavelength of 1500 m at a power of 400 kW. The energy of radio photon (in joule) is
a) 1.32×10^{-24} J b) 1.32×10^{-28} J c) 1.32×10^{-26} J d) 1.32×10^{-32} J

311. In an X-rays tube, the intensity of the emitted X-rays beam is increased by
a) Increasing the filament current b) Decreasing the filament current
c) Increasing the target potential d) Decreasing the target potential

312. Radiations of two photon's energy, twice and ten times the work function of metal are incident on the metal surface successively. The ratio of maximum velocities of photoelectrons emitted in two cases is
a) 1 : 2 b) 1 : 3 c) 1 : 4 d) 1 : 1

313. The charge on electron was discovered by
a) J.J. Thomson b) Neil Bohr c) Millikan d) Chadwick

314. A beam of electrons is moving with constant velocity in a region having electric and magnetic fields of strength $20\ Vm^{-1}$ and $0.5\ T$ at right angles to the direction of motion of the electrons. What is the velocity of the electrons?
a) $20\ ms^{-1}$ b) $40\ ms^{-1}$ c) $8\ ms^{-1}$ d) $5.5\ ms^{-1}$

315. The mean free path of the electrons in a discharge tube is 20 cm. The length of the tube is 15 cm only. Then length of Crooke's dark space is
a) 5 cm b) 20 cm c) 15 cm d) 25 cm

316. What should be the velocity of an electron so that its momentum becomes equal to that of a photon of wavelength 5200 Å?
a) $700\ \mathrm{ms}^{-1}$ b) $1000\ \mathrm{ms}^{-1}$ c) $1400\ \mathrm{ms}^{-1}$ d) $2800\ \mathrm{ms}^{-1}$

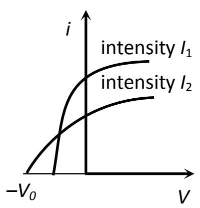
317. When the light source is kept 20 cm away from a photo cell, stopping potential 0.6 V is obtained. When source is kept 40 cm away, the stopping potential will be
a) 0.3 V b) 0.6 V c) 1.2 V d) 2.4 V

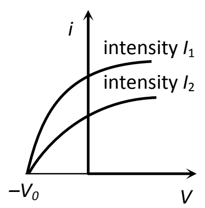
318. The wavelength of a 1 keV photon is 1.24×10^{-9}m. What is the frequency of 1 MeV photon?
a) 2.4×10^{15}Hz b) 2.4×10^{20}Hz c) 1.24×10^{15}Hz d) 1.24×10^{20}Hz

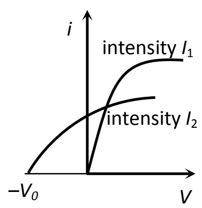
319. A charged oil drop of mass 9.75×10^{-15}kg and charge 30×10^{-16} C is suspended in a uniform electric field existing between two parallel plates. The field between the plates, taking ($\mathrm{g} = \mathrm{ms}^{-2}$) is
a) $3.25\ \mathrm{Vm}^{-1}$ b) $300\ \mathrm{Vm}^{-1}$ c) $325\ \mathrm{Vm}^{-1}$ d) $32.5\ \mathrm{Vm}^{-1}$

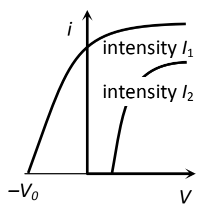
320. Intensity of X-rays depends upon the number of
a) Electrons b) Protons c) Neutrons d) Positrons

321. The curves (a), (b) (c) and (d) show the variation between the applied potential difference (V) and the photoelectric current (i), at two different intensities of light ($I_1 > I_2$). In which figure is the correct variation shown

a) 

b) 

c) 

d) 

322. A strong argument for the particle nature of cathode rays is that they
a) Produce fluorescence b) Travel through vacuum
c) Get deflected by electric and magnetic fields d) Cast shadow

323. A proton accelerated through a potential V has de-Broglie wavelength λ. Then the de-Broglie wavelength of an α-particle, when accelerated through the same potential V is

a) $\frac{\lambda}{2}$ b) $\frac{\lambda}{\sqrt{2}}$ c) $\frac{\lambda}{2\sqrt{2}}$ d) $\frac{\lambda}{8}$

324. An α-particle and a proton are accelerated from rest by a potential difference of 100 V. After this, their de-Broglie wavelengths are λ_α and λ_p respectively. The ratio $\frac{\lambda_p}{\lambda_\alpha}$, to the nearest integer, is

a) 3 b) 4 c) 2 d) 4.5

325. de-Broglie hypothesis treated electrons as

a) Particles b) Waves c) Both $'a'$ and $'b'$ d) None of these

326. Threshold wavelength for photoelectric effect on sodium is 5000 Å. Its work function is

a) $15\,J$ b) $16 \times 10^{-14} J$ c) $4 \times 10^{-19} J$ d) $4 \times 10^{-81} J$

327. When ultraviolet rays are incident on metal plate, then photoelectric effect does not occur. It occurs by the incidence of

a) X-rays b) Radio wave c) Infrared rays d) Green house effect

328. When a proton is accelerated with 1 $volt$ potential difference, then its kinetic energy is

a) $\frac{1}{1840} eV$ b) $1840\ eV$ c) $1\ eV$ d) $1840\ c^2\ eV$

329. The momentum of a charged particle moving in a perpendicular magnetic field depends on

a) Its charge
b) The strength of magnetic field
c) Radius of its path
d) All of the above

330. Hard X-rays for the study of factures in bones should have a minimum wavelength of $10^{-11} m$. The accelerating voltage for electrons in X-ray machine should be

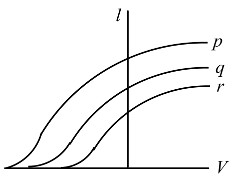
a) $< 124.2\ kV$
b) $> 124.2\ kV$
c) Between 60 kV and 70 kV
d) $= 100\ kV$

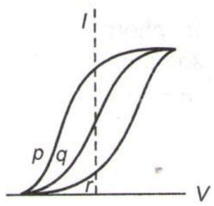
331. e/m ratio of anode rays produced in a discharge tube, depends on the

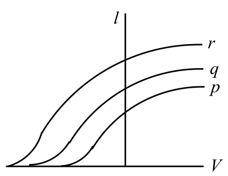
a) Nature of the gas filled in the tube
b) Nature of the material of anode
c) Nature of the material of cathode
d) All of the above

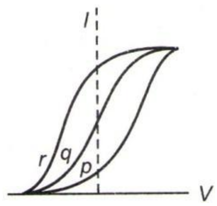
332. Photoelectric effect experiments are performed using three different metal plates p, q and r having work functions $\phi_p = 2.0$ eV, $\phi_q = 2.5$ eV and ϕ_r 3.0 eV, respectively

A light beam containing wavelengths of 550 nm, 450 nm and 350 nm with equal intensities illuminates each of the plates. The correct I-V graph for the experiment is

a) 

b) 

c) 

d) 

333. In a discharge tube at 0.02 mm, there is a formation of

a) FDS b) CDS c) Both space d) None of these

334. In photoelectric effect, the KE of electrons emitted from the metal surface depends upon

a) Intensity of light
b) Frequency of incident light
c) Velocity of incident light
d) Both intensity and velocity of light

335. In an electron gun, the electrons are accelerated by the potential V. If e is the charge and m is the mass of an electron, then maximum velocity of these electron will be

a) $\frac{2eV}{m}$ b) $\sqrt{\frac{2eV}{m}}$ c) $\sqrt{\frac{2m}{eV}}$ d) $\frac{V^2}{2em}$

336. Energy conversion in a photoelectric cell takes place form

a) Chemical to electrical
b) Magnetic to electrical
c) Optical to electrical
d) Mechanical to electrical

337. If alpha, beta and gamma rays carry same momentum, which has the longest wavelength?

a) Alpha rays
b) Beta rays
c) Gamma rays
d) None, all have same length

338. K_α characteristic X-ray refers to the transition
a) $n = 2$ to $n = 1$
b) $n = 3$ to $n = 2$
c) $n = 3$ to $n = 1$
d) $n = 4$ to $n = 2$

339. Photoelectric effect is an example of
a) Elastic collision
b) Inelastic collision
c) Two dimensional collision
d) Oblique collision

340. Which of the following devices makes use of the electrons to strike certain substances to produce fluorescence
a) Thermionic valve
b) Photoelectric cell
c) Cathode ray oscilloscope
d) Electron gun

341. When light of wavelength 300 nm falls on a photoelectric emitter, photoelectrons are liberated. For another emitter, light of wavelength 600 nm is sufficient for liberating photoelectrons. The ratio of the work function of the two emitter is
a) 1:2
b) 2:1
c) 4:1
d) 1:4

342. An electron is accelerated through a potential difference of V volt. The speed of electrons will be
a) $\sqrt{\frac{eV}{m}}$
b) $\sqrt{\frac{2eV}{m}}$
c) $\sqrt{\frac{eV}{2m}}$
d) $\sqrt{\frac{m}{2eV}}$

343. Photoelectric effect can be explained by
a) Corpusular theory of light
b) Wave nature of light
c) Bohr's theory
d) Quantum theory of light

344. Photoelectric effect was first successfully explained by
a) Planck
b) Hallwach
c) Hertz
d) Einstein

345. When a monochromatic point source of light is at a distance 0.2 m from a photoelectric cell, the saturation current and cut-off voltage are 12.0 mA and 0.5 V. If the same source is placed 0.4 m away from the photoelectric cell, then the saturation current and the stopping potential respectively are
a) 4 mA and 1V
b) 12 mA and 1V
c) 3 mA and 1V
d) 3 mA and 0.5 V

346. Solid targets of different elements are bombarded by highly energetic electron beams. The frequency (f) of the characteristic X-rays emitted from different targets varies with atomic number Z as
a) $f \propto \sqrt{Z}$
b) $f \propto Z^2$
c) $f \propto Z$
d) $f \propto Z^{3/2}$

347. Photons of energy of 6 eV are incident on a metal surface whose work function is 4 eV. The minimum kinetic energy of the emitted photoelectrons will be
a) Zero
b) 1 eV
c) 2 eV
d) 10 eV

348. If particles are moving with same velocity, then maximum de-Bronglie wavelength will be for
a) Neutron
b) Proton
c) β-particle
d) α-particle

349. In order to coincide the parabolas formed by singly ionised ions in one spectrograph and doubly ionized ions in the other Thomson's mass spectrograph, the electric field and magnetic fields are kept in the ratios 1:2 and 3:2 respectively. Then the ratio of masses of the ions is
a) 3 :4
b) 1 :3
c) 9 :4
d) None of these

350. If an electron moves from rest from a point at which potential is 50 V to another point at which potential is 70 V, then its kinetic energy in the final state will be
a) 3.2×10^{-20}J
b) 3.2×10^{-18}J
c) 3.2×10^{-19}J
d) Zero

351. Cathode rays are produced when the pressure is of the order of
a) 2 cm of Hg
b) 0.1 cm of Hg
c) 0.01 mm of Hg
d) 1 μm of Hg

352. Photoelectric effect supports quantum nature of light because
V. There is minimum frequency of light below which no photoelectrons are emitted.
VI. Electric charge of photoelectrons is quantized.
VII. Maximum kinetic energy of photoelectrons depends only on the frequency of light and not on its intensity.
VIII. Even when metal surface is faintly illuminated the photoelectrons leave the surface immediately.

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

353. The minimum wavelength of X-rays produced by electrons accelerated by a potential difference of $volts$ is equal to

a) $\frac{eV}{hc}$ b) $\frac{eh}{cV}$ c) $\frac{hc}{eV}$ d) $\frac{cV}{eh}$

354. The structure of solid crystals is investigated by using

a) Cosmic rays b) X-rays c) Infrared radiations d) γ-rays

355. The de-Broglie wavelength of a particle moving with a velocity $2.25 \times 10^8\ m/s$ is equal to the wavelength of photon. The ratio of kinetic energy of the particle to the energy of the photon is (velocity of light is $3 \times 10^8 m/s$)

a) 1/8 b) 3/8 c) 5/8 d) 7/8

356. For the production of X-rays, the target should be made of

a) Steel b) Copper c) Aluminimum d) Tungsten

357. The threshold wavelength for photoelectric effect of a metal is 6500 Å. The work function of the metal is approximately

a) 2 eV b) 1 eV c) 0.1 eV d) 3 eV

358. A particle of mass 1 mg has the same wavelength as an electron moving with a velocity of $3 \times 10^6 ms^{-1}$. The velocity of the particle is

a) $3 \times 10^{-31} ms^{-1}$ b) $2.7 \times 10^{-21} ms^{-1}$ c) $2.7 \times 10^{-18} ms^{-1}$ d) $9 \times 10^{-2} ms^{-1}$

359. The electrons are emitted in the photoelectric effect from a metal surface

a) Only if the frequency of the incident radiation is above a certain threshold value
b) Only if the temperature of the surface is high
c) At a rate that is independent of the nature of the metal
d) With a maximum velocity proportional to the frequency of the incident radiation

360. The frequency of the incident light falling on a photosensitive metal plate is doubled, the kinetic energy of the emitted photoelectron is

a) Double the earlier value b) Unchanged
c) More than doubled d) Less than doubled

361. The stopping potential V for photoelectric emission for a metal surface is plotted along Y-axis and frequency v of incident light along X-axis. A straight line is obtained as shown. Planck's constant is given by

a) Slope of the line
b) Product of slope of the line and charge on the electron
c) Intercept along Y-axis divided by charge on the electron
d) Product of intercept along X-axis and mass of the electron

362. An X-ray pulse of wavelength 4.9 Å is sent through a section of Wilson cloud chamber containing a super saturated gas, and tracks of photoelectron ejected from the gaseous atoms are observed. Two groups of tracks of lengths 1.40 cm and 2.02 cm are noted. If the range-energy relation for cloud chamber is given by $R = \alpha E$ with $\alpha = 1 cm/keV$, obtain the binding energies of the two levels from which electrons are emitted. Given $h = 6.63 \times 10^{-34} J - s, e = 1.6 \times 10^{-19} J$

a) 0.52 KeV b) 0.75 eV c) 0.52 eV d) 0.75 keV

363. The de-Broglie wavelength of an electron, α- particle and proton all having the same kinetic energy is respectively given as $\lambda_e, \lambda_\alpha$ and λ_p. Then which of the following is not true?

a) $\lambda_e < \lambda_p$ b) $\lambda_p > \lambda_\alpha$ c) $\lambda_e > \lambda_\alpha$ d) $\lambda_\alpha < \lambda_p < \lambda_e$

364. The specific charge of a proton is 9.6×10^7 C Kg^{-1}. The specific charge of an alpha particle will be

a) 9.6×10^7 C Kg^{-1} b) 19.2×10^7 C Kg^{-1} c) 4.8×10^7 C Kg^{-1} d) 2.4×10^7 C Kg^{-1}

365. A oil drop having a mass 4.8×10^{-10}g and charge 2.4×10^{-18} C stands still between two charged horizontal plates separated by a distance of 1 cm. If now the polarity of the plates is changed, instantaneous acceleration of the drop is (g=10 ms^{-2})

a) 5 ms^{-2} b) 10 ms^{-2} c) 15 ms^{-2} d) 20 ms^{-2}

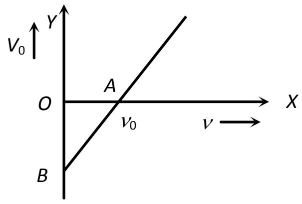
366. Light of wavelength 1824 Å, incident on the surface of a metal, produces photo-electrons with maximum energy 5.3 eV. When light of wavelength 1216 Å is used, the maximum energy of photoelectrons is 8.7 eV. The work function of the metal surface is

a) 3.5 eV b) 13.6 eV c) 6.8 eV d) 1.5 eV

367. Monochromatic light of frequency 6.0×10^4 Hz is produced by a laser. The power emitted is 2×10^{-3} W. The number of photons emitted, on the average, by the source per second is

a) 5×10^{15} b) 5×10^{16} c) 5×10^{17} d) 5×10^{14}

368. In an experiment on photoelectric effect the frequency f of the incident light is plotted against the stopping potential V_0. The work function of the photoelectric surface is given by (e is electronic charge)



a) $OB \times e$ in eV b) OB in $volt$

c) OA in eV d) The slope of the line AB

369. An X-ray tube with a copper target emits K_α line of wavelength 1.50 Å. What should be the minimum voltage through which electrons are to be accelerated to produce this wavelength of X rays ($h = 6.63 \times 10^{-34} J\text{-}s, c = 3 \times 10^8 m/s$)

a) 8280 V b) 828 V c) 82800 V d) 8.28 V

370. Mixed He^+ and O^{2+} ions (mass of $He^+ = 4$ amu and that of $O^{2+} = 16$ amu) beam passes a region of constant perpendicular magnetic field. If kinetic energy of all the ions is same then

a) He^+ ions will be deflected more than those of O^{2+}

b) He^+ ions will be deflected less than that of O^{2+}

c) All the ions will be deflected equally

d) No ions will be deflected

371. The mass of a proton is 1836 times that of an electron. An electron and a proton are projected into a uniform electric field in a direction perpendicular to the field with equal initial kinetic energies. Then

a) The electron trajectory is less curved than the proton trajectory

b) The proton trajectory is less curved than the electron trajectory

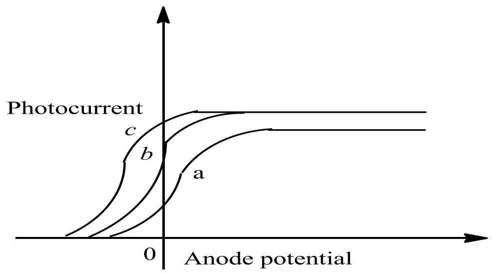
c) Both trajectories are equally curved

d) Both trajectories will be straight

372. A $1\mu A$ beam of protons with a cross-sectional area of 0.5 $sq. mm$ is moving with a velocity of $3 \times 10^4 ms^{-1}$. Then charge density of beam is

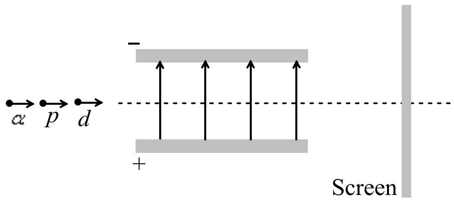
a) $6.6 \times 10^{-4} C/m^3$ b) $6.6 \times 10^{-5} C/m^3$ c) $6.6 \times 10^{-6} C/m^3$ d) None of these

373. The figure shows variation of photocurrent with anode potential for a photo-sensitive surface for three different radiations. Let I_a, I_b and I_c be the intensities and v_a, v_b and v_c be the frequencies for the curves a, b and c respectively. Then



a) $v_a = v_b and\ I_a \neq I_b$ b) $v_a = v_c$and $I_a = I_c$ c) $v_a = v_b$and $I_a = I_b$ d) $v_b = v_c$and $I_b = I_c$

374. A proton, a deuteron and an α-particle having the same momentum, enters a region of uniform electric field between the parallel plates of a capacitor. The electric field is perpendicular to the initial path of the particles. Then the ratio of deflections suffered by them is



a) 1 :2 :8 b) 1 :2 :4 c) 1 :1 :2 d) None of these

375. The K_α X-rays arising from a cobalt $(z = 27)$ target have a wavelength of 179 pm. The K_α X-rays arising from a nickel target $(z = 28)$ is

a) $> 179\ pm$ b) $< 179\ pm$ c) $= 179\ pm$ d) None of these

376. A photon of energy E ejects a photoelectrons from a metal surface whose work function is W_0. If this electron enters into a uniform magnetic field of induction B in a direction perpendicular to the field and describes a circular path of radius r, then the radius r, is given by, (in the usual notation)

a) $\sqrt{\frac{2m(E - W_0)}{eB}}$ b) $\sqrt{2m(E - W_0)eB}$ c) $\frac{\sqrt{2e(E - W_0)}}{mB}$ d) $\frac{\sqrt{2m(E - W_0)}}{eB}$

377. Cathode rays of velocity 10^6 ms^{-1} describe an approximate circular path of radius 1 m in an electric field 300 Vcm^{-1}. If velocity of cathode rays are doubled. The value of electric field so that the rays describe the same circular path, will be

a) 2400 Vcm^{-1} b) 600 Vcm^{-1} c) 1200 Vcm^{-1} d) 12000 Vcm^{-1}

378. The energy of an X-ray photon of wavelength 1.65 Å is $(h = 6.6 \times 10^{-34} J\text{-}sec, c = 3 \times 10^8 ms^{-1}, 1eV = 1.6 \times 10^{-19} J)$

a) 3.5 keV b) 5.5 keV c) 7.5 keV d) 9.5 keV

379. The threshold wavelength for photoelectric emission from a material is 4800 Å. Photoelectrons will be emitted from the material, when it is illuminated with light from a

a) 40 W blue lamp b) 40 W green lamp

c) 100 W red lamp d) 100 w yellow lamp

380. What is the momentum of a photon having frequency $1.5 \times 10^{13} Hz$

a) $3.3 \times 10^{-29} kg\ m/s$ b) $3.3 \times 10^{-34} kg\ m/s$ c) $6.6 \times 10^{-34} kg\ m/s$ d) $6.6 \times 10^{-30} kg\ m/s$

381. Positive rays were discovered by

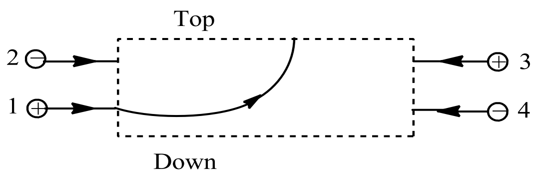
a) Thomson b) Goldstein c) W. Crookes d) Rutherford

382. X-rays are produced in X-ray tube operating at a given accelerating voltage. The wavelength of the continuous X-rays has values from

a) 0 to ∞ b) $\lambda_{\min}$ to ∞, where $\lambda_{\min} > 0$

c) 0 to $\lambda_{\max}$, where $\lambda_{\max} < \infty$ d) $\lambda_{\min}$ to $\lambda_{\max}$, where $0 < \lambda_{\min} < \lambda_{\max} < \infty$

383. The figure shows the path of a positively charged particle 1 through a rectangular region of uniform electric field as shown in the figure. What is the direction of electric field and the direction of deflection of particles 2,3 and 4?



a) Top; down , top, down b) Top; down, down, top

c) Down; top, top, down d) Down; top, down, down

384. A particle which has zero rest mass and non-zero energy and momentum, must travel with a speed

a) Equal to c, the speed of light in vacuum b) Greater than c

c) Less than c d) Tending of infinity

385. The kinetic energy of an electron with de-Broglie wavelength of 3 nm is

a) 0.168 eV b) 16.6 eV c) 1.68 eV d) 2.5 eV

386. Which of the following is dependent on the intensity of incident radiation in a photoelectric experiment

a) Work function of the surface

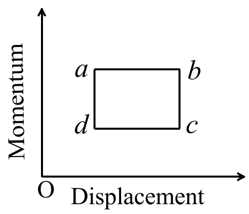
b) Amount of photoelectric current
c) Stopping potential will be reduced
d) Maximum kinetic energy of photoelectrons

387. Stopping potential for photoelectrons
a) Does not depend on the frequency of the incident light
b) Does not depend upon the nature of the cathode material
c) Depends on both the frequency of the incident light and nature of the cathode material
d) Depends upon the intensity of the incident light

388. A proton and an α-particle are accelerated through same potential difference. The ratio of their de-Broglie wavelengths λ_p/λ_α will be
a) $\frac{1}{\sqrt{8}}$ b) $\sqrt{8}$ c) 2 d) 1

389. Cathode rays are similar to visible light rays as
a) They both can be deflected by electric and magnetic fields
b) They both have a definite magnitude of wavelength
c) They both can ionize a gas through which they pass
d) They both can expose a photographic plate

390. Irreducible area $a\ b\ c\ d$, in figure is



a) Work b) Plank's constant c) Joule d) Charge

391. A photon in motion has a mass
a) $c/h\nu$ b) h/ν c) $h\nu$ d) $h\nu/c^2$

392. The de-Broglie wavelength associated with a particle moving with momentum *(p)* and mass *(m)* is
a) $\frac{h}{p}$ b) $\frac{h}{mp}$ c) $\frac{h}{p^2}$ d) $\frac{h^2}{p^2}$

393. An electron of mass m and charge q is accelerated from rest in a uniform electric field of strength E. The velocity acquired by it as it travels a distance l is
a) $\sqrt{2Eql/m}$ b) $\sqrt{2Eq/ml}$ c) $\sqrt{2Em/ql}$ d) $\sqrt{Eq/ml}$

394. If the frequency of light incident on metal surface is doubled, then kinetic energy of emitted electron wii become
a) Doubled b) Less than double c) More than double d) Nothing can be said

395. Which of the following is accompanied by the characteristic X-ray emission
a) α-particle emission b) Electron emission c) Positron emission d) K-electron capture

396. An X-ray machine is operated at 40 kV. The short wavelength limit of continuous X-rays will be $(h = 6.63 \times 10^{-34} Js, c = 3 \times 10^8\ ms^{-1}, e = 1.6 \times 10^{-19}\ C)$
a) 0.31Å b) 0.62Å c) 0.155Å d) 0.62Å

397. A photo-sensitive material would emit electrons, if excited by photons beyond a threshold. To overcome the threshold, one would increase the
a) Voltage applied to the light source
b) Intensity of light
c) Wavelength of light
d) Frequency of light

398. Davisson and Germer experiment proved
a) Wave nature of light
b) Particle nature of light
c) Both (a) and (b)
d) Neither (a) nor (b)

399. The energy of a photon of wavelength λ is given by
a) $h\lambda$ b) $ch\lambda$ c) λ/hc d) hc/λ

400. The threshold frequency for a metallic surface corresponds to an energy of 6.2 eV and the stopping

potential for a radiation incident on this surface is 5V. The incident radiation lies in

a) Ultra-violet region b) Infra-red region c) Visible region d) X-ray region

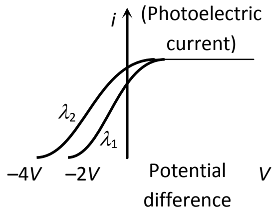
401. When the momentum of a proton is changed by an amount P_0, the corresponding change in the de-Broglie wavelength is found to be 0.25%. Then, the original momentum of the proton was

a) p_0 b) 100 p_0 c) 400 p_0 d) 4 p_0

402. Energy of a quanta of frequency 10^{15} Hz and $h = 6.6 \times 10^{-34} J$-$s$ will be

a) $6.6 \times 10^{-19} J$ b) $6.6 \times 10^{-12} J$ c) $6.6 \times 10^{-49} J$ d) $6.6 \times 10^{-41} J$

403. The maximum value of stopping potential in the following diagram is



a) $-4V$ b) $-1V$ c) $-3V$ d) $-2V$

404. The wavelength of K_α line in copper is 1.54 Å. The ionization energy of K electron in copper in $Joule$ is

a) 11.2×10^{-27} b) 12.9×10^{-16} c) 1.7×10^{-15} d) 10×10^{-16}

405. The minimum light intensity that can be perceived by the eye is about 10^{10} $\mathrm{Wm^{-2}}$. The number of photons of wavelength 5.6×10^{-7}m that must enter the pupil of area $10^{-4}\mathrm{m^3s^{-1}}$, for vision is approximately equal to ($h = 6.6 \times 10^{-34}$J-s)

a) 3×10^2 photons b) 3×10^3 photons c) 3×10^4 photons d) 3×10^5 photons

406. X-rays are known to be electromagnetic radiations. Therefore the X-ray photon has

a) Electric charge b) Magnetic moment

c) Both electric charge and magnetic moment d) Neither electric charge nor magnetic moment

407. A charged particle is at rest in the region where magnetic field and electric field are parallel. The particle will move in a

a) Straight line b) Circle c) Ellipse d) None of these

408. Nuclear radii may be measured by scattering high energy electrons from nuclei. What is the de-Broglie wavelength for 200 MeV electrons?

a) 8.28 fm b) 7.98 fm c) 6.45 fm d) 6.20 fm

409. The longest wavelength that can be analysed by a sodium chloride crystal of spacing $d = 2.82\ A°$ in the second order is

a) 2.82 $A°$ b) 5.64 $A°$ c) 8.46 $A°$ d) 11.28 $A°$

410. The minimum wavelength of photon is 5000 Å, its energy will be

a) 2.5 eV b) 50 V c) 5.48 eV d) 7.48 eV

411. A positively charged particle enters a magnetic field of value $B\hat{\mathbf{j}}$ with a velocity $v\hat{\mathbf{k}}$. The particle will move along

a) $+X$ axis b) $-X$ axis c) $+Z$ axis d) $-Z$ axis

412. In vacuum an electron of energy 10 keV hits tungsten target, then emitted radiation will be

a) Cathode rays b) X-rays c) Infrared rays d) Visible spectrum

413. K_α wavelength emitted by an atom of atomic number Z =11 is λ. Find the atomic number for an atom that emits K_α radiation with wavelength 4λ

a) Z = 6 b) Z = 4 c) Z =11 d) Z = 44

414. O^{++}, C^{+}, He^{++} and H^{+} ions are projected on the photographic plate with same velocity in a mass spectrograph. Which one will strike farthest

a) O^{++} b) C^{+} c) He^{++} d) H_2^{+}

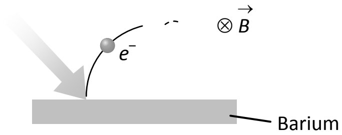
415. In radio therapy, X-rays are used to

a) Detect bone factures b) Treat cancer by controlled exposure

c) Detect heart diseases d) Detect fault in radio receving circuits

416. Light of wavelength 2475 Å is incident on barium. Photoelectrons emitted describe a circle of radius

100 cm by a magnetic field of flux density $\frac{1}{\sqrt{17}} \times 10^{-5} Tesla$. Work function of the barium is (Given $\frac{e}{m} = 1.7 \times 10^{11}$)



a) 1.8 eV b) 2.1 eV c) 4.5 eV d) 3.3 eV

417. In Bainbridge mass spectrograph a potential difference of 1000 V is applied between two plates distant 1 cm apart and magnetic field $B = 1T$. The velocity of undeflected positive ions in m/s from the velocity selector is
a) $10^7\ m/s$ b) $10^4\ m/s$ c) $10^5\ m/s$ d) $10^2\ m/s$

418. Work function of a metal is 2.1 eV. Which of the waves of the following wavelengths will be able to emit photoelectrons from its surface
a) 4000 Å, 7500 Å b) 5500 Å, 6000 Å c) 4000 Å, 6000 Å d) None of these

419. The working principle of the mass spectrograph is that for a given combination of accelerating potential and magnetic field, the ion beam (with charge q and mass M) to be collected at different positions of ion collectors will depend upon the value of
a) $\sqrt{q/M}$ b) $(q/M)^2$ c) q/M d) qM

420. A charged particle of mass m and charge q is released from rest in an uniform electric field E neglecting the effect of gravity,the kinetic energy of the charged particle after t second is
a) $\frac{2E^2t^2}{mq}$ b) $\frac{Eq^2m}{2t^2}$ c) $\frac{Eqm}{t}$ d) $\frac{E^2q^2t^2}{2m}$

421. The photoelectric threshold frequency of a metal is ν. When light of frequency 4ν is incident on the metal. The maximum kinetic energy of the emitted photoelectrons is
a) 4 $h\nu$ b) 3 $h\nu$ c) 5 $h\nu$ d) $\frac{5}{2}\ h\nu$

422. A and B are two metals with threshold frequencies 1.8×10^{14}Hz and 2.2×10^{14}Hz. Two idential photons of energy 0.825 eV each are incident on them. Then photoelectrons are emitted by $(Take\ h = 6.6 \times 10^{-34}\ J - s)$
a) B alone b) A alone c) Neither A nor B d) both A and B

423. The mass of a particle is 400 times than that of an electron and charge is double. The particle is accelerated by 5V. Initially the particle remained in rest, then its final kinetic energy will be
a) 5 eV b) 10 eV c) 100 eV d) 200 eV

424. The energy of incident photons corresponding to maximum wavelength of visible light is
a) 3.2 eV b) 7 eV c) 1.55 eV d) 1 eV

425. If e/m of electron is 1.76×10^{11} C kg^{-1} and stopping potential is 0.71 V, then the maximum velocity of the photoelectron is
a) 150 km/s b) 200 km/s c) 500 km/s d) 250 km/s

426. Assuming photoemission to take place, the factor by which the maximum velocity of the emitted photoelectrons changes when the wavelength of the incident radiation is increased four times, is
a) 4 b) 1/4 c) 2 d) 1/2

427. Photon and electron are given energy $(10^{-2}J)$. Wavelengths associated with photon and electron are λ_{ph} and λ_{el} then, correct statement will be
a) $\lambda_{\text{ph}} > \lambda_{\text{el}}$ b) $\lambda_{\text{ph}} < \lambda_{\text{el}}$ c) $\lambda_{\text{ph}} = \lambda_{\text{el}}$ d) $\frac{\lambda_{\text{el}}}{\lambda_{\text{ph}}} = c$

428. A uniform electric field and a uniform magnetic field exist in a region in the same direction. An electron is projected with a velocity pointed in the same direction. Then the electron will be
a) Be deflected to the left without increase in speed
b) Be deflected to the right without increase in speed
c) Not be deflected but its speed will decrease

d) Not be deflected but its speed will increase

429. The minimum intensity of light to be detected by human eye is $10^{-10} W/m^2$. The number of photons of wavelength $5.6 \times 10^{-7} m$ entering the eye, with pupil area $10^{-6} m^2$, per second for vision will be nearly

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

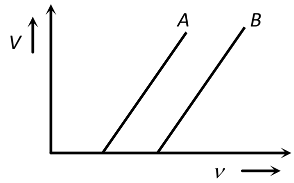
430. In a photoelectric effect experiment, the slope of the graph between the stopping potential and the incident frequency will be

a) 1 b) 0.5 c) 10^{-15} d) 10^{-34}

431. An oil drop carrying a charge q has a mass m kg. It is falling freely in air with terminal speed v. The electric field required to make the drop move upwards with the same speed is

a) $\frac{mg}{q}$ b) $\frac{2mg}{q}$ c) $\frac{mgv}{q^2}$ d) $\frac{2mgv}{q}$

432. The stopping potential as a function of the frequency of the incident radiation is plotted for two different photoelectric surfaces A and B. The graphs show that work function of A is



a) Grater than that of B

b) Smaller than that of B

c) Equal to that of B

d) No inference can be drawn about their work functions from the given graphs

433. What is the strength of transverse magnetic field required to bend all the photoelectrons within a circle of a radius 50 cm. When light of wavelength 3800 Å is incident on a barium emitter? (Given that work function of barium is 2.5 eV; $h = 6.63 \times 10^{-34}$ J-s; $e = 1.6 \times 10^{-19}$ C; $m = 9.1 \times 10^{-31}$kg)

a) 6.32×10^{-4} T b) 6.32×10^{-5} T c) 6.32×10^{-6} T d) 6.32×10^{-8} T

434. X-rays are produced due to

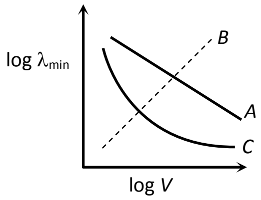
a) Break up of molecules

b) Changing in atomic energy level

c) Changing in nuclear elergy level

d) Radioactive disintegration

435. The dependence of the short wavelength limit $\lambda_{\min}$ on the accelerating potential V is represented by the curve of figure



a) A b) B c) C d) None of these

436. The values $+\frac{1}{2}$ and $-\frac{1}{2}$ of spin quantum number show

a) Rotation of e^- clockwise and anticlockwise direction respectively

b) Rotation of e^- anticlockwise and clockwise directions respectively

c) Rotation in any direction according to convention

d) None of the above

437. The colour of the positive column in a gas discharge tube depends on

a) The type of glass used to construct the tube

b) The gas in the tube

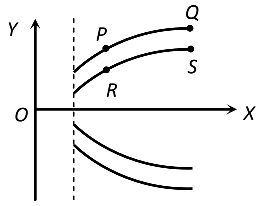
c) The applied voltage

d) The material of the cathode

438. X-rays of which of the following wavelengths are hardest

a) 4 Å b) 1 Å c) 0.1 Å d) 2 Å

439. In Thomson spectrograph experiment, four positive ions P, Q, R and S are situated on Y-X curve a shown in the figure



a) The specific charge of R and S are same
b) The masses of P and S are same
c) The specific charges of Q and R are same
d) The velocities of R and S are same

440. In a photoelectric effect measurement, the stopping potential for a given metal is found to be V_0 volt when radiation of wavelength λ_0 is used. If radiation of wavelength $2\lambda_0$ is used with the same metal then the stopping potential (in volt) will be
a) $\frac{V_0}{2}$
b) $2V_0$
c) $V_0 + \frac{hc}{2e\lambda_0}$
d) $V_0 - \frac{hc}{2e\lambda_0}$

441. The resistance of a discharge tube is
a) Zero
b) Ohmic
c) Non-ohmic
d) Infinity

442. A photosensitive metallic surface has work function ϕ.If photon of energy 3ϕ fall on this surface, the electron comes out with a maximum velocity of 6×10^6 m/s. when the photon energy is increased to 9ϕ, then maximum velocity of photoelectron will be
a) 12×10^6 m/s
b) 6×10^6 m/s
c) 3×10^6 m/s
d) 24×10^6 m/s

443. A cathode emits 1.8×10^{14} electrons per second, when heated. When 400 V is applied to anode all the emitted electrons reach the anode. The charge on electron is $1.6 \times 10^{-19} C$. The maximum anode current is
a) 2.7 μA
b) 29 μA
c) 72μA
d) 29 mA

444. A metal block is exposed to beams of X-ray of different wavelengths X-rays of which wavelength penetrate most
a) 2 Å
b) 4 Å
c) 6 Å
d) 8 Å

445. In the photoelectric effect the velocity of ejected electrons depends upon the nature of the target and
a) The frequency of the incident light
b) The polarisation of the incident light
c) The time for which the light has been incident
d) The intensity of the incident light

446. An ionisation chamber, with parallel conducting plates as anode and cathodes has 5×10^7 cm^{-3} electrons and the same number of singly charged positive ions per cm^3. The electrons are moving toward the anode with velocity 0.4ms^{-1}. The current density from anode to cathode is 4μAm^{-2}. The velocity of positive ions moving towards cathode is
a) 0.1 ms^{-1}
b) 0.4 ms^{-1}
c) Zero
d) 1.6 ms^{-1}

447. An electron initially at rest is accelerated through a potential difference of 1V. The energy acquired by electron is
a) 10^{-19} J
b) 1.6×10^{-19} erg
c) 1.6×10^{-19} J
d) 1 J

448. Maximum velocity of photoelectron emitted is 4.8 ms^{-1}. The e/m ratio of electron is 1.76×10^{11} Ckg^{-1}, then stopping potential is given by
a) 5×10^{-10} JC^{-1}
b) 3×10^{-7} JC^{-1}
c) 7×10^{-11} JC^{-1}
d) 2.5×10^{-2} JC^{-1}

449. If a proton and electron have the same de Broglie wavelength, then
a) Kinetic energy of electron < kinetic energy of proton
b) Kinetic energy of electron = kinetic energy of proton
c) Momentum of electron > momentum of proton
d) Momentum of electron = momentum of proton

450. The slope of frequency of incident light and stopping potential graph for a given surface will be
a) h
b) h/e
c) eh
d) e

451. The variation of photoelectric current given by the photocell, with the intensity of light, is give by a graph, which is a straight line with
a) +ve slope with intercept on current axis
b) −ve slope with intercept of current axis
c) +ve slope passing through origin
d) −ve slope passing through origin

452. The continuous X-rays spectrum produced by an X-ray machine at constant voltage has
a) A maximum wavelength
b) A minimum wavelength

c) A single wavelength | d) A minimum frequency

453. The de-Broglie wavelength of an electron in the ground state of the hydrogen atom is

a) πr^2 b) $2\pi r$ c) πr d) $\sqrt{2\pi r}$

454. $4\ eV$ is the energy of the incident photon and the work function is $2eV$. What is the stopping potential

a) $2V$ b) $4V$ c) $6V$ d) $2\sqrt{2}V$

455. The photoelectric threshold of Tungsten is 2300Å. The energy of the electrons ejected from the surface by ultraviolet light of wavelength 1800 Å is
($h = 6.6 \times 10^{-34}$ J-s)

a) 0.15 eV b) 1.5 eV c) 15 eV d) 150 eV

456. In a photoelectric experiment, if both the intensity and frequency of the incident light are doubled, then the saturation photoelectric current

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

457. The difference between kinetic energies of photoelectrons emitted from a surface by light of wavelength 2500Å and 5000Å will be

a) 1.61 eV b) 2.47 eV c) 3.96 eV d) 3.96×10^{-19}eV

458. Gases begin to conduct electricity at low pressure because

a) At low pressure, gases turn to plasma
b) Colliding electrons can acquire higher kinetic energy due to increased mean free path leading to ionization of atoms
c) Atoms break up into electrons and protons
d) The electrons in atom can move freely at low pressure

459. If a proton and an electron are confined to the same region, then uncertainty in momentum

a) For proton is more, as compared to the electron b) For electron is more, as compared to the proton
c) Same for both the particles d) Directly proportional to their masses

460. Monochromatic light of frequency f incident on emitter having threshold frequency f_0. The kinetic energy of ejected electron will be

a) hf b) $h(f - f_0)$ c) hf_0 d) $h(f + f_0)$

461. The essential distinction between X-rays and γ-rays it that

a) γ —rays have smaller wavelength than X-rays
b) γ —rays emanate from nucleus while X-rays emanate from outer part of the atom
c) γ —rays have greater ionizing power than X-rays
d) γ —rays are more penetrating than X-rays

462. Light of energy 2.0 eV falls on a metal of work function 1.4 eV. The stopping potential is

a) 0.6 V b) 2.0 V c) 3.4 V d) 1.4 V

463. A caesium photocell, with a steady potential difference of $60V$ across, is illuminated by a bright point source of light 50 cm away. When the same light is placed $1m$ away the photoelectrons emitted from the cell

a) Are one quarter as numerous
b) Are half as numerous
c) Each carry one quarter of their previous momentum
d) Each carry one quarter of their previous energy

464. Which of the following supports the wave nature of X-rays?

a) Photoelectric effect b) Photosynthesis c) Compton scattering d) Diffraction

465. If maximum velocity with which an electron can be emitted from a photo cell is $4 \times 10^8 cm/s$, the stopping potential is
(mass of electron $= 9 \times 10^{-31} kg$)

a) 30 $volt$ b) 45 $volt$
c) 59 $volt$ d) Information is insufficient

466. The shortest wavelength of X-rays emitted from an X-ray tube depends on the

a) Current in the tube b) Voltage applied to the tube

c) Nature of gas in the tube
d) Atomic number of target material

467. The radius of the orbital of electron in the hydrogen atom is 0.5 Å. The speed of the electron is $2 \times 10^6\ m/s$. Then the current in the loop due to the motion of the electron is

a) $1\ mA$ b) $1.5\ mA$ c) $2.5\ mA$ d) $1.5 \times 10^{-2}\ mA$

468. Which of the following is incorrect statement regarding photon

a) Photon exerts no pressure
b) Photon energy is hv
c) Photon rest mass is zero
d) None of these

469. A photon in motion has a mass equal to

a) c/hv b) h/λ c) hv d) hv/c^2

470. A photocell is illuminated by a small bright source placed 1 m away. When the same source of light is placed $1/2\ m$ away, the number of electrons emitted by photo cathode would

a) Decrease by a factor of 2
b) Increase by a factor of 2
c) Decrease by a factor of 4
d) Increase by a factor of 4

471. The de-Broglie wavelength of a neutron at 927°C is λ. What will be its wavelength at 27°C ?

a) $\lambda/2$ b) $\lambda/4$ c) 4λ d) 2λ

472. The velocity, v, at which the mass of a particle is double its rest mass is

a) $v = c$ b) $v = \sqrt{\frac{3}{4}}c$ c) $v = \sqrt{\frac{3}{2}}c$ d) $v = 2c$

473. The wavelength of de-Broglie wave associated with a thermal neutron of mass m at absolute temperature T is given by (Here, k is the Boltzmann constant)

a) $\frac{h}{\sqrt{2mkT}}$ b) $\frac{h}{\sqrt{mkT}}$ c) $\frac{h}{\sqrt{3kmT}}$ d) $\frac{h}{2\sqrt{mkT}}$

474. The wavelength of characteristic X-rays K_α line emitted by hydrogen like atom is 0.32 Å. The wavelength of K_β line emitted by the same element is

a) 0.21 Å b) 0.27 Å c) 0.33 Å d) 0.40 Å

475. A charged oil drop is suspended in uniform field of $3 \times 10^4\ \text{Vm}^{-1}$ so that it neither falls nor rises. The charge on the drop will be
(Take the mass of the charge $= 9.9 \times 10^{-15}$ Kg and $g = 10\ \text{ms}^{-2}$)

a) 3.3×10^{-18}C b) 3.2×10^{-18} C c) 1.6×10^{-18} C d) 4.8×10^{-18} C

476. Positive rays consists of

a) Electrons
b) Neutrons
c) Positive ions
d) Electro magnetic waves

477. The photons in a radiowave of wavelength 3×10^4 cm have energy

a) 6.62×10^{-10} J b) 19.86×10^{-24} J c) 6.62×10^{-28} J d) 2.2×10^{-35} J

478. In the experiment for the determination of $\frac{e}{m}$ of electrons by the Thomson method, electric and magnetic fields are

a) Parallel and both are perpendicular to the motion of the electron
b) Both mutually perpendicular and parallel to the motion of electron
c) Both mutually perpendicular and also perpendicular to the motion of electron
d) Both mutually perpendicular and have no relation with motion of the electron

479. The largest distance between the interatomic places of a crystal is $10^7\ cm$. The upper limit for the wavelength of X-rays which can be usefully studied with this crystal is

a) 1 Å b) 2 Å c) 10 Å d) 20 Å

480. What is de-Broglie wavelength of electron having energy 10 ke V?

a) 0.12Å b) 1.2Å c) 12.2Å d) None of these

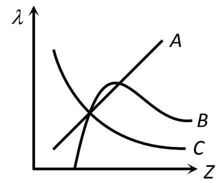
481. The surface of a metal is illuminated with the light of 400 nm. The kinetic energy of the ejected photoelectrons was found to be 1.68 eV. The work function of the metal is ($hc\ = 1240\ eV -$ nm)

a) 3.09 eV b) 1.42 eV c) 151 eV d) 1.68 eV

482. The incident photon involved in the photoelectric effect experiment

a) Completely disappears
b) Comes out with an increased frequency
c) Comes out with a decreased frequency
d) Comes out without change in frequency

483. The variation of wavelength λ of the K_α line with atomic number Z of the target is shown by the following curve of

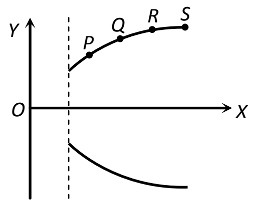


a) A b) B c) C d) None of these

484. The kinetic energy of an electron, which is accelerated in the potential difference of 100 V, is

a) 1.6×10^{-17} J b) 1.6×10^{-14} J c) 1.6×10^{-10} J d) 1.6×10^{-8} J

485. In a parabola spectrograph, the velocities of four positive ions P, Q, R and S are v_1, v_2, v_3 and v_4 respectively. Then



a) $v_1 > v_2 > v_3 > v_4$ b) $v_1 < v_2 < v_3 < v_4$ c) $v_1 = v_2 = v_3 = v_4$ d) $v_1 << v_2 > v_3 < v_4$

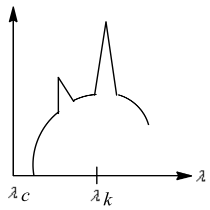
486. Cathode rays of velocity 10^6 ms^{-1} describe an approximate circular path of radius 1 m in an electric field of 500 V cm^{-1}. If the velocity of cathode rays is doubled, the value of electric field needed so that the rays describe the same circular path is

a) 1000 V cm^{-1} b) 1500 V cm^{-1} c) 2000 V cm^{-1} d) 500 V cm^{-1}

487. A uniform electric field and a uniform magnetic field are acting along the same direction in a certain region. If an electron is projected along the direction of the fields with a certain velocity, then

a) Its velocity will decrease
b) Its velocity will increase
c) It will turn towards right of direction of motion
d) It will turns towards left of direction of motion

488. The intensity of X-rays from a coolidge tube is plotted against wavelength λ as shown in figure. The minimum wavelength found is λ_c and the wavelength of K_α like is λ_K. As the accelerating voltage is increased



a) $\lambda_K - \lambda_c$ increases b) $\lambda_K - \lambda_c$ decreases c) λ_K increases d) λ_K decreases

489. X-rays are produced by accelerating electrons by voltage V and let they strike a metal of atomic number Z. The highest frequency of X-rays produced is proportional to

a) V b) Z c) $(Z-1)$ d) $(Z-1)^2$

490. In photoelectric effect, the number of electrons ejected per second is

a) Proportional to the wavelength of light
b) Proportional to the intensity of light
c) Proportional to the work function of the metal
d) Proportional to the frequency of light

491. Which is the incorrect statement of the following

a) Photon is a particle with zero rest mass
b) Photon is a particle with zero momentum
c) Photons travel with velocity of light in vacuum
d) Photon even feel the pull of gravity

492. The maximum kinetic energy of emitted electrons in a photoelectric effect does not depend upon

a) Wavelength b) Frequency c) Intensity d) Work function

493. Light of wavelength 4000 Å falls on a photosensitive metal and a negative $2V$ potential stops the emitted electrons. The work function of the material (in eV) is approximately
$(h = 6.6 \times 10^{-34} Js, e = 1.6 \times 10^{-19} C, c = 3 \times 10^{8} ms^{-1})$

a) 1.1 b) 2.0 c) 2.2 d) 3.1

494. In X-ray spectrum wavelength λ of line K_α depends on atomic number Z as

a) $\lambda \propto Z^2$ b) $\lambda \propto (Z-1)^2$ c) $\lambda \propto \frac{1}{(Z-1)}$ d) $\lambda \propto \frac{1}{(Z-1)^2}$

495. The linear momentum of an electron, initially at rest, accelerated through a potential difference of 100 V is

a) 9.1×10^{-24} b) 6.5×10^{-24} c) 5.4×10^{-24} d) 1.6×10^{-24}

496. Electron of mass m and charge e in external field E experiences acceleration

a) $\frac{e}{mE}$, in the opposite direction to the field b) $\frac{eE}{m}$, in the direction of the field

c) $\frac{em}{E}$, in the direction of the field d) $\frac{eE}{m}$,in the opposite direction of the field

497. If the energy of photons corresponding to the wavelength of 6000Å is 3.2×10^{-19} J, the photon energy for a wavelength of 4000Å will be

a) 1.11×10^{-19} J b) 2.22×10^{-19} J c) 4.40×10^{-19} J d) 4.80×10^{-19} J

498. A source S_1 is producing 10^{15} photons per second of wavelength 5000Å. Another source S_2 is producing 1.02×10^{15} photons per second of wavelength 5100Å. Then (power of S_2)/(power of S_1) is equal to

a) 0.98 b) 1.00 c) 1.02 d) 1.04

499. Threshold wavelength for photoelectric emission from a metal surface is 5200Å. Photoelectrons will emitted when this surface is illuminated with monochromatic radiation from

a) 1 W IR lamp b) 50 W UV lamp c) 50 W IR lamp d) 10 W IR lamp

500. The number of photons of wavelength 540 nm emitted per second by an electric bulb of power 100 W is (taking $h = 6 \times 10^{-34} J\text{-}s$)

a) 100 b) 1000 c) 3×10^{20} d) 3×10^{18}

501. When green light is incident on the surface of metal, it emits photo-electrons but there is no such emission with yellow colour light. Which one of the colours can produce emission of photo-electrons

a) Orange b) Red c) Indigo d) None of the above

502. When a metal surface is illuminated by light of wavelengths 400 nm and 250 nm, the maximum velocities of the photoelectrons ejected are v and $2v$ respectively. The work function of the metal is (h = Plank's constant, c = velocity of light in air)

a) $2\, hc \times 10^6 J$ b) $1.5\, hc \times 10^6 J$ c) $hc \times 10^6 J$ d) $0.5\, hc \times 10^6 J$

503. A photo cell is receiving light from a source placed at a distance of 1 m. If the same source is to be placed at a distance of 2 m, then the ejected electron

a) Moves with one-fourth energy as that of the initial energy

b) Moves with one-fourth of momentum as that of the initial momentum

c) Will be half in number

d) Will be one-fourth in number

504. In Thomson's method of determining e/m of electrons

a) Electric and magnetic fields are parallel to electrons beam

b) Electric and magnetic fields are parallel to each other and perpendicular to electrons beam

c) Magnetic field is parallel to the electrons beam

d) Electric field is parallel to the electrons beam

505. If in a Thomson's mass spectrograph, the ratio of the electric fields and magnetic fields, in order to obtain coincident parabola of singly ionised and doubly ionised positive ions are 1 : 2 and 3 : 2 respectively, then the ratio of masses of particles will be

a) 3 : 1 b) 2 : 1 c) 9 : 4 d) 9 : 2

506. In a photocell bichromatic light of wavelength 2475 Å and 6000 Å are incident on cathode whose work

function is 4.8 eV. If a uniform magnetic field of $3 \times 10^{-5} tesla$ exists parallel to the plate, the radius of the path described by the photoelectron will be (mass of electron $= 9 \times 10^{-31} kg$)

a) 1 cm b) 5 cm c) 10 cm d) 25 cm

507. The frequency and work function of an incident photon are v and ϕ_0. If v_0 is the threshold frequency then necessary condition for the emission of photo electron is

a) $v < v_0$ b) $v = \frac{v_0}{2}$ c) $v \geq v_0$ d) None of these

508. Which of the following is not the property of a cathode ray

a) It casts shadow b) It produces heating effect
c) It produces flurosence d) It does not deflect in electric field

509. Light of frequency $4v_0$ is incident on the metal of the threshold frequency v_0. The maximum kinetic energy of the emitted photoelectrons is

a) $3hv_0$ b) $2hv_0$ c) $\frac{3}{2}hv_0$ d) $\frac{1}{2}hv_0$

510. Electrons used in an electron microscope are accelerated by a voltage of 25 kV. If the voltage is increased to 100 kV then the de-Broglie wavelength associated with the electrons would

a) Increase by 4 times b) Increase by 2 times c) Decrease by 2 times d) Decrease by 4 times

511. For a certain metal $v = 2\ v_0$ and the electrons come out with a maximum velocity of 4×10^6 ms^{-1}. If the value of $v = 5\ v_0$, then maximum velocity of photoelectrons will be

a) 2×10^7 ms^{-1} b) 8×10^6 ms^{-1} c) 2×10^6 ms^{-1} d) 8×10^5 ms^{-1}

512. The work function of a metal is 1eV. Light of wavelength 3000 Å is incident on this metal surface. The velocity of emitted photoelectrons will be

a) 10 ms^{-1} b) 10^3 ms^{-1} c) 10^4 ms^{-1} d) 10^6 ms^{-1}

513. When monochromatic radiation of intensity I falls on a metal surface, the number of photoelectron and their maximum kinetic energy are N and T respectively. If the intensity of radiation is $2I$, the number of emitted electrons and their maximum kinetic energy are respectively

a) N and $2T$ b) $2N$ and T c) $2N$ and $2T$ d) N and T

514. G. P. Thomson experimentally confirmed the existence of matter waves by the phenomenon

a) Diffraction b) Refraction c) Polarisation d) Scattering

515. Given that a photon of light of wavelength 10,000 Å has an energy equal to 1.23 eV. When light of wavelength 5000 Å and intensity I_0 falls on a photoelectric cell, the surface current is 0.40×10^{-6} A and the stopping potential is 1.36 V, then the work function is

a) 0.43 eV b) 0.55 eV c) 1.10 eV d) 1.53 eV

516. Maximum velocity of the photoelectrons emitted by a metal surface is 1.2×10^6 ms^{-1}. Assuming the specific charge of the electron to be 1.8×10^{11} C kg^{-1}, the value of the stopping potential in volt will be

a) 2 b) 3 c) 4 d) 6

517. Characteristic X-rays are produced due to

a) Transfer of momentum in collision of electrons with target atoms
b) Transition of electrons from higher to lower electronic orbits in an atom
c) Heating of the target
d) Transfer of energy in collision of electrons with atoms in the target

518. Energy required to remove an electron from an aluminium surface is 4.2 eV. If light of wavelength 2000 Å falls on the surface, the velocity of fastest electrons ejected from the surface is

a) 2.5×10^{18}ms^{-1} b) 2.5×10^{13}ms^{-1} c) 6.7×10^{18}ms^{-1} d) None of these

519. In cathode ray oscillograph, the focusing of beam on the screen is achieved by

a) Convex lenses b) Magnetic field c) Electric potential d) All of these

520. Compton effect shows that

a) X-rays are waves b) X-rays have high energy
c) X-rays can penetrate matter d) Photons have momentum

521. In an experiment of photoelectric effect the stopping potential was measured to be V_1 and V_2 volts with

incident light of wavelength λ and $\lambda/2$ respectively. The relation between V_1 and V_2 may be

a) $V_2 < V_1$ b) $V_1 < V_2 < 2V_1$ c) $V_2 = 2V_1$ d) $V_2 > 2V_1$

522. If an electron and a photon propagate in the form of waves having the same wavelength, it implies that they have the same

a) Energy b) Momentum c) Velocity d) Angular momentum

523. The work function of a metal is 4.2 eV, its threshold wavelength will be

a) 4000 Å b) 3500 Å c) 2955 Å d) 2500 Å

524. From the following, what charges can be present on oil drops in Millikan's experiment (Here e is the electronic charge)

a) Zero, equal to the magnitude of charge on α −particle b) $2e, 1.6 \times 10^{-18}C$

c) $1.6 \times 10^{-19}C, 2.5e$ d) $1.5e, e$

525. The photoelectric threshold wavelength for a metal surface is 6600Å. The work function for this metal is

a) 0.87 eV b) 1.87 eV c) 18.7 eV d) 0.18 eV

526. In X-ray experiment K_α, K_β denotes

a) Characteristic b) Continuous wavelength

c) α, β-emissions respectively d) None of these

527. One electron and one proton is accelerated by equal potential. Ratio in their de-Broglie wavelength is

a) 1 b) $\frac{m_e}{m_p}$ c) $\sqrt{\frac{m_p}{m_e}}$ d) $\sqrt{\frac{m_e}{m_p}}$

528. An electric field of intensity 6×10^4 Vm^{-1} is applied perpendicular to the direction of motion of the electron. A magnetic field of induction 8×10^{-2} Wm^{-2} is applied perpendicular to both the electric field and direction of motion of the electron. What is the velocity of the electron if it passes undeflected?

a) 7.5×10^5 ms^{-1} b) 7.5×10^{-5} ms^{-1} c) 48×10^{-2} ms^{-1} d) It is never possible

529. If an electron oscillates at a frequency of 1 GHz it gives

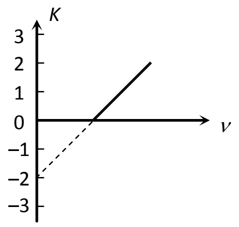
a) X-rays b) Mirowaves c) Infrared rays d) None of these

530. The de-Broglie wavelength λ

a) Is proportional to mass b) Is proportional to impulse

c) Inversely proportional to impulse d) Does not depend on impulse

531. Figure represents a graph of kinetic energy (K) of photoelectrons (in eV) and frequency (v) for a metal used as cathode in photoelectric experiment. The work function of metal is



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

532. A photo-cell employs photoelectric effect to convert

a) Change in the intensity of illumination into a change in the work function of the photo cathode

b) Change in the frequency of light into a change in the electric current

c) Change in the frequency of light into a change in electric voltage

d) Change in the intensity of illumination into a change in photoelectric current

533. The X-ray wavelength of L_α line of platinum ($Z = 78$) is 1.30Å. The X-ray wavelength of L_α line of Molybdenum ($Z = 42$) is

a) 5.41 Å b) 4.20 Å c) 2.70 Å d) 1.35 Å

534. The work functions of metals A and B are in the ratio 1:2. If light of frequencies f and $2f$ are incident on the surfaces of A and B respectively, the ratio of the maximum kinetic energies of photoelectrons emitted is (f is greater than threshold frequency of A, $2f$ is greater than threshold of B)

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

535. According to Moseley's law of X-rays the frequency (v) of particular characteristic X-ray and the atomic number (Z) of the element depend on each other as

a) $\sqrt{v} = kZ^2$ b) $\sqrt{v} = \frac{k}{Z^2}$ c) $v = kZ$ d) $\sqrt{v} = kZ$

536. An electron is accelerated through a potential difference of 45.5 V.The velocity acquired by it is (in ms^{-1})

a) 10^6 b) Zero c) 4×10^6 d) 4×10^4

537. Doubly ionised helium atom and hydrogen ions are accelerated, from rest, through the same potential difference. The ratio of final velocities of helium and hydrogen is

a) $1 : \sqrt{2}$ b) $\sqrt{2} : 1$ c) $1 : 2$ d) $2 : 1$

538. The potential difference applied to an X-ray tube is increased. As a result, in the emitted radiation

a) The intensity increases b) The minimum wavelength increases
c) The intensity decreases d) The minimum wavelength decreases

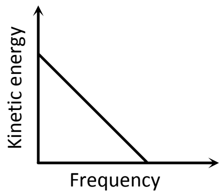
539. Hard X-ray for the study of fractures in bones should have a minimum wavelength of 10^{-11} m. The accelerating voltage for electrons in X-ray machine should be

a) <124 kV b) >124 kV
c) Between 60 kV and 70 kV d) =100 kV

540. In producing X-rays a beam of electrons accelerated by a potential difference V is made to strike a metal target. For what value of V, X-rays will have the lowest wavelength of 0.3094 Å

a) 10 kV b) 20 kV c) 30 kV d) 40 kV

541. According to Einstein's photoelectric equation, the graph between the kinetic energy of photoelectrons ejected and the frequency of incident radiation is

a)


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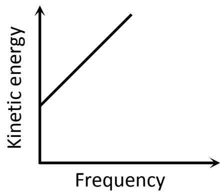

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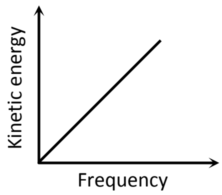
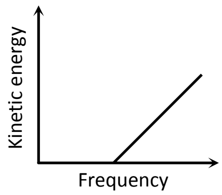


d)


542. For production of characteristic K_β X-rays, the electron transition is

a) $n = 2$ to $n = 1$ b) $n = 3$ to $n = 2$ c) $n = 3$ to $n = 1$ d) $n = 4$ to $n = 2$

543. The most penetrating radiation out of the following is

a) X-rays b) β-rays c) α-particles d) γ-rays

544. λ_e, λ_p and λ_α are the de Broglie wavelengths of electron, proton and α particle. If all are accelerated by same potential, then

a) $\lambda_e < \lambda_p < \lambda_\alpha$ b) $\lambda_e < \lambda_p > \lambda_\alpha$ c) $\lambda_e > \lambda_p < \lambda_\alpha$ d) $\lambda_e > \lambda_p > \lambda_\alpha$

545. If we express the energy of a photon in KeV and the wavelength in angstroms, then energy of a photon can be calculated from the relation

a) $E = 12.4\, hv$ b) $E = 12.4\, h/\lambda$ c) $E = 12.4/\lambda$ d) $E = hv$

546. For intensity I of a light of wavelength 5000Å the photoelectron saturation current is 0.40 μA and stopping potential is 1.36 V, the work function of metal is

a) 2.47 eV b) 1.36 eV c) 1.10 eV d) 0.43 eV

547. A 100 W light bulb is placed at the centre of a spherical chamber of radius 0.10m. Assume that 66% of the energy supplied to the bulb is converted into light and that the surface of chamber is perfectly absorbing. The pressure exerted by the light on the surface of the chamber is

a) 0.87×10^{-6}Pa b) 1.77×10^{-6}Pa c) 3.50×10^{-6}Pa d) None of these

548. According to Einstein's photoelectric equation, the graph of KE of the photoelectron emitted from the metal *versus* the frequency of the incident radiation gives a straight line graph, whose slope

a) Depends on the intensity of the incident radiation
b) Depends on the nature of the metal and also on the intensity of incident radiation
c) Is same for all metals and independent of the intensity of the incident radiation
d) Depends on the nature of the metal

549. In photoelectric effect, the electrons are ejected from metals if the incident light has a certain minimum

a) Wavelength b) Frequency c) Amplitude d) Angle of incidence

550. In an electron gun the control grid is given a negative potential relative to cathode in order to

a) Decelerate electrons

b) Repel electrons and thus to control the number of electrons passing through it

c) To select electrons of same velocity and to converge them along the axis

d) To decrease the kinetic energy of electrons

551. Electron with energy 80 keV are incident on the tungsten target of a X-rays tube. K shell electrons of tungsten have −72.5 keV energy. X-rays emitted by the tube contain only

a) A continuous X-rays spectrum (Bremsstrahlung) with a minimum wavelength of ~0.155Å

b) A continuous X-ray spectrum (Bremsstrahlung) with all wavelengths

c) The characteristic X-rays spectrum of tungsten

d) A continuous X-rays spectrum (Bremsstrahlung) with a minimum wavelength of ~0.155 Å and the characteristic X-rays spectrum of tungsten

552. What is the de-Broglie wavelength (in Å) of the α-particle accelerated through a potential difference V?

a) $\frac{0.287}{\sqrt{V}}$ b) $\frac{12.27}{\sqrt{V}}$ c) $\frac{0.101}{\sqrt{V}}$ d) $\frac{0.22}{\sqrt{V}}$

553. When subjected to a transverse electric field, cathode rays move

a) Down the potential gradient b) Up the potential gradient

c) Along a hyperbolic path d) Along a circular path

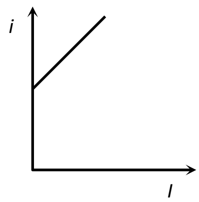
554. The wavelength of X-rays is of the order of

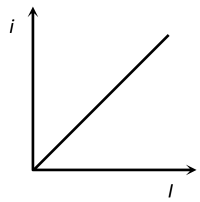
a) *Centimetre* b) *Micron* $(10^6 m)$ c) *Angstrom* $(10^{-10} m)$ d) *Metre*

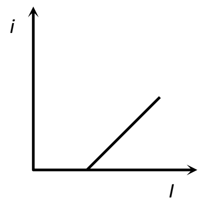
555. If the kinetic energy of a free electron doubles, its de-Broglie wavelength changes by the factor

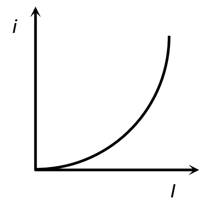
a) $\frac{1}{2}$ b) 2 c) $\frac{1}{\sqrt{2}}$ d) $\sqrt{2}$

556. The graph between intensity of light falling on a metallic plate (I) with the current (i) generated is

a) 

b) 

c) 

d) 

557. The kinetic energy of electron and proton is $10^{-32} J$. Then the relation between their de-Broglie wavelength is

a) $\lambda_p < \lambda_e$ b) $\lambda_p > \lambda_e$ c) $\lambda_p = \lambda_e$ d) $\lambda_p = 2\lambda_e$

558. In Thomson's mass spectrographs, when an electric field of 2×10^4 Vm^{-1} is applied then the deflection produced on the screen is 20 mm. If the length of the plates is 5 cm and the distance of the screen from plates is 21cm and the velocity of positive ions is 10^6 ms^{-1}, then their specific charge will be

a) 10^7 Ckg^{-1} b) 2.59×10^7 Ckg^{-1} c) 5.9×10^7 Ckg^{-1} d) 9.52×10^7 Ckg^{-1}

559. The work function of a substance is 4.0 eV. The longest wavelength of light that can cause photoelectron emission from this substance is approximately

a) 540 nm b) 400 nm c) 310 nm d) 220 nm

560. A beam of electrons of velocity 3×10^7 ms^{-1} is deflected 1.5 mm is passing 10 cm through an electric field of 1800 Vm^{-1} perpendicular to their path. The value of e/m for electron is

a) 1.78×10^{11} Ckg^{-1} b) 2×10^{11} Ckg^{-1} c) 1.5×10^{11} Ckg^{-1} d) 3.5×10^{11} Ckg^{-1}

561. A photon and an electron have equal energy E. $\lambda_{\text{photon}}/\lambda_{\text{electron}}$ is proportional to

a) $\sqrt{E}$ b) $1/\sqrt{E}$

c) $1/E$ d) Does not depend upon E

562. When wavelength of incident photon is decreased then

a) Velocity of emitted photoelectron decreases

b) Velocity of emitted photoelectron increases

c) Velocity of photoelectron do not change

d) Photo electric current increases

563. Vidicon works on the principle of

a) Electrical conductivity
b) Photoconductivity
c) Thermal conductivity
d) SONAR

564. The photoelectric threshold wavelength for silver is λ_0. The energy of the electron ejected from the surface of silver by an incident wavelength λ $(\lambda < \lambda_0)$will be

a) $hc(\frac{\lambda_0 - \lambda}{\lambda\lambda_0})$
b) $\frac{h}{c}(\frac{\lambda_0-\lambda}{\lambda\lambda_0})$
c) $\frac{hc}{\lambda_0 - \lambda}$
d) $hc(\lambda_0 - \lambda)$

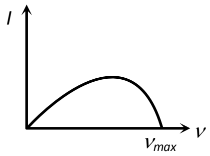
565. X-rays and γ-rays of the same energies may be distinguished by

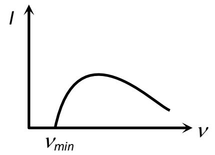
a) Their velocity
b) Their ionizing power
c) Their intensity
d) Method of production

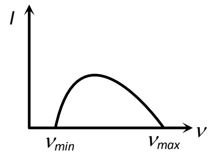
566. In an X-ray tube electrons bombarding the target produce X-rays of minimum wavelength 1 Å. What must be the energy of bombarding electrons

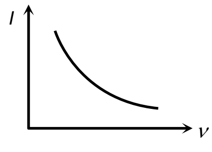
a) 13375 eV
b) 12375 eV
c) 14375 eV
d) 15375 eV

567. The continuous x-ray spectrum obtained from a Coolidge tube is of the form

a) 

b) 

c) 

d) 

568. Ultraviolet radiation of 6.2 eV falls on an aluminium surface (work function 4.2 eV). The kinetic energy of the faster electron emitted is approximately

a) 3.2×10^{-15} J
b) 3.2×10^{-17} J
c) 3.2×10^{-19} J
d) 3.2×10^{-21} J

569. The momentum of a photon in an X-ray beam 10^{-10} metre wavelength is

a) $1.5 \times 10^{-23} kg - m/s$
b) $6.6 \times 10^{-24} kg - m/s$
c) $6.6 \times 10^{-44} kg - m/s$
d) $2.2 \times 10^{-52} kg - m/s$

570. Absorption of X-ray is maximum in which of the following different sheets

a) Copper
b) Gold
c) Beryllium
d) Lead

571. X-rays region lies between

a) Short radiowave and visible region
b) Visible and ultraviolet region
c) Gamma rays and ultraviolet region
d) Short radiowave and long radiowave

572. An X-ray tube produces a continuous spectrum of radiation with its shortest wavelength of 45×10^{-2}A. The maximum energy of a photon in the radiation in eV is $(h = 6.62 \times 10^{-34}$ Js , $c = 3 \times 10^8$ ms$^{-1})$

a) 27500
b) 22500
c) 17500
d) 12500

573. The photo-electrons emitted from a surface of sodium metal are such that

a) They all are of the same frequency
b) They have the same kinetic energy
c) They have the same de Broglie wavelength
d) They have their speeds varying from zero to a certain maximum

574. A charged particle is moving in the presence of electric field $\vec{\mathbf{E}}$ and magnetic field $\vec{\mathbf{B}}$. The directions of $\vec{\mathbf{E}}$ and $\vec{\mathbf{B}}$ are such that the charged particle moves in a straight line and its speed increases. The relations amongst $\vec{\mathbf{E}}$, $\vec{\mathbf{B}}$ and velocity $\vec{\mathbf{v}}$ must be such that

a) $\vec{\mathbf{E}} \cdot \vec{\mathbf{B}} = 0, \vec{\mathbf{v}}$ is arbitrary
b) $\vec{\mathbf{E}}$, $\vec{\mathbf{B}}$ and $\vec{\mathbf{v}}$ are all parallel to each other
c) $\vec{\mathbf{E}} \cdot \vec{\mathbf{v}} = 0; \vec{\mathbf{B}} \cdot \vec{\mathbf{v}} = 0$ but $\vec{\mathbf{E}} \cdot \vec{\mathbf{B}} \neq 0$
d) $\vec{\mathbf{v}}$ is parallel to $\vec{\mathbf{E}}$ and perpendicular to $\vec{\mathbf{B}}$

575. Energy of electrons can be increased by allowing them

a) To fall through electric potential
b) To move in high magnetic field
c) To fall from great heights
d) To pass through lead blocks

576. The time taken by a photoelectron to come out after the photon strikes is approximately

a) 10^{-4}s
b) 10^{-10} s
c) 10^{-16}s
d) 10^{-1}s

577. An oxide coated filament is useful in vacuum tubes because essentially

a) It has high melting point

b) It can withstand high temperatures
c) It has good mechanical strength
d) It can emit electrons at relatively lower temperatures

578. If the threshold wavelength for sodium is 5420 Å, then the work function of sodium is
a) 4.58 eV
b) 2.28 eV
c) 1.14 eV
d) 0.23 eV

579. If the work function for a certain metal is 3.2×10^{-19}J and it is illuminated with light of frequency $v = 8 \times 10^{14}$Hz, the maximum kinetic energy of the photoelectron would be
a) 2.1×10^{-19}J
b) 3.2×10^{-19}J
c) 5.3×10^{-19}J
d) 8.5×10^{-19}J

580. Which of the following law is used in the Millikan's method for the determination of charge
a) Ampere's law
b) Stoke's law
c) Fleming's left hand rule
d) Fleming's right hand rule

581. When photons of energy hv fall on an aluminium plate (of work function $= E_0$), photoelectrons of maximum kinetic energy K are ejected. If the frequency of the radiation is doubled, the maximum kinetic energy of the ejected photoelectrons will be
a) K
b) $K + hv$
c) $K + E_0$
d) $2K$

582. The energy of a photon of green light of wavelength 50000 Å is
a) 3.459×10^{-19} J
b) 3.973×10^{-19} J
c) 4.132×10^{-19} J
d) 8453×10^{-19} J

583. An electron is moving in electric field and magnetic field it will gain energy from
a) Electric field
b) Magnetic field
c) Both of these
d) None of these

584. When the speed of electrons increase, then the value of its specific charge
a) Increases
b) Decreases
c) Remains unchanged
d) Increases upto some velocity and then begins to decrease

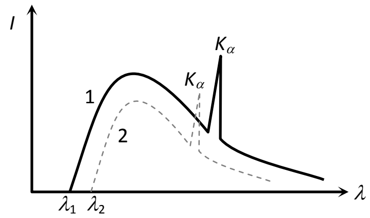
585. In a mass spectrograph, an ion X of mass number 24 and charge $+e$ and another ion Y of mass number 22 and charge $+ 2e$ enter in a perpendicular magnetic field with the same velocity. The ratio of the radii of the circular path in the field will be
a) 11/22
b) 11/2
c) 22/11
d) 24/11

586. The fact that electric charges are integral multiples of the fundamental electronic charge was proved experimentally by
a) Planck
b) J. J. Thomson
c) Einstein
d) Millikan

587. Which of one is correct
a) $E^2 = p^2c^2$
b) $E^2 = p^2c$
c) $E^2 = pc^2$
d) $E^2 = p^2/c^2$

588. In above question the energy of the characteristic X-rays given out is
a) Less than 40 keV
b) More than 40 keV
c) Equal to 40 keV
d) $\geq$ 40 keV

589. The intensity distribution of X-rays from two coolidge tubes operated on different voltages V_1 and V_2 and using different target materials of atomic numbers Z_1 and Z_2 is shown in the figure. Which one of the following inequalities is true



a) $V_1 > V_2, Z_1 < Z_2$
b) $V_1 > V_2, Z_1 > Z_2$
c) $V_1 < V_2, Z_1 > Z_2$
d) $V_1 = V_2, Z_1 < Z_2$

590. Two identical, photocathodes receive light of frequencies f_1 and f_2. If the velocities of the photoelectrons (of mass m) coming out are respectively v_1 and v_2, then
a) $v_1^2 - v_2^2 = \frac{2h}{m}(f_1 - f_2)$
b) $v_1 + v_2 = \left[\frac{2h}{m}(f_1 + f_2)\right]^{1/2}$

c) $v_1^2 + v_2^2 = \frac{2h}{m}(f_1 + f_2)$ d) $v_1 - v_2 = \left[\frac{2h}{m}(f_1 - f_2)\right]^{1/2}$

591. A light whose frequency is equal to 6×10^{14}Hz is incident on a metal whose work function is 2eV. $[h = 6.63 \times 10^{-34}\, Js, 1eV = 1.6 \times 10^{-19}\, J]$. The maximum energy of the electrons emitted will be
a) 2.49 eV b) 4.49 eV c) 0.49 eV d) 5.49 eV

592. Bragg's equation will have no solution is
a) $\lambda > 2d$ b) $\lambda < 2d$ c) $\lambda < d$ d) $\lambda = d$

593. The threshold wavelength for a metal having work function W_0 is λ_0. What is the threshold wavelength for a metal whose work function is $W_0/2$
a) $4\lambda_0$ b) $2\lambda_0$ c) $\lambda_0/2$ d) $\lambda_0/4$

594. The momentum of a photon of energy 1 MeV in kg ms^{-1}, will be
a) 0.33×10^6 b) 7×10^{-24} c) 10^{-22} d) 5×10^{-22}

595. The nature of X-ray's spectrum is
a) Continuous b) Line c) Continuous and line d) None of above

596. An electron in the hydrogen atom jumps excited state n to the ground state. The wavelength so emitted illuminates a photosensitive material having work function 2.75 eV. If the stopping potential of the photoelectron is 10 eV, then the value of n is
a) 5 b) 2 c) 3 d) 4

597. Photons of 5.5 eV energy falls on the surface of the metal emitting photoelectrons of maximum kinetic energy 4.0 eV. The stopping voltage required for these electrons are
a) 5.5 V b) 1.5 V c) 9.5 V d) 4.0 V

598. Light of frequency v is incident on a substance of threshold frequency $v_0(v_0 < v)$. The energy of the emitted photoelectron will be
a) $h(v - v_0)$ b) h/v c) $he(v - v_0)$ d) h/v_0

599. A metal plate gets heated when cathode rays strike against it due to
a) Kinetic energy of cathode rays b) Potential energy of cathode rays
c) Linear velocity of cathode rays d) Angular velocity of cathode rays

600. If the momentum of an electron is changed by Δp, then the de-Broglie wavelength associated with it changes by 0.50%. The initial momentum of the electron will be
a) $\frac{\Delta p}{200}$ b) $\frac{\Delta p}{199}$ c) 199 Δp d) 400 Δp

601. The de-Broglie wavelength of a neutron at 27°C is λ. What will be its wavelength at 927°C ?
a) $\lambda/4$ b) $\lambda/3$ c) $\lambda/2$ d) $3\,\lambda/2$

602. The threshold frequency for certain metal is 3.3×10^{14} Hz. If light of frequency 8.2×10^{14} Hz is incident on the metal, the cut-off voltage of the photoelectric current will be
a) 4.9 V b) 3.0 V c) 2.0 V d) 1 V

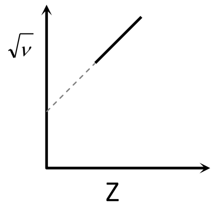
603. According to de-Broglie, the de-Broglie wavelength for electron in an orbit of (radius $5.3 \times 10^{-11} m$) hydrogen atom is $10^{-10} m$. The principle quantum number for this electron is
a) 1 b) 2 c) 3 d) 4

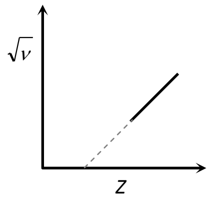
604. The collector plate in an experiment on photoelectric effect is kept vertically above the emitter plate. Light source is put on and a saturation photo current is recorded. An electric field is switched on which has a vertically downward direction
a) The photo current will increase
b) The kinetic energy of the electrons will increase
c) The stopping potential will decrease
d) The threshold wavelength will increase

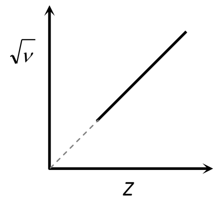
605. Photo cell is a device to
a) Store photons
b) Measure light intensity
c) Convert photon energy into mechanical energy
d) Store electrical energy for replacing storage batteries

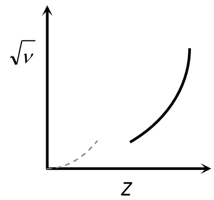
606. What determines the hardness of the X-rays obtained from the Coolige tube
a) Current in the filament
b) Pressure of air in the tube
c) Nature of target
d) Potential difference between cathode and target

607. The graph between the square root of the frequency of a specific line of characteristic spectrum of X-rays and the atomic number of the target will be

a) 

b) 

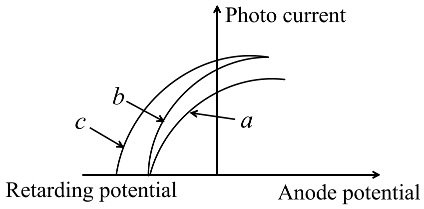
c) 

d) 

608. A light having wavelength 300 nm falls on a metal surface. Work function of metal is 2.54 eV. What is stopping potential?
a) 2.3 V
b) 2.59 V
c) 1.60 V
d) 1.29 V

609. The number of photo-electrons emitted per second from a metal surface increases when
a) The energy of incident photons increases
b) The frequency of incident light increases
c) The wavelength of the incident light increases
d) The intensity of the incident light increases

610. The figure shows a plot of photo current versus anode potential for a photo sensitive for three different radiations. Which one of the following is a correct statement



a) Curves (a) and (b) represent incident radiations of different frequencies and different intensities
b) Curves (a) and (b) represents incident radiations of same frequency but of different intensities
c) Curves (b) and (c) represent incident radiations of different frequencies and different intensities
d) Curves (b) and (c) represent incident radiations of same frequency having same intensity

611. The work function of aluminium is 4.2 eV. If two photons, each of energy 3.5 eV strike an electron of aluminium, then emission of electrons will be
a) Possible
b) Not possible
c) Data is incomplete
d) Depends upon the density of the surface

612. Stopping potential required to reduce the photoelectric current to zero
a) Is directly proportional to the wavelength of the incident radiation
b) Increases uniformly with wavelength of the incident radiation
c) Is directly proportional to the frequency of the incident radiation
d) Decreases uniformly with the frequency of the incident radiation

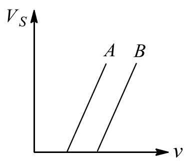
613. If 10000 V is applied across an X-ray tube, what will be the ratio of de-Broglie wavelength of the incident electrons to the shortest wavelength of X-ray produced ($\frac{e}{m}$ for electron is $1.8 \times 10^{11} ckg^{-1}$)
a) 1
b) 0.1
c) 0.2
d) 0.3

614. The wavelength of the matter wave is independent of
a) Mass
b) Velocity
c) Momentum
d) Charge

615. Monochromatic light of wavelength 3000Å is incident on a surface area 4 cm^2. If intensity of light is $150 mWm^{-2}$, then rate at which photones strike the target is
a) $3 \times 10^{10}\ s^{-1}$
b) $9 \times 10^{13} s^{-1}$
c) $7 \times 10^{15}\ s^{-1}$
d) $6 \times 10^{19}\ s^{-1}$

616. If the momentum of a photon is p, then its frequency is
Where m is the rest mass of the photon
a) $\frac{ph}{c}$
b) $\frac{pc}{h}$
c) $\frac{mh}{c}$
d) $\frac{mc}{h}$

617. An electron of K_α spectral line of an atom is 59 keV, then the wavelength of K_α line will be
a) 0.20 Å b) 0.42 Å c) 0.31 Å d) 0.62 Å
618. An electron and a proton have the same de-Broglie wavelength. Then the kinetic energy of the electron is
a) Zero b) Infinity
c) Equal to kinetic energy of the proton d) Greater than the kinetic energy of proton
619. A photocell stops emission if it is maintained at $2V$ negative potential. The energy of most energetic photoelectron is
a) $2eV$ b) $2J$ c) $2kJ$ d) $2keV$
620. The ratio of the de-Broglie wavelength of an α-particle and a proton of same kinetic energy is
a) 1:2 b) 1:1 c) $1:\sqrt{2}$ d) 4:1
621. A potential difference of 42,000 $volts$ is used in an X-ray tube to accelerate electrons. The maximum frequency of the X-raditions produced is
a) $10^{19}Hz$ b) $10^{18}Hz$ c) $10^{16}Hz$ d) $10^{20}Hz$
622. $An\ \alpha$ - particle of energy 5 MeV is scattered through 180^0 by a fixed uranium nucleus. The distance of the closest approach is of the order of
a) 1 Å b) 10^{-10} cm c) 10^{-12} cm d) 10^{-15} cm
623. If the energy of photon is increased by a factor of 4, then its momentum
a) does not change b) decreases by a factor of 4
c) increases by a factor of 4 d) decreases by a factor of 2
624. X-rays of $\lambda = 1$Å have frequency
a) $3 \times 10^8 Hz$ b) $3 \times 10^{18} Hz$ c) $3 \times 10^{10} Hz$ d) $3 \times 10^{15} Hz$
625. The sun radiates energy at the rate of $3.77 \times 10^{26} J/s$. The loss of mass it suffers per seconds is
a) $41.9 \times 10^{18} g$ b) $41.9 \times 10^8 kg$ c) $1.29 \times 10^{16} kg$ d) $1.29 \times 10^{10} kg$
626. For the production of characteristic K_γ X-ray, the electron transition is
a) $n = 2$ to $n = 1$ b) $n = 3$ to $n = 2$ c) $n = 3$ to $n = 1$ d) $n = 4$ to $n = 1$
627. If a photon has velocity c and frequency v, then which of following represents its wavelength
a) $\frac{hc}{E}$ b) $\frac{hv}{c}$ c) $\frac{hv}{c^2}$ d) hv
628. When the photons of energy hv fall on a photosensitive metallic surface (work function hv_0) electrons are emitted from the metallic surface. The electrons coming out of the surface have some kinetic energy. The most energetic ones have the kinetic energy equal to



a) Less b) More c) Equal d) Nothing can be said
629. X-rays cannot be deflected by means of an ordinary grating due to
a) Large wavelength b) High speed c) Short wavelength d) None of these
630. For characteristic X-ray of some material
a) $E(K_\gamma) < E(K_\beta) < E(K_\alpha)$ b) $E(K_\alpha) < E(L_\alpha) < E(M_\alpha)$
c) $\lambda(K_\gamma) < \lambda(K_\beta) < \lambda(K_\alpha)$ d) $\lambda(M_\alpha) < \lambda(L_\alpha) < \lambda(K_\alpha)$
631. In Davisson - Germer experiment maximum intensity is observed at
a) 50^0 and 54 V b) $54^0$and 50 V c) 50^0 and 50 V d) 65^0 and 50 V
632. The specific charge for positive rays is much less than that for cathode rays. This is because
a) Masses of positive rays are much larger b) Charge on positive ray is less
c) Positive rays are positively charged d) Experimental method is wrong
633. X-rays were discovered by
a) Becquerel b) Roentgen c) Marie Curie d) Von Laue
634. The de-Broglie wavelength λ associated with an electron having kinetic energy E is given by the expression

a) $\frac{h}{\sqrt{2mE}}$ b) $\frac{2h}{mE}$ c) $2mhE$ d) $\frac{2\sqrt{2mE}}{h}$

635. The de-Broglie wavelength of a ball of mass 120 g moving at a speed of 20 m/s is
a) 3.5×10^{-34} m b) 2.8×10^{-34} m c) 1.2×10^{-34} m d) 2.1×10^{-34} m

636. The filament current in the electron gun of a coolidge tube is increased while the potential difference used to accelerate the electrons is decreased. As a result, in the emitted radiation
a) The intensity increases while the minimum wavelength decreases
b) The intensity decreases while the minimum wavelength increases
c) The intensity as well as the minimum wavelength increases
d) The intensity as well as the minimum wavelength decreases

637. The kinetic energy of an electron gets tripled, then the de-Broglie wavelength associated with it changes by a factor
a) $\frac{1}{3}$ b) $\sqrt{3}$ c) $\frac{1}{\sqrt{3}}$ d) 3

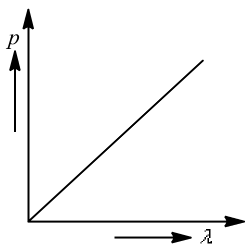
638. When radiation of the wavelength λ is incident on a metallic surface, the stopping potential is 4.8 V. If the same surface is illuminated with radiation of double the wavelength, then the stopping potential becomes 1.6 V. Then the threshold wavelength for the surface is
a) 2λ b) 4λ c) 6λ d) 8λ

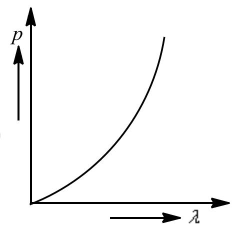
639. According to Einstein's photoelectric equation, the plot of the kinetic energy of the emitted photoelectrons from a metal V_s the frequency, of the incident radiation gives a straight line whose slope
a) Depends on the nature of the metal used
b) Depends on the intensity of the radiation
c) Depends both on the intensity of the radiation and the metal used
d) Is the same for all metals and independent of the intensity of the radiation

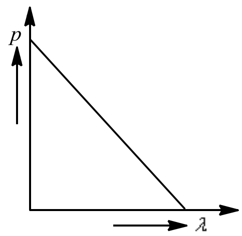
640. An electron initially at rest, is accelerated through a potential difference of 200 $volt$, so that it acquires a velocity $8.4\times 10^{6} m/s$. The value of e/m of electron will be
a) $2.76\times 10^{12} C/kg$ b) $1.76\times 10^{11} C/kg$ c) $0.76\times 10^{12} C/kg$ d) None of these

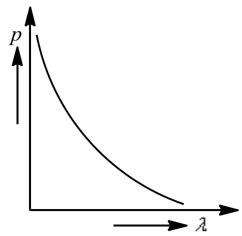
641. The binding energy of the innermost electron in tungsten is 40 keV. To produce characteristic X-rays using a tungsten target in an X-rays tube the potential difference V between the cathode and the anti-cathode should be
a) $V < 40\ kV$ b) $V \leq 40\ kV$ c) $V > 40\ kV$ d) $V >/< 40\ kV$

642. Which of the following figures represents the variation of particle momentum and associated de-Broglie wavelength?

a) 

b) 

c) 

d) 

643. The maximum velocity of an electron emitted by light of wavelength λ incident on the surface of a metal of work function ϕ, is
Where $h =$ Planck's constant, $m =$ mass of electron and $c =$ speed of light
a) $\left[\frac{2(hc+\lambda\phi)}{m\lambda}\right]^{1/2}$ b) $\frac{2(hc-\lambda\phi)}{m}$ c) $\left[\frac{2(hc-\lambda\phi)}{m\lambda}\right]^{1/2}$ d) $\left[\frac{2(h\lambda-\phi)}{m}\right]^{1/2}$

644. When yellow light is incident on a surface, no electrons are emitted while green light can emit. If red light is incident on the surface, then
a) No electrons are emitted
b) Photons are emitted
c) Electrons of higher energy are emitted
d) Electrons of lower energy are emitted

645. An α-particle of mass 6.65×10^{-27} kg travels at right angles to a magnetic field of 0.2 T with a speed of

6×10^5 ms^{-1}. The acceleration of α-particle will be

a) 5.77×10^{11} ms^{-2} b) 7.55×10^{11} ms^{-2} c) 5.77×10^{12} ms^{-2} d) 7.55×10^{12} ms^{-2}

646. When a monochromatic point source of light is at a distance of 0.2 m from a photocell, the cut-off voltage and the saturation current are respectively $V_0 = 0.6$V and $I_s = 18.0$mA. If the same source is placed o.6 m away from the photocell, then

a) Stopping potential $V_0 = 0.2$ V and saturation current $I_s = 18.0$mA
b) Stopping potential is $0V_0 = 0.6$V and saturation current $I_s = 18.0$mA
c) Stopping potential $V_0 = 0.6$ V and saturation current $I_S = 2.0$ mA
d) Stopping potential $V_0 = 2.0$ V and saturation current $I_S = 2.0$mA

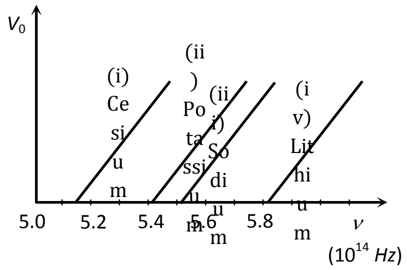
647. Light of wavelength λ falls on a metal having work function $\frac{hc}{\lambda_0}$. Photoelectric effect will take place only if

a) $\lambda \geq \lambda_0$ b) $\lambda \geq 2\lambda_0$ c) $\lambda \leq \lambda_0$ d) $\lambda = 4\lambda_0$

648. An electron of mass m and charge e initially at rest gets accelerated by a constant electric field E. The rate of change of de-Broglie wavelength of this electron at time t ignoring relativistic effects is

a) $\frac{-h}{eEt^2}$ b) $\frac{-e\,Et}{E}$ c) $\frac{-mh}{e\,Et^2}$ d) $\frac{-h}{e\,E}$

649. The figure shows different graphs between stopping potential (V_0) and frequency (v) for photosensitive surface of cesium, potassium, sodium and lithium. The plots are parallel. Correct ranking of the targets according to their work function greatest first will be



a) (i) > (ii) > (iii) > (iv) b) (i) > (iii) > (ii) > (iv)
c) (iv) > (iii) > (ii) < (i) d) (i) = (iii) > (ii) = (iv)

650. When radiation is incident on a photoelectron emitter, the stopping potential is found to be 9 V. If e/m for the electron is 1.8×10^{11} Ckg^{-1}, the maximum velocity of ejected electrons is

a) 6×10^5ms^{-1} b) 8×10^5ms^{-1} c) 10^6ms^{-1} d) 1.8×10^6ms^{-1}

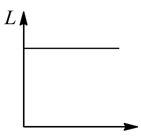
651. The linear momentum of photon is p. The wavelength of photon is λ , then (h is Planck constant)

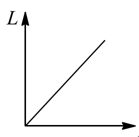
a) $\lambda = hp$ b) $\lambda = \frac{h}{p}$ c) $\lambda = \frac{p}{h}$ d) $\lambda = \frac{p^2}{h}$

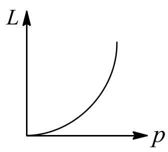
652. Calculate the energy of a photon with momentum 3.3×10^{-13} kg-ms^{-1}, given Planck's constant to be 6.6×10^{-34} Js

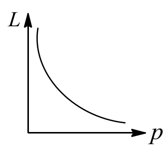
a) 7.3×10^4 J b) 9.9×10^{-5} J c) 1.3×10^5 J d) 8.1×10^3 J

653. The de-Broglie wavelength L associated with an elementary particle of linear momentum p is best represented by the graph

a) 

b) 

c) 

d) 

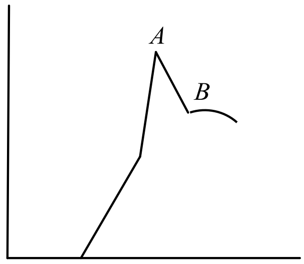
654. A photon creates a pair of electron-positron with equal kinetic energy. Let kinetic energy of each particle is 0.29 MeV. Then what should be energy of the photon

a) 1.60 MeV b) 1.63 MeV c) 2.0 MeV d) 1.90 MeV

655. Particle nature and wave nature of electromagnetic waves and electrons can be shown by

a) Electron has small mass, deflected by the metal sheet
b) X-ray is diffracted, reflected by thick metal sheet
c) Light is reflected and defracted
d) Photoelectricity and electron microscopy

656. Sharp peak point A represents



a) Characteristic X-ray
b) Continuous X-ray
c) Bremsstrahlung
d) Discontinuous spectrum

657. Which one of the following is true in photoelectric emission
a) Photoelectric current is directly proportional to the amplitude of light of a given frequency
b) Phototelectric current is directly proportional to the intensity of light of a given frequency at moderate intensities
c) Above the threshold frequency, the maximum K.E. of photoelectrons is inversely proportional to the frequency of incident light
d) The threshold frequency depends upon the wavelength of incident light

658. Light of frequency v falls on material of threshold frequency v_0. Maximum kinetic energy of emitted electron is proportional to
a) $v - v_0$
b) v
c) $\sqrt{v - v_0}$
d) v_0

659. An electron and photon have same wavelength. If E is the energy of photon and p is the momentum of electron, then the magnitude of E/p in SI unit is
a) 3.33×10^{-9}
b) 3.0×10^{8}
c) 1.1×10^{-19}
d) 9×10^{16}

660. In Milikan's experiment, an oil drop having charge q gets stationary on applying a potential difference V in between two plates separated by a distance $'d'$. The weight of the drop is
a) qVd
b) $q\frac{d}{V}$
c) $\frac{q}{Vd}$
d) $q\frac{V}{d}$

661. The ratio of de-Broglie wavelengths of molecules of hydrogen and helium which are at temperature 27°C and 127°C respectively is
a) $\frac{1}{2}$
b) $\sqrt{\frac{3}{8}}$
c) $\sqrt{\frac{8}{3}}$
d) 1

662. A potential difference of 10^4 V is applied across an X-ray tube. The ratio of the de-Broglie wavelength of X-rays produced is ($\frac{e}{m}$ for electron $= 1.8 \times 10^{11}\,\text{Ckg}^{-1}$)
a) $\frac{1}{20}$
b) $\frac{1}{10}$
c) 1
d) $\frac{1}{100}$

663. A particle with rest mass zero is moving speed c. The de-Broglie wavelength associated with it
a) Zero
b) Infinity
c) $\frac{hv}{c}$
d) $\frac{m_0 c}{h}$

664. A photon and electron have same de-Broglie wavelength. Give that v is the speed of electron and c is the velocity of light. E_e, E_p are the kinetic energy of electron and photon respectively. p_e, p_h are the momentum of electron and photon respectively. Then which of the following relation is correct?
a) $\frac{E_e}{E_p} = \frac{v}{2c}$
b) $\frac{E_e}{E_p} = \frac{2c}{v}$
c) $\frac{p_e}{p_h} = \frac{c}{2v}$
d) $\frac{p_e}{p_h} = \frac{2c}{v}$

665. If g_E and g_M are the acceleration due to gravity on the surfaces of the earth and the moon respectively and it Millikan's oil drop experiment could be performed on the two surfaces, one will find the ratio $\frac{\text{electronic charge on the moon}}{\text{electronic charge on the earth}}$ to be
a) 1
b) Zero
c) g_E/g_M
d) g_M/g_E

666. The specific charge of an electron is
a) 1.6×10^{-19} *coulomb*
b) 4.8×10^{-10} *stat coulomb*

c) $1.76 \times 10^{11} coulomb/kg$ d) $1.76 \times 10^{-11} coulomb/kg$

667. X-ray are diffracted from a crystal of lattice plane spacing 2Å. The maximum wavelength that can be diffracted is

a) 1Å b) 2 Å c) 2.5Å d) 4Å

668. Penetrating power of X-rays does not depend on

a) Wavelength b) Energy

c) Potential difference d) Current in the filament

669. The energy of a photon of light of wavelength 450 nm is

a) $4.4 \times 10^{-19} J$ b) $2.5 \times 10^{-19} J$ c) $1.25 \times 10^{-17} J$ d) $2.5 \times 10^{-17} J$

670. If the kinetic energy of the particle is increased by 16 times, the percentage change in the de Broglie wavelength of the particle is

a) 25% b) 75% c) 60% d) 50%

671. Ultraviolet light of wavelength 300 nm and intensity 1.0 $\mathrm{Wm^{-2}}$ falls on the surface of a photosensitive material. If one percent of the incident photons produce photoelectrons, then the number of photoelectrons emitted from an area of 1.0 $\mathrm{cm^2}$ of the surface is nearly

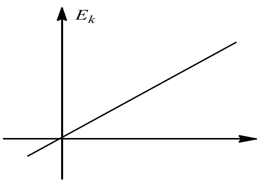
a) $9.61 \times 10^{14} \mathrm{s^{-1}}$ b) $4.12 \times 10^{13} \mathrm{s^{-1}}$ c) $1.51 \times 10^{12} \mathrm{s^{-1}}$ d) $2.13 \times 10^{11} \mathrm{s^{-1}}$

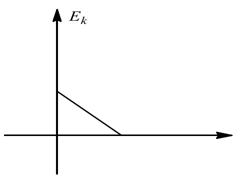
672. Cathode rays and canal rays produced in a certain discharge tube are deflected in the same direction if

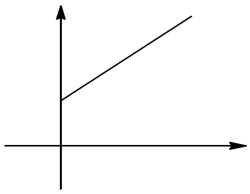
a) A magnetic field is applied normally b) An electric field is applied normally

c) An electric field is applied tangentially d) A magnetic field is applied tangentially

673. Which one of the following graph represents the variation of maximum kinetic energy (E_k)of the emitted electrons with frequency ν in photoelectric effect correctly?

a) 

b) 

c) 

d) None of these

: ANSWER KEY :

1)	b	2)	c	3)	d	4)	b	189)	a	190)	c	191)	c	192)	c
5)	a	6)	a	7)	c	8)	a	193)	c	194)	c	195)	d	196)	c
9)	b	10)	b	11)	c	12)	b	197)	c	198)	c	199)	b	200)	c
13)	c	14)	b	15)	a	16)	d	201)	b	202)	b	203)	c	204)	c
17)	c	18)	b	19)	b	20)	d	205)	b	206)	b	207)	d	208)	d
21)	a	22)	b	23)	d	24)	c	209)	a	210)	c	211)	a	212)	b
25)	b	26)	c	27)	b	28)	c	213)	d	214)	b	215)	c	216)	c
29)	b	30)	c	31)	c	32)	b	217)	d	218)	b	219)	b	220)	c
33)	b	34)	b	35)	b	36)	c	221)	a	222)	c	223)	d	224)	a
37)	a	38)	a	39)	d	40)	b	225)	b	226)	a	227)	d	228)	c
41)	a	42)	b	43)	c	44)	d	229)	c	230)	c	231)	b	232)	d
45)	c	46)	d	47)	c	48)	c	233)	d	234)	c	235)	d	236)	c
49)	c	50)	a	51)	b	52)	c	237)	c	238)	b	239)	a	240)	d
53)	d	54)	b	55)	c	56)	b	241)	a	242)	a	243)	b	244)	c
57)	c	58)	a	59)	a	60)	a	245)	c	246)	a	247)	c	248)	d
61)	c	62)	b	63)	a	64)	c	249)	c	250)	a	251)	c	252)	b
65)	b	66)	b	67)	c	68)	c	253)	d	254)	c	255)	b	256)	c
69)	c	70)	c	71)	a	72)	a	257)	a	258)	d	259)	b	260)	b
73)	b	74)	a	75)	d	76)	b	261)	c	262)	a	263)	d	264)	b
77)	a	78)	b	79)	c	80)	c	265)	b	266)	c	267)	a	268)	b
81)	b	82)	b	83)	b	84)	b	269)	c	270)	d	271)	c	272)	b
85)	c	86)	b	87)	b	88)	c	273)	c	274)	d	275)	c	276)	b
89)	c	90)	a	91)	a	92)	d	277)	b	278)	c	279)	b	280)	b
93)	c	94)	d	95)	b	96)	a	281)	b	282)	c	283)	a	284)	d
97)	b	98)	b	99)	b	100)	b	285)	c	286)	d	287)	a	288)	b
101)	a	102)	b	103)	b	104)	c	289)	d	290)	d	291)	d	292)	d
105)	a	106)	b	107)	b	108)	c	293)	d	294)	b	295)	c	296)	b
109)	d	110)	a	111)	c	112)	c	297)	b	298)	b	299)	d	300)	a
113)	c	114)	b	115)	a	116)	c	301)	c	302)	a	303)	a	304)	d
117)	b	118)	a	119)	c	120)	c	305)	a	306)	a	307)	a	308)	c
121)	a	122)	d	123)	b	124)	d	309)	c	310)	b	311)	a	312)	b
125)	c	126)	a	127)	d	128)	a	313)	c	314)	b	315)	c	316)	c
129)	d	130)	c	131)	b	132)	b	317)	b	318)	b	319)	d	320)	a
133)	a	134)	d	135)	b	136)	a	321)	b	322)	c	323)	c	324)	a
137)	a	138)	b	139)	b	140)	d	325)	c	326)	c	327)	a	328)	c
141)	a	142)	a	143)	d	144)	b	329)	d	330)	a	331)	a	332)	a
145)	b	146)	b	147)	d	148)	d	333)	b	334)	b	335)	b	336)	c
149)	a	150)	b	151)	c	152)	a	337)	d	338)	a	339)	b	340)	c
153)	a	154)	b	155)	d	156)	d	341)	b	342)	b	343)	d	344)	d
157)	a	158)	a	159)	c	160)	b	345)	d	346)	b	347)	a	348)	c
161)	b	162)	a	163)	c	164)	c	349)	c	350)	b	351)	c	352)	d
165)	d	166)	c	167)	c	168)	a	353)	c	354)	b	355)	b	356)	d
169)	c	170)	b	171)	b	172)	b	357)	a	358)	c	359)	a	360)	c
173)	c	174)	c	175)	c	176)	c	361)	b	362)	a	363)	a	364)	c
177)	a	178)	b	179)	c	180)	c	365)	b	366)	d	367)	a	368)	a
181)	c	182)	a	183)	c	184)	c	369)	a	370)	c	371)	c	372)	b
185)	d	186)	a	187)	a	188)	b	373)	a	374)	a	375)	b	376)	d

377)	c	378)	c	379)	a	380)	a
381)	b	382)	b	383)	a	384)	a
385)	b	386)	b	387)	c	388)	b
389)	d	390)	b	391)	d	392)	a
393)	a	394)	c	395)	d	396)	a
397)	d	398)	a	399)	d	400)	a
401)	c	402)	a	403)	a	404)	b
405)	c	406)	d	407)	a	408)	d
409)	a	410)	a	411)	b	412)	b
413)	a	414)	b	415)	b	416)	c
417)	c	418)	d	419)	c	420)	d
421)	b	422)	b	423)	b	424)	c
425)	c	426)	d	427)	a	428)	c
429)	c	430)	c	431)	b	432)	b
433)	c	434)	b	435)	a	436)	c
437)	b	438)	c	439)	a	440)	d
441)	c	442)	b	443)	b	444)	a
445)	a	446)	a	447)	c	448)	c
449)	d	450)	b	451)	c	452)	b
453)	b	454)	a	455)	b	456)	c
457)	b	458)	b	459)	c	460)	b
461)	b	462)	a	463)	a	464)	d
465)	b	466)	b	467)	a	468)	a
469)	d	470)	d	471)	d	472)	b
473)	c	474)	b	475)	a	476)	c
477)	c	478)	c	479)	d	480)	a
481)	b	482)	a	483)	c	484)	a
485)	a	486)	c	487)	a	488)	a
489)	d	490)	b	491)	b	492)	c
493)	a	494)	d	495)	c	496)	a
497)	d	498)	b	499)	b	500)	c
501)	c	502)	a	503)	d	504)	b
505)	c	506)	b	507)	c	508)	d
509)	a	510)	c	511)	b	512)	d
513)	b	514)	b	515)	c	516)	c
517)	b	518)	d	519)	c	520)	d
521)	d	522)	b	523)	c	524)	b
525)	b	526)	a	527)	c	528)	a

529)	d	530)	c	531)	c	532)	d
533)	a	534)	b	535)	d	536)	c
537)	a	538)	d	539)	a	540)	d
541)	d	542)	c	543)	d	544)	d
545)	c	546)	c	547)	b	548)	c
549)	b	550)	b	551)	d	552)	c
553)	b	554)	c	555)	c	556)	b
557)	a	558)	d	559)	c	560)	c
561)	b	562)	b	563)	b	564)	a
565)	d	566)	b	567)	a	568)	c
569)	b	570)	d	571)	c	572)	a
573)	d	574)	b	575)	a	576)	b
577)	d	578)	b	579)	a	580)	b
581)	b	582)	b	583)	a	584)	b
585)	d	586)	d	587)	a	588)	a
589)	a	590)	a	591)	c	592)	a
593)	b	594)	d	595)	c	596)	d
597)	d	598)	a	599)	a	600)	c
601)	c	602)	c	603)	c	604)	b
605)	b	606)	d	607)	b	608)	c
609)	d	610)	b	611)	b	612)	c
613)	b	614)	d	615)	b	616)	b
617)	a	618)	d	619)	a	620)	a
621)	a	622)	c	623)	c	624)	b
625)	b	626)	d	627)	a	628)	a
629)	c	630)	c	631)	b	632)	a
633)	b	634)	a	635)	b	636)	c
637)	c	638)	b	639)	d	640)	b
641)	c	642)	d	643)	c	644)	a
645)	c	646)	c	647)	c	648)	a
649)	c	650)	d	651)	b	652)	b
653)	d	654)	a	655)	d	656)	a
657)	b	658)	a	659)	b	660)	d
661)	c	662)	b	663)	a	664)	a
665)	a	666)	c	667)	d	668)	d
669)	a	670)	b	671)	c	672)	a
673)	d						

: HINTS AND SOLUTIONS :

1 **(b)**

Energy $E = hv = h\frac{c}{\lambda} \therefore \frac{E_1}{E_2} = \frac{\lambda_2}{\lambda_1} = \frac{5000}{1}$

2 **(c)**

$E = W_0 + K_{\max} \Rightarrow \frac{hc}{\lambda_1} = W_0 + E_1$ and $\frac{hc}{\lambda_2}$

$= W_0 + E_2$

$\Rightarrow hc = W_0\lambda_1 + E_1\lambda_1$ and $hc = W_0\lambda_2 + E_2\lambda_2$

$\Rightarrow W_0\lambda_1 + E_1\lambda_1 = W_0\lambda_2 + E_2\lambda_2 \Rightarrow W_0$

$= \frac{E_1\lambda_1 - E_2\lambda_2}{(\lambda_2 - \lambda_1)}$

3 **(d)**

$\lambda_{\min} = \frac{hc}{eV}$

$\Rightarrow \quad \lambda \propto \frac{1}{V}$

$\because \quad \lambda_2 > \lambda_1$ (see graph)

$\Rightarrow \quad V_1 > V_2$

$\sqrt{v} = a(Z-b)$ Moseley's law

$v \propto (Z-1)^2$

$\Rightarrow \quad \lambda \propto \frac{1}{(Z-1)^2} \quad (\because v \propto \frac{1}{\lambda})$

$\lambda_1 > \lambda_2$ (see graph for characteristic lines)

$\Rightarrow \quad Z_2 > Z_1$

4 **(b)**

Given, the linear momentum of particle (p)

$= 2.2 \times 10^4 kg - ms^{-1}$

$h = 6.6 \times 10^{-34}$ JS

The de-Broglie wavelength of particle

$\lambda = \frac{h}{p}$

$\lambda = \frac{6.6\times10^{-34}}{2.2\times10^4}$

Or $\lambda = 3 \times 10^{-38}$ m

Or $\lambda = 3 \times 10^{-29}$ mm

7 **(c)**

Specific charge $= \frac{q}{m}$; Ratio $= \frac{\left(\frac{q}{m}\right)_\alpha}{\left(\frac{q}{m}\right)_p} = \frac{q_\alpha}{q_p} \times \frac{m_p}{m_\alpha} = \frac{1}{2}$

8 **(a)**

$K_{\max} = hv - hv_0 = \frac{hc}{\lambda} - \frac{hc}{\lambda_0}$, *i.e.*, graph between $K_{\max}$ and $\frac{1}{\lambda}$ will be straight line having slope (hc) and intercept $\frac{hc}{\lambda_0}$ on $-KE$ axis

9 **(b)**

$K_A = \frac{hc}{\lambda_A} - \phi_0$ and $K_B = \frac{hc}{\lambda_B} - \phi_0$

$\frac{K_A}{K_B} = \frac{\frac{hc}{2\lambda_B}}{\frac{hc}{\lambda_B}} < \frac{1}{2}$ or $K_A < K_B/2$

11 **(c)**

Energy received from the sun

$= 2$ cal cm^{-2}(min)$^{-1}$

$=8.4$ J cm^{-2} (min)$^{-1}$

Energy of 1 photon received from the sun

$E = \frac{hc}{\lambda}$

$= \frac{6.6\times10^{-34}\times3\times10^8}{5500\times10^{-10}}$

$=3.6\times 10^{-19}$ J

$\therefore$ Number of photons reaching the earth per cm^{2}per minute will be

$n = \frac{\text{energy received from sun}}{\text{energy of one photon}}$

$n = \frac{8.4}{3.6\times10^{-19}} = 2.3 \times 10^{19}$

12 **(b)**

Wave nature of matter of de Broglie was proved when accelerated electrons showed diffraction by metal foil in the same manner as X-ray diffraction

13 **(c)**

In X-ray spectra, depending on the accelerating voltage and the target element, we may find sharp peaks super imposed on continuous spectrum. These are at different wavelengths for different elements. They form characteristic X-ray spectrum

14 **(b)**

$E = hv \Rightarrow 100 \times 1.6 \times 10^{-19} = 6.6 \times 10^{-34} \times v$

$\Rightarrow v = 2.42 \times 10^{16} Hz$

16 **(d)**

Planck's constant,

$h = E/v = [\mathrm{ML^2T^{-2}/T^{-1}}] = [\mathrm{ML^2T^{-1}}]$

Angular momentum, $L = I\omega = [\mathrm{ML^2T^{-1}}]$

17 **(c)**

$\lambda = \frac{h}{p} \Rightarrow \lambda \propto \frac{1}{p}$

18 **(b)**

Momentum of incident light per second

$p_1 = \frac{E}{c} = \frac{60}{3\times10^8} = 2\times10^{-7}$

Momentum of reflected light per second

$p_2 = \frac{60}{100} \times \frac{E}{c} = \frac{60}{3\times10^8} = 1.2\times10^{-7}$

Force on the surface = change in momentum per second
$= p_2 - (-p_1) = p_2 + p_1 = (2 + 1.2) \times 10^{-7} = 3.2 \times 10^{-7}$N

20 **(d)**

From the symmetry of figure, the angle $\theta = 45°$. The path of moving proton in a normal magnetic field is circular. If r is the radius of the circular path, then from the figure,

$AC = 2\,r\cos 45° = 2r \times \frac{1}{\sqrt{2}} = \sqrt{2}r$ ...(i)

As $B\,q\,V = \frac{mv^2}{r}$ or $r = \frac{mv}{Bq}$

$$AC = \frac{\sqrt{2}\,mv}{B\,q} = \frac{\sqrt{2} \times 1.67 \times 10^{-27} \times 10^7}{1 \times 1.6 \times 10^{-19}}$$
$$= 0.14 \text{ m}$$

21 **(a)**

$$\delta p = \frac{\hbar}{\Delta x} = \frac{\hbar}{\lambda}$$

22 **(b)**

Threshold wavelength for $Na, \lambda_{Na} = \frac{12375}{2} = 6187.5$Å

Also $\lambda_{Cu} = \frac{12375}{4} = 3093.75$

Since $\lambda_{Na} > 4000$Å; So Na is suitable

23 **(d)**

In photocell, at a particular negative potential (stopping potential V_0) of anode, photoelectric current is zero, as the potential difference between cathode and anode increases current through the circuit increases but after some time constant current (saturation current) flows through the circuit even if potential difference still increases

24 **(c)**

Energy of photon

$$E = \frac{hc}{\lambda} = \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{590 \times 10^{-9}}$$
$$= \frac{6.63 \times 3}{59} \times 10^{-18}$$

Light energy produced per second $= \frac{90}{100} \times 10 = 9$W

∴ Number of photons emitted per sec

$$= \frac{9 \times 59}{6.63 \times 3 \times 10} - 18 = 2.67 \times 10^{19}$$

25 **(b)**

$mvr = \frac{nh}{2\pi}$, according to Bohr's theory

$\Rightarrow \quad 2\pi r = n\left(\frac{h}{mv}\right) = n\lambda$ for n=2, $\lambda = \pi r$

27 **(b)**

$$\Delta p = m\Delta v = \frac{\hbar}{\Delta x}$$

or $\Delta v = \frac{\hbar}{m\Delta x} = \frac{1.034 \times 10^{-34}}{1.67 \times 10^{-27} \times 6 \times 10^{-8}}$

$\approx 1\text{ms}^{-1}$

28 **(c)**

Momentum $p = \frac{E}{c} \Rightarrow E^2 = p^2c^2$

$= \frac{12375}{4100} = 3.01\,eV$

Work functions of metal A and B are less than $3.01eV$, so A and B will emit photo electrons

29 **(b)**

Energy of a photon, $E = \frac{hc}{\lambda}$

$\lambda_{\text{infrared}} > \lambda_{\text{red}} > \lambda_{\text{Blue}} > \lambda_{\text{Violet}}$

Therefore, violet has the highest energy

30 **(c)**

Higher the voltage, higher is the KE. Higher the work function, smaller is the KE

31 **(c)**

$$\frac{1}{2}mv^2 = eV$$

$$\frac{1}{2} \times 9 \times 10^{-31} \times v^2 = 1.6 \times 10^{-19} \times 182$$

$$v^2 = \frac{1.6 \times 10^{-19} \times 182 \times 2}{9.1 \times 10^{-31}}$$
$$v^2 = 64 \times 10^2 \text{ m/s}$$
$$v = 8 \times 10^6 \text{ m/s}$$

34 **(b)**

$K = QV = e \times V = eV$

36 **(c)**

Work function $W_0 = hv_0 = 6.6 \times 10^{-34} \times 1.6 \times 10^{15}$

$= 1.056 \times 10^{-18}J = 6.6\,eV$

From $E = W_0 + K_{\max} \Rightarrow K_{\max} = E - W_0 = 1.4\,eV$

37 **(a)**

$$\lambda = \frac{h}{\sqrt{2mE}} = \frac{6.6 \times 10^{-34}}{\sqrt{2 \times 9.1 \times 10^{-31} \times 5 \times 1.6 \times 10^{-19}}}$$

$= 5.469 \times 10^{-10}m = 5.47$Å

38 **(a)**

$\because m_e < m_p < m_\alpha \Rightarrow \left(\frac{q}{m}\right)_e > \left(\frac{q}{m}\right)_p > \left(\frac{q}{m}\right)_\alpha$

39 **(d)**

$\because V_0 = \left(\frac{h}{e}\right)v - \left(\frac{W_0}{e}\right)$. From the graph $V_2 > V_1$

$\Rightarrow \frac{hv_2}{e} - \frac{W_0}{e} > \frac{hv_1}{e} - \frac{W_0}{e} \Rightarrow v_2 > v_1$

$\Rightarrow \lambda_1 > \lambda_2$ (as $\lambda \propto \frac{1}{v}$)

40 **(b)**

KE of fastest electron

$= E = \phi_0 = 6.2 - 4.2 = 2.0$ eV

$= 2 \times 1.6 \times 10^{-19} = 3.2 \times 10^{-19}$ J

42 **(b)**

With the increase in intensity of light

photoelectric current increases, but kinetic energy of ejected electron, stopping potential and work function remains unchanged

43 **(c)**

The wavelength of X-ray lines is given by Rydberg Formula $\frac{1}{\lambda}=RZ^2\left(\frac{1}{n_1^2}-\frac{1}{n_2^2}\right)$

For K_α line, $n_1=1$ and $n_2=2$

$\therefore \frac{1}{\lambda}=RZ^2\left(\frac{3}{4}\right)\Rightarrow Z=\left(\frac{4}{3R\lambda}\right)^{1/2}$

$=\left[\frac{4}{3(1.097\times10^7 m^{-1})(0.76\times10^{-10}m)}\right]^{1/2}$

$=39.99\approx 40$

44 **(d)**

$\Delta\lambda=\lambda_{K_\alpha}-\lambda_{\min}$ When V is halved $\lambda_{\min}$ becomes two time but λ_{K_α} remains the same.

$\therefore \Delta\lambda'=\lambda_{K_\alpha}-2\lambda_{\min}=2(\Delta\lambda)-\lambda_{K_\alpha}$

$\therefore \Delta\lambda'<2(\Delta\lambda)$

45 **(c)**

X-rays are electromagnetic waves of wavelength ranging from 0.1 to 100Å

46 **(d)**

$qE=mg$ … (i)

$6\pi\eta rv=mg$

$\frac{4}{3}\pi r^3\rho g=mg$ … (ii)

$\therefore \quad r=\left(\frac{3mg}{4\pi\rho g}\right)^{1/3}$ … (iii)

Substituting the value of r in Eq. (ii), we get

$6\pi\eta v\left(\frac{3mg}{4\pi\rho g}\right)^{1/3}=mg$

or $(6\pi\eta v)^3\left(\frac{3mg}{4\pi\rho g}\right)=(mg)^3$

Again substituting $mg=$ qE, we get

$(qE)^2=\left(\frac{3}{4\pi\rho g}\right)(6\pi\eta v)^3$

Or $qE=\left(\frac{3}{4\pi\rho g}\right)^{1/2}(6\pi\eta g)^{3/2}$

$\therefore \quad q=\frac{1}{E}\left(\frac{3}{4\pi\rho g}\right)^{\frac{1}{2}}(6\pi\eta v)^{3/2}$

Substituting the values, we get

$q=\frac{7}{81\pi\times10^5}\sqrt{\frac{3}{4\pi\times900\times9.8}\times216\pi^3}$

$\times\sqrt{(1.8\times10^{-5}\times2\times10^{-3})^3}=$

8.0×10^{-19} C

47 **(c)**

$K.E.=2E_0-E_0=E_0$ (for $0\le x\le1$) $\Rightarrow \lambda_1=\frac{h}{\sqrt{2mE_0}}$

$K.E.=2E_0$(for $x>1$) $\Rightarrow \lambda_2=\frac{h}{\sqrt{4mE_0}}\Rightarrow\frac{\lambda_1}{\lambda_2}=\sqrt{2}$

48 **(c)**

Among the given metals, aluminium thermionically emits an electron at a relatively lowest temperature

49 **(c)**

Speed obtained by the particle after falling through a potential difference of V volt is

$v_A=\sqrt{\frac{2Vq}{m}}$ … (i)

And $v_B=\sqrt{\frac{2V\times4q}{m}}$ …(ii)

Now dividing Eq. (i) by Eq. (ii), we get

$\frac{v_A}{v_B}=\sqrt{\frac{1}{4}}=\frac{1}{2}$

So, $v_A:v_B=1:2$

50 **(a)**

$\frac{u_1}{u_2}=\frac{1}{2}$

Accelerations of cathode rays in electric field, $\vec{a}=\frac{eE}{m}$

It is same for both the cathode rays

As displacement, $s=ut+\frac{1}{2}at^2$

So for a given value of a and $t, s\times u$

So, $\frac{s_1}{s_2}=\frac{u_1}{u_2}=\frac{1}{2}$

51 **(b)**

Here, $\lambda_0=200$nm; $\lambda=100$nm;

$hc/e=1240$eV nm

maximum KE $=\frac{hc}{\lambda e}-\frac{hc}{\lambda_0 e}$ (in eV)

$=\frac{hc}{e}\left(\frac{1}{\lambda}-\frac{1}{\lambda_0}\right)$

$=1240\left(\frac{1}{100}-\frac{1}{200}\right)$

$=6.2$ eV

52 **(c)**

According to J. J. Thomson's cathode ray tube experiment the e/m of electrons is much greater than the e/m of protons.

54 **(b)**

Maximum KE$=\frac{hc}{\lambda}-\phi_0$

$=\frac{6.6\times10^{-34}\times3\times10^8}{400\times10^{-10}}\times\frac{1}{1.6\times10^{-19}}-2$

$=1.1$ eV

55 **(c)**

$\lambda=\frac{h}{\sqrt{2mE}}=\frac{h}{\sqrt{2m}}.\frac{1}{\sqrt{E}}$. Taking log of both sides

$$\log\lambda = \log\frac{h}{\sqrt{2m}} + \log\frac{1}{\sqrt{E}}$$

$$\Rightarrow \log\lambda = \log\frac{h}{\sqrt{2m}} - \frac{1}{2}\log E$$

$$\Rightarrow \log\lambda = -\frac{1}{2}\log E + \log\frac{h}{\sqrt{2m}}$$

This is the euation of straight line having slope $(-1/2)$ and positive intercept on $\log\lambda$ axis

56 **(b)**

Cut-off wavelength depends on the applied voltage not on the atomic number of the target. Characteristic wavelengths depends on the atomic number of target.

57 **(c)**

For k_α emission

transition L shell to $k-$ shell

For k_β emission

transition M shell to $k-$ shell

For L_α emission

transition M shell to $L-$ shell

$E_M - E_K = (E_M - E_L) + (E_L - E_K)$

$\Rightarrow hf_2 = hf_3 + hf_1 \Rightarrow f_2 = f_1 + f_3$

58 **(a)**

Number of photons emitted per second

$$n = \frac{p}{hv} = \frac{10\times10^3}{6.6\times10^{-34}\times880\times10^3} = 1.72\times10^{31}$$

59 **(a)**

$$p = \frac{h}{\lambda} = \frac{6.6\times10^{-34}}{4400\times10^{-10}} = 1.5\times10^{-27}kg.m/s$$

and mass $m = \frac{p}{c} = \frac{1.5\times10^{-27}}{3\times10^8} = 5\times10^{-36}kg$

60 **(a)**

$$\lambda = \frac{h}{p} = \frac{h}{mv}$$

61 **(c)**

Slope of $V_0 - v$ curve for all metals be same $\left(\frac{h}{e}\right)$, *i.e.*, curves should be parallel

62 **(b)**

According to de-Broglie hypothesis

$$\lambda = \frac{h}{p}$$

$$= \frac{h}{\sqrt{2mE}} = \frac{h}{\sqrt{2mqV}}$$

$\therefore$ $$\lambda = \frac{6.6\times10^{-34}}{\sqrt{2\times(1.6\times10^{-27})(1.6\times10^{-19})\times1000}}$$

$$= \frac{6.6\times10^{-34}}{7.16\times10^{-22}}$$

$$=0.9\times10^{-12}\text{ m}$$

63 **(a)**

$$i = \frac{Ne}{t} \Rightarrow \frac{N}{t} = \frac{i}{e} = \frac{3.2\times10^{-3}}{1.6\times10^{-19}} = 2\times10^{16}/s$$

64 **(c)**

Speed of the cathode rays is $10^7 m/sec - 3\times10^7 m/s$

65 **(b)**

Stopping potential $V_0 = \frac{hc}{e}\left[\frac{1}{\lambda} - \frac{1}{\lambda_0}\right]$. As λ decreases so V_0 increases

66 **(b)**

The momentum of the photon

$$p = \frac{h}{\lambda} = \frac{hv}{c}$$

67 **(c)**

When pressure in a tube is reduced in the range 1 cm and 10^{-3}cm; the mean free path of moving electron in the discharge tube increases. As a result of which the electron gets higher KE while moving towards anode and then cause ionisation of the atoms with which it will collide on its ways causing excitation phenomenon.

68 **(c)**

Specific charge on proton $=\left(\frac{e}{m}\right)_p$

$=9.6\times10^7\text{C}-\text{kg}^{-1}$ specific charge on α- particle,

$$\left(\frac{q}{m}\right)_\alpha = \frac{2e}{4m} = \frac{1}{2}\left(\frac{e}{m}\right)_p = \frac{1}{2}\times9.6\times10^7$$

$= 4.8\times10^7\ C-kg^{-1}$

69 **(c)**

$$mv = \frac{h}{\lambda}$$

or $v = \frac{h}{m\lambda} = \frac{6.6\times10^{-34}}{9.1\times10^{-31}\times5200\times10^{-10}}$

$= 1.4\times10^3\ \text{ms}^{-1}$

70 **(c)**

For photoelectric effect,

$$eV_0 = hv \Rightarrow v = \frac{eV_0}{h}$$

$$v = \frac{1.6\times10^{-19}\times3.2}{6.6\times10^{-34}}$$

$$= 0.775\times10^{15}\text{Hz}$$

71 **(a)**

On increasing wavelength of light of the photoelectric current decreases and at a certain wavelength (cut off) above which photoelectric current stops

72 **(a)**

If an electron and a proton propagating in the form of waves and their wavelength are same, then according to the relation

$$E = \frac{hc}{\lambda}$$

Also, $\lambda_{\text{electron}} = \lambda_{proton}$

$\therefore$ $E_e = E_p$

Hence, their energies are same.

73 **(b)**

Stopping potential does not depend upon intensity of incident light (I)

74 **(a)**

Any charge in the universe is given by

$q = ne \Rightarrow e = \frac{q}{n}$ (where n is an integer)

$q_1 : q_2 : q_3 : q_4 : q_5 : q_6 :: n_1 : n_2 : n_3 : n_4 : n_5 : n_6$

6.563 : 8.204 : 11.5 : 13.13 : 16.48 : 18.09

$:: n_1 : n_2 : n_3 : n_4 : n_5 : n_6$

Divide by 6.563

1 : 1.25 : 1.75 : 2.0 : 2.5 : 2.75

$:: n_1 : n_2 : n_3 : n_4 : n_5 : n_6$

Multiplied by 4

4 : 5 : 7 : 8 : 10 : 11 $:: n_1 : n_2 : n_3 : n_4 : n_5 : n_6$

$$e = \frac{q_1 + q_2 + q_3 + q_4 + q_5 + q_6}{n_1 + n_2 + n_3 + n_4 + n_5 + n_6}$$

$$= \frac{73.967 \times 10^{-19}}{45}$$

$= 1.641 \times 10^{-19} C$

[**Note** : If you take 45.0743 in place of 45, you will get the exact value]

76 **(b)**

In the presence of inert gas photoelectrons emitted by cathode ionize the gas by collision and hence the current increases

77 **(a)**

Energy of photon $E = \frac{hc}{\lambda} = mc^2$;

momentum of photon $= mc = h/\lambda$

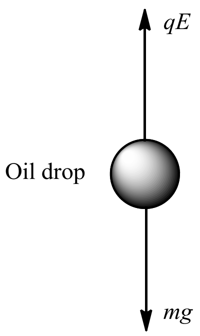
78 **(b)**

In X-ray tube, target must be heavy element with high melting point

79 **(c)**

Robert Millikan performed the experiment to determine the charge on an electron.

When a drop is suspended, its weight mg is exactly equal to the electric force applied qE, where E is electric field, q the charge, m the mass of drop and g the acceleration due to gravity.



Hence, solving for q, we get

$$q = \frac{mg}{E}$$

Given, $m = 16 \times 10^{-6}$kg, $\quad g = 10\text{ms}^{-2}$,

$E = 10^6 \text{V–m}^{-1}$

$\therefore \quad q = \frac{16 \times 10^6 \times 10}{10^6} = 16 \times 10^{-11}$ C

81 **(b)**

The work function of sodium

$$W = \frac{hc}{\lambda}$$

$$W = \frac{6.6 \times 10^{-34} \times 3 \times 10^8}{5 \times 10^{-7}}$$

or $\quad W = 3.96 \times 10^{-19}$J

or $\quad W = 2.47$eV $\quad (\because 1\text{eV} = 1.6 \times 10^{-19}$ J)

or $\quad W = 2.5$eV(approximately)

82 **(b)**

$$p = \frac{h}{\lambda} = \frac{6.6 \times 10^{-34}}{0.01 \times 10^{-10}} = 6.6 \times 10^{-22} kg - m/s$$

84 **(b)**

If an electron and a photon propagates in the form of waves having the same wavelength, it implies that they have same momentum. This is according to de-Broglie equation

$$p \propto \frac{1}{\lambda}$$

86 **(b)**

Retarding potential,

$$V_s = \frac{hc}{\lambda e} - \frac{\phi_0}{e} = \frac{1240 \times 10^{-9}}{330 \times 10^{-9}} - 1.07$$

$= 3.73 - 1.07 = 2.66$ V

87 **(b)**

$K_{\text{max}} = (hv - W_0); v =$ frequency of incident light

88 **(c)**

$$\lambda_{\text{min}} = \frac{12375}{50 \times 10^3} \text{Å} = 0.247 = 0.25\text{Å}$$

89 **(c)**

$$E_K - E_L = \frac{hc}{\lambda} = \frac{(6.6 \times 10^{-34})(3 \times 10^8)}{(0.021 \times 10^{-9})(1.6 \times 10^{-19})} eV$$

$= 59 KeV$

90 **(a)**

Maximum KE $= E - \phi_0 = 3.4 - 2 = 1.4$ eV

91 **(a)**

The cut-off wavelength λ_{min} corresponds to an electron transferring (approximately) all of its energy to an X-ray photon, thus producing a photon with the greatest possible frequency and least possible wavelengh.

From relation

$$\lambda_{\text{min}} = \frac{hc}{K_o}$$

$$= \frac{(4.14 \times 10^{-15})(3 \times 10^8)}{35.0 \times 10^3}$$

$= 3.55 \times 10^{-11}$ m $= 35.5$pm

92 **(d)**

de-Broglie wavelength

$$\lambda = \frac{h}{\sqrt{2mE}}$$

$\therefore \quad \frac{\lambda_1}{\lambda_2} = \sqrt{\frac{E_2}{E_1}} \Rightarrow \frac{1 \times 10^{-9}}{0.5 \times 10^{-9}} = \sqrt{\frac{E_2}{E_1}}$

$\Rightarrow \quad 2 = \sqrt{\frac{E_2}{E_1}} \Rightarrow \frac{E_2}{E_1} = 4$

$\therefore \quad E_2 = 4E_1$

$\therefore$ Energy to be added $= E_2 - E_1$

$= 4E_1 - E_1 = 3E_1$

93 **(c)**

We know that

$qE = mg$

$\frac{qQ}{\varepsilon_0 A} = mg$ or $q = \frac{\varepsilon_0 Amg}{Q}$

$= \frac{8.85 \times 10^{-12} \times 2 \times 10^{-2} \times 2.5 \times 10^{-7} \times 10}{5 \times 10^{-7}} C$

$= 8.85 \times 10^{-13} C$

95 **(b)**

For an electron

Mass, $m_e = 9.11 \times 10^{-31} kg$

Kinetic energy, $K = 10eV = 10 \times 1.6 \times 10^{-19} J$

de Broglie wavelength, $\lambda_e = \frac{h}{\sqrt{2m_e K}}$ ...(i)

For the person Mass, $m = 66kg$

Speed, $v = 100 kmhr^{-1} = 100 \times \frac{5}{18} ms^{-1}$

de Broglie wavelength, $\lambda = \frac{h}{mv}$ ...(ii)

Diving (i) by (ii), we get

$\frac{\lambda_e}{\lambda} = \frac{h}{\sqrt{2m_e K}} \times \frac{mv}{h} = \frac{mv}{\sqrt{2m_e K}}$

$= \frac{66 \times 100 \times \frac{5}{18}}{\sqrt{2 \times 9.11 \times 10^{-31} \times 10 \times 1.6 \times 10^{-19}}}$

$= 1.07 \times 10^{27}$

97 **(b)**

$\lambda = \frac{h}{mv} = \frac{h\sqrt{1 - v^2/c^2}}{m_0 v} = 0 \quad (\because v = c)$

98 **(b)**

Slope of $V_0 - v$ curve $= \frac{h}{e}$

$\Rightarrow h =$ Slope $\times e = 1.6 \times 10^{-19} \times 4.12 \times 10^{-15}$

$= 6.6 \times 10^{-34} J\text{-}s$

99 **(b)**

The wavelength range of X-ray is 0.1 Å $- 100$ Å

100 **(b)**

$q V = \frac{1}{2} mv^2$ or $v = \sqrt{2qV/m}$ $ie, v \propto \sqrt{V}$

101 **(a)**

According to Einstein, the energy of photon is given by

$$E = hv = \frac{hc}{\lambda}$$

Where h is Planck's constant, c the speed of light and λ the wavelength.

$\therefore \quad \frac{E_1}{E_2} = \frac{\lambda_2}{\lambda_1}$

Given, $\lambda_1 = 150$ nm , $\lambda = 300$nm

$\therefore \quad \frac{E_1}{E_2} = \frac{300}{150} = \frac{2}{1}$

102 **(b)**

By using $hv - hv_0 = K_{\max}$

$\Rightarrow h(v_1 - v_0) = K_1$ ...(i)

And $h(v_2 - v_0) = K_2$ ...(ii)

$\Rightarrow \frac{v_1 - v_0}{v_2 - v_0} = \frac{K_1}{K_2} = \frac{1}{K}$, Hence $v_0 = \frac{Kv_1 - v_2}{K - 1}$

104 **(c)**

Stopping potential $= 1.8eV - 1.2eV = 0.6\ eV$

105 **(a)**

The work function has no effect on current so long as $hv > W_0$. The photoelectric current is proportional to the intensity of light. Since there is no change in the intensity of light, therefore $I_1 = I_2$

106 **(b)**

The value of saturation current depends on intensity. It is independent of stopping potential

107 **(b)**

For similar parabola; $y^2 = \frac{B^2 lD}{E} \frac{q}{m} x$, will be same for two particles. It means $\frac{B^2 q}{m}$ = a constant for these two particles.

$\therefore \frac{m_1}{m_2} = \frac{B_1^2 q_1}{B_2^2 q_2} = \left(\frac{0.8}{1.2}\right)^2 \times \frac{e}{2e} = \frac{2}{9}$

108 **(c)**

$E \propto \frac{1}{\lambda} \Rightarrow \frac{2.5}{E'} = \frac{1}{5000} \Rightarrow E' = (2.5) \times 5000\ eV$

109 **(d)**

According to Planck, energy emitted or absorbed from the objects is not continous while it is in small packets of energy which are called photons or quanta. Einstein explained photoelectric effect on the basic of Planck's hypothesis.

110 **(a)**

In tungsten, photoemission take place with a light of wavelength 2300 Å. As emission of electron is inversely proportional to wavelength, all the wavelengths smaller then 2300 Å will cause emission of electrons

111 **(c)**

When a charged particle (charge q, mass m) enters perpendicularly in a magnetic field (B) then, radius of the path described by it

$r = \frac{mv}{qB} \Rightarrow mv = qBr$

Also de-Broglie wavelength $\lambda = \frac{h}{mv}$

$$\Rightarrow \lambda = \frac{h}{qBr} \Rightarrow \frac{\lambda_\alpha}{\lambda_p} = \frac{q_p r_p}{q_\alpha r_\alpha} = \frac{1}{2}$$

112 **(c)**

$\phi_0 = hc/\lambda_0$ (in eV)

$$= \frac{6.62 \times 10^{-34} \times 3 \times 10^8}{5420 \times 10^{-10} \times 1.6 \times 10^{-19}} = 2.29 \text{ eV}$$

113 **(c)**

Frequency of hard X-rays is greater than that of soft X-rays

114 **(b)**

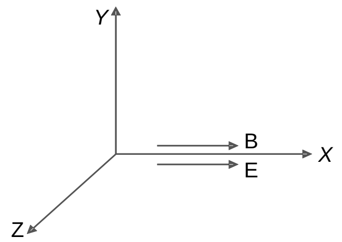
$$\lambda = \frac{h}{\sqrt{2mE}} \Rightarrow \lambda \propto \frac{1}{\sqrt{m}} \quad [E = \text{same}]$$

115 **(a)**

$\lambda_{\min} = \frac{12375}{40,000} = 0.30$ Å Hence wavelength less than 0.30 Å is not possible

117 **(b)**

Let **E** and **B** be along X-axis. When a charged particle is released from rest, it will experience an electric force along the direction of electric field or opposite to the direction of electric field depending on the nature of charge. Due to this force, it acquires some velocity along X-axis. Due to this motion of charge, magnetic force can not have non-zero value because angle between **v** and **B** would be either 0^0 or 180^0. So, only electric force is acting on particle and hence, it will move along a straight line.



118 **(a)**

According to Einstein's quantum theory, light propagates in the form of bundles (packet or quanta) of energy, each bundle is called a photon. The photoelectric effect represents that light has a particle nature.

120 **(c)**

When current in X-ray tube is increased, then the number of electrons striking the anticathode increases which in turn increases the intensity of X-rays

121 **(a)**

$$\lambda = \frac{h}{mv} = \frac{6.6 \times 10^{-34}}{1 \times 2000} = 3.3 \times 10^{-37} m$$
$$= 3.3 \times 10^{-27} \text{Å}$$

123 **(b)**

$$\text{KE} = \frac{p^2}{2m}$$

Momentum is same, so KE$\propto \frac{1}{m}$

Out of the given choices, mass of electron is minimum, so its KE will be maximum.

124 **(d)**

Cathode rays are beam of electrons

125 **(c)**

Due to 10.2 eV photon one photon of energy 10.2 eV will be detected.

Due to 15 eV photon the electron will come out of the atom with energy $(15 - 13.6) = 1.4\ eV$

126 **(a)**

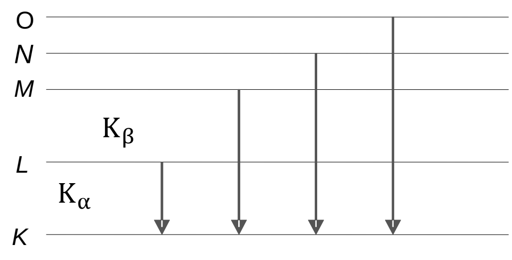
Photos move with velocity of light and have energy $h\nu$. Therefore, they also exert pressure

127 **(d)**

The maximum KE of the emitted photoelectrons is independent of the intensity of the incident light but depends upon the frequency of the incident light

128 **(a)**

When the colliding electron remove an electron from innermost k-shell (corresponding to n=1) of atom and electron from some higher shell jumps to k-shell to fill up this vacancy, characteristic X-ray of k- series are obtained



K- Series

$\therefore K_\propto$ and K_β X-rays are emitted when there is transition of electron between the levels n=2 to n=1 and n=3 to n=1 respectively.

129 **(d)**

$\left.\begin{array}{l}\text{Photoelectric effect } \rightarrow \text{Particle nature} \\ \text{Diffraction } \rightarrow \text{Wave nature}\end{array}\right\}$ Dual nature

130 **(c)**

$$p = \frac{E}{c} \Rightarrow E = p \times c = 2 \times 10^{-16} \times (3 \times 10^{10})$$
$$= 6 \times 10^{-6} erg$$

131 **(b)**

The momentum of the incident radiation is given as $p = \frac{h}{\lambda}$. When the light is totally reflected normal to the surface the direction of the ray is reversed.

That means it reverses the direction of it's momentum without changing it's magnitude

$$\therefore \Delta p = 2p = \frac{2h}{\lambda} = \frac{2 \times 6.6 \times 10^{-34}}{6630 \times 10^{-10}}$$
$$= 2 \times 10^{-27} kg - m/sec$$

132 **(b)**

Number of photons emitted is proportional to the intensity. Also $\frac{hc}{\lambda} = W_0 + E$

133 **(a)**

Since, de-Broglie wavelength is related to momentum by the relation

$\lambda = \frac{h}{P}$ (where h=plack's constant)

For electron $\lambda_e = \frac{h}{P_e}$

For neutron $\lambda_n = \frac{h}{p_n}$

$\therefore$ $\frac{\lambda_e}{\lambda_n} = \frac{P_n}{P_e}$ ... (i)

Case I since, $(\text{KE})_{\text{electron}} = (\text{KE})_{\text{neutron}}$

$$\Rightarrow \frac{p_e^2}{2m_e} = \frac{p_n^2}{2m_n}$$

$$\Rightarrow \frac{p_n}{p_e} = \sqrt{\frac{m_n}{m_e}} \text{ ...(ii)}$$

From Eqs. (i) and (ii),we get

$$\frac{\lambda_e}{\lambda_n} = \sqrt{\frac{m_n}{m_e}}$$

But $m_n > m_e$

$$\therefore \frac{m_n}{m_e} > 1$$

$$\Rightarrow \frac{\lambda_e}{\lambda_n} \gg 1$$

$$\lambda_e \gg \lambda_n$$

case II If momenta are equal, then

$$p_e = p_n$$

From Eq.(i)

$$\frac{\lambda_e}{\lambda_n} = 1$$

Case III If speeds are same

$$v_e = v_n$$

then $\frac{\lambda_e}{\lambda_n} = \frac{p_n}{p_e} = \frac{m_n v_n}{m_e v_e} = \frac{m_n}{m_e}$

Now, $m_n \gg m_e$

$$\therefore \frac{m_n}{m_e} \gg 1$$

$$\therefore \frac{\lambda_e}{\lambda_n} \gg 1$$

$$\lambda_e \gg \lambda_n$$

134 **(d)**

$$\frac{\lambda_p}{\lambda_\alpha} = \frac{\frac{h}{\sqrt{2em_p V}}}{\sqrt{2 \times 2e4\, m_p\, V}} = 2\sqrt{2}$$

135 **(b)**

$n\, e\, E = 6\pi\, \eta\, r\, v$ or $n = \frac{6\pi\, \eta\, r\, v}{e\, E}$

$$= \frac{6 \times 3.14 \times 1.6 \times 10^{-5} \times 5 \times 10^{-7} \times 0.01}{1.6 \times 10^{-19} \times 6.28 \times 10^{5}} = 15$$

136 **(a)**

Energy of the electron, when it comes out from the second plate $= 200\, eV - 100\, eV = 100\, eV$

Hence accelerating potential difference $= 100\, V$

$$\lambda_{Electron} = \frac{12.27}{\sqrt{V}} = \frac{12.27}{\sqrt{100}} = 1.23\text{Å}$$

137 **(a)**

$$\lambda = \frac{h}{\sqrt{2mE}} \Rightarrow \lambda \propto \frac{1}{\sqrt{m}} \Rightarrow \frac{\lambda_p}{\lambda_\alpha} = \sqrt{\frac{m_a}{m_p}} = \frac{2}{1}$$

138 **(b)**

Given $m_0c^2 = 0.51\, MeV$ and $v = 0.8\, c$

$K.E.$ of the electron $= mc^2 - m_0c^2$

But $m = \frac{m_0}{\sqrt{1 - \frac{v^2}{c^2}}} = \frac{m_0}{\sqrt{1 - \left(\frac{0.8c}{c}\right)^2}} = \frac{m_0}{\sqrt{0.36}} = \frac{m_0}{0.6}$

Now, $mc^2 = \frac{0.51}{0.6} MeV = 0.85\, MeV$

$\therefore K.E. = (0.85 - 0.51) MeV = 0.34\, MeV$

139 **(b)**

Intensity of light source is

$$I \propto \frac{1}{d^2}$$

When distance is doubled, intensity becomes one-fourth.

As number of photoelectrons ∝ intensity, so number of photoelectrons is quarter of the initial number.

140 **(d)**

Given : $E = 13.2 keV$

$$\lambda(in\text{ Å}) = \frac{hc}{E(eV)} = \frac{12400}{13.2 \times 10^3} = 0.939\text{Å} = 1\text{Å}$$

X-rays covers wavelengths ranging from about $10^{-8}m(10nm)$ to $10^{-3}m(10^{-4}nm)$.
An electromagnetic radiation of energy 13.2 keV belongs to X-ray region of electromagnetic spectrum

142 **(a)**
According to Einstein's photoelectric equation

$$eV = hc\left[\frac{1}{\lambda} - \frac{1}{\lambda_0}\right]$$

Ist case $\quad 3eV_s = hc\left[\frac{1}{\lambda} - \frac{1}{\lambda_0}\right] \quad$ ...(i)

IInd case $\quad eV_s = hc\left[\frac{1}{2\lambda} - \frac{1}{\lambda_0}\right] \quad$ ...(ii)

Dividing Eq. (i)by Eq. (ii), we get

$$\lambda_0 = 4\lambda$$

143 **(d)**
$K_{\max}$ of photoelectrons doesnot depend upon intensity of incident light.

144 **(b)**
$\frac{\lambda_1}{\lambda_2} = \frac{\frac{h}{\sqrt{2mE}}}{\frac{hc}{E}}$ or $\frac{\lambda_1}{\lambda_2} \propto E^{1/2}$

146 **(b)**
$$p = \frac{E}{c} = \frac{hv}{c}$$

147 **(d)**
The mass of electron is about $\frac{1}{1836}$ times that of a neutron and angular momentum of electron is quantised in the hydrogen atoms but not the linear momentum of electron

148 **(d)**
$$hv - W_0 = \frac{1}{2}mv_{\max}^2 \Rightarrow \frac{hc}{\lambda} - \frac{hc}{\lambda_0} = \frac{1}{2}mv_{\max}^2$$

$$\Rightarrow hc\left(\frac{\lambda_0 - \lambda}{\lambda\lambda_0}\right) = \frac{1}{2}mv_{\max}^2 \Rightarrow v_{\max}$$

$$= \sqrt{\frac{2hc}{m}\left(\frac{\lambda_0 - \lambda}{\lambda\lambda_0}\right)}$$

When wavelength is λ and velocity is v, then

$$v = \sqrt{\frac{2hc}{m}\left(\frac{\lambda_0 - \lambda}{\lambda\lambda_0}\right)} \quad \text{... (i)}$$

When wavelength is $\frac{3\lambda}{4}$ and velocity is v' then

$$v' = \sqrt{\frac{2hc}{m}\left[\frac{\lambda_0 - (3\lambda/4)}{(3\lambda/4) \times \lambda_0}\right]} \quad \text{... (ii)}$$

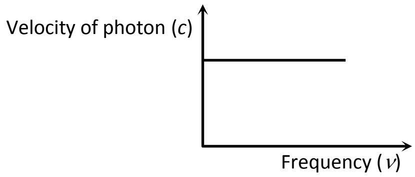
Divide equation (ii) by (i), we get

$$\frac{v'}{v} = \sqrt{\frac{[\lambda_0 - (3\lambda/4)]}{\frac{3}{4}\lambda\lambda_0} \times \frac{\lambda\lambda_0}{\lambda_0 - \lambda}}$$

$$v' = v\left(\frac{4}{3}\right)^{1/2}\sqrt{\frac{[\lambda_0 - (3\lambda/4)]}{\lambda_0 - \lambda}}$$

$$i.e.\, v' > v\left(\frac{4}{3}\right)^{1/2}$$

149 **(a)**
Velocity of photon ($i.e.$ light) does not depend upon frequency. Hence the graph between velocity of photon and frequency will be as follows



150 **(b)**
$$\lambda_{\min} = \frac{hc}{eV} \Rightarrow \lambda_1 = \frac{hc}{eV_1} \text{ and } \lambda_2 = \frac{hc}{eV_2}$$

$\therefore \Delta\lambda = \lambda_2 - \lambda_1 = \frac{hc}{e}\left[\frac{1}{V_2} - \frac{1}{V_1}\right]$. Given $V_2 = 1.5\, V_1$

on solving we get $V_1 = 16000\, volt = 16\, kV$

152 **(a)**
$$\lambda_{\min} = \frac{12375}{40 \times 10^3} = 0.309\text{ Å} \approx 0.31\text{ Å}$$

153 **(a)**
Energy of photon, $E = hv = \frac{hc}{\lambda_{Ph}}$

where λ_{Ph} is the wavelength of a photon $\lambda_{ph} = \frac{hc}{E}$

Wavelength of the electron, $\lambda_e = \frac{h}{\sqrt{2mE}}$

$$\therefore \frac{\lambda_{Ph}}{\lambda_e} = \frac{hc}{E} \times \frac{\sqrt{2mE}}{h} = c\sqrt{\frac{2m}{E}}$$

154 **(b)**
For electron and positron pair production, minimum energy is 1.02 MeV

Energy of photon is given $1.7 \times 10^{-3}J = \frac{1.7\times10^{-13}}{1.6\times10^{-19}}$
$= 1.06\, MeV$

Since energy of photon is greater than 1.02 MeV
So electron positron pair will be created

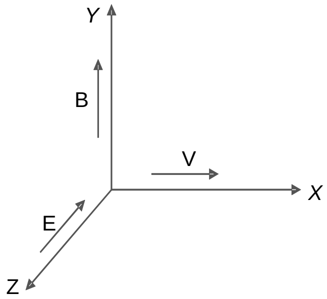
155 **(d)**
Velocity of photon $c = v\lambda$

156 **(d)**
According to Einstein's equation

$$hv = W_o + K_{max} \Rightarrow V_o = \left(\frac{h}{e}\right)v - \frac{W_o}{e}$$

This is the equation of straight line having positive slope (h/e) and intercept on $-V_o$ axis, equal to $\frac{W_o}{e}$

158 **(a)**
The force on a particle is



So, $\boldsymbol{F} = q(\boldsymbol{E} + \boldsymbol{v} \times \boldsymbol{B})$

or $\mathbf{F} = \mathbf{F}_e + \mathbf{F}_m$

$\mathbf{F}_e = q\mathbf{E}$

$= -16\times 10^{-18} \times 10^4(-\hat{k})$

$=16\times 10^{-14}\hat{k}$

and $\mathbf{F}_m = -16 \times 10^{-18}(10\hat{\imath} \times B\hat{\jmath})$

$= -16 \times 10^{-17} \times B(+\hat{k})$

$= -16 \times 10^{-17} B \times \hat{k}$

Since, particle will continue to move along $+ x$-axis, so resultant force is equal to 0.

$\mathbf{F}_e + \mathbf{F}_m = 0$

$\therefore \quad 16 \times 10^{-14} = 16 \times 10^{-17} B$

$\Rightarrow \quad B = \frac{16\times10^{-14}}{16\times10^{-17}} = 10^3$

$B = 10^3 \text{Wb-m}^{-2}$

159 **(c)**

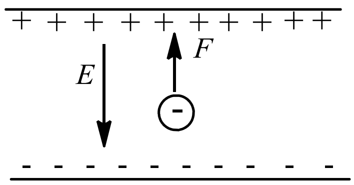
$E = hv/\lambda = \frac{hc}{e\lambda}$ (in eV)

$= \frac{6.6\times10^{-34}\times3\times10^8}{1.6\times10^{-19}\times0.21} = 5.9 \times 10^{-6}$ eV

160 **(b)**

Electric force *(F)* is straight forwarded, given by

$F = qE$



Where, q is charge and E is electric field.

Given, $q = 3e$

$\therefore \quad F = 3eE \quad$ ...(i)

From Newton's law, force experienced by a particle of mass $2m$ witn acceleration a is

$F = 2ma$ .... (ii)

Equating Eqs. (i) and (ii) we get

$3eE = 2ma$

$\Rightarrow \quad a = \frac{3eE}{2m}$

163 **(c)**

Potential difference $V = \frac{hc}{e\lambda}$

$= \frac{6.6\times10^{-34}\times3\times10^8}{1.6\times10^{-19}\times2\times10^{-10}}$

$= 6200$ V

166 **(c)**

$E = \frac{hc}{\lambda} - W_0$ and $2E = \frac{hc}{\lambda'} - W_0$

$\Rightarrow \frac{\lambda'}{\lambda} = \frac{E + W_0}{2E + W_0} \Rightarrow \lambda' = \lambda\left(\frac{1 + W_0/E}{2 + W_0/E}\right)$

Since $\frac{(1+W_0/E)}{(2+W_0/E)} > \frac{1}{2}$ so $\lambda' > \frac{\lambda}{2}$

167 **(c)**

$mg = q\,E$ or $\frac{4}{3}\pi r^3 \rho g = \frac{qV}{d}$ or $V \propto r^3$

$\therefore \quad V_2 = V_1\left(\frac{r_2}{r_1}\right)^3 = 400 \times \left(\frac{2}{1}\right)^3 = 3200\text{V}$

168 **(a)**

$qvB = qE \Rightarrow v = \frac{E}{B}$

But $\frac{1}{2}mv^2 = qV$ so $\frac{q}{m} = \frac{v^2}{2V} = \frac{E^2}{2VB^2}$

169 **(c)**

When drop is stationary, then

$q_1 E = 6\pi\,\eta r\,v_0$ or $q_1 = 6\pi\,\eta r\,v_0/E$

When drop moves upwards, then

$3q = \frac{6\pi\,\eta r(v_0 + v_0)}{E} = 2 \times \left(\frac{6\pi\,\eta r v_0}{E}\right) = 2q_1$

$\therefore \quad q_1 = \frac{3}{2}q$

170 **(b)**

According to Einstein's photoelectric equation the work function of metal is given by

$\therefore \ \phi = hc/\lambda - KE_m$

$= \frac{6.6\times10^{-34}\times3\times10^8}{4000\times10^{-10}} - 2eV$

$= 4.95 \times 10^{-19} - 2\ eV$

$= \frac{4.95\times10^{-19}}{1.6\times10^{-19}} - 2\ eV$

$= 3$ eV-2 eV $= 1$ eV

171 **(b)**

$E_k = \frac{1}{2}\frac{q^2B^2r^2}{m}$ $ie, r \propto \sqrt{E_k}$

So, $r_2 = r_1\sqrt{E_{k_2}/E_{k_1}} = R\sqrt{3} = \sqrt{3}\,R$

172 **(b)**

When the charged particle enters the magnetic field making angle other than 90^0 with it, the path is helix.

173 **(c)**

By Moseley's law, $\sqrt{v} = a(Z - b)$ or, $v = a^2(Z - b)^2$

Comparing with the equation of a parabola, $y^2 = 4ax$ it conforms to graph c

174 **(c)**

According to Einstein's photoelectric equation

175 **(c)**

According to the energy diagram of X-ray spectra

$\because \Delta E = \frac{hc}{\lambda} \Rightarrow \lambda \propto \frac{1}{\Delta E}$

($\Delta E =$ Energy radiated when e^- jumps from, higher energy orbit to lower energy orbit)

$\because (\Delta E)_{k_\beta} > (\Delta E)_{k_\alpha} > (\Delta E)_{L_\alpha} \therefore \lambda'_\alpha > \lambda_\alpha > \lambda_\beta$

Also $(\Delta E)_{k_\beta} = (\Delta E)_{k_\alpha} + (\Delta E)_{L_\alpha}$

$\Rightarrow \frac{hc}{\lambda_\beta} = \frac{hc}{\lambda_\alpha} + \frac{hc}{\lambda'_\alpha} \Rightarrow \frac{1}{\lambda_\beta} = \frac{1}{\lambda_\alpha} + \frac{1}{\lambda'_\alpha}$

176 **(c)**

$n \to 2 - 1$

$E = 10.2\ eV$

$kE = E - \phi$

$Q = 10.20 - 3.57$

$hv_0 = 6.63\ eV$

$v_0 = \frac{6.63 \times 1.6 \times 10^{-19}}{6.67 \times 10^{-34}} = 1.6 \times 10^{15}$

178 **(b)**

Minimum wavelength = 5Å

$\lambda = \frac{12.2\ \text{Å}}{\sqrt{V}} = 5\text{Å}$

Acceleration potential = 6.25 V

179 **(c)**

$\frac{1}{2}mv^2 = \frac{hc}{\lambda} - \phi\ (\text{in eV})$

$= \frac{6.6 \times 10^{-34} \times 3 \times 10^8}{4000 \times 10^{-10} \times 1.6 \times 10^{-19}} - 2$

$= 3.1 - 2 = 1.1\ \text{eV} = 1.1 \times 1.6 \times 10^{-19}\ \text{J}$

$= 1.76 \times 10^{-19}\ \text{J}$

$v = \frac{1.76 \times 10^{-19} \times 2}{9 \times 10^{-13}}$

$= 6.2 \times 10^5\ \text{ms}^{-1}$

180 **(c)**

According to Mosley's law $v = a(Z - b)^2$ and $v \propto \frac{1}{\lambda}$

181 **(c)**

Here, $E_1 = E_2$

$n_1 hv_1 = n_2 hv_2$

So, $\frac{n_1}{n_2} = \frac{v_2}{v_1}$

182 **(a)**

Energy of photon

$$E = \frac{hc}{\lambda}$$

Given, $\lambda = 5000\ \text{Å} = 5 \times 10^{-7} m$

$\therefore$ $E = \frac{6.6 \times 10^{-34} \times 3 \times 10^8}{5 \times 10^{-7}}$

$= 3.96 \times 10^{-19}\ J$

Energy received per second $= 10^{-8}\ \text{Js}^{-1}$

$\therefore$ Number of photon's received per second

$= \frac{\text{Energy received per second}}{\text{Energy of one photon}}$

$= \frac{10^{-8}}{3.96 \times 10^{-19}} = 2.5 \times 10^{10}$

183 **(c)**

$$\frac{1}{2} m v_{\text{max}}^2 = eV_0$$

$\Rightarrow$ $v_{\text{max}} = \sqrt{2\left(\frac{e}{m}\right)V_0}$

$= \sqrt{2 \times 1.8 \times 10^{11} \times 9}$

$= 18 \times 10^5\ ms^{-1}$

$= 1.8 \times 10^6\ ms^{-1}$

184 **(c)**

$QE = mg \Rightarrow Q = \frac{mg}{E} \Rightarrow n = \frac{mgd}{Ve}$

$\Rightarrow n = \frac{1.8 \times 10^{-14} \times 10 \times 0.9 \times 10^{-2}}{2 \times 10^3 \times 1.6 \times 10^{-19}} = 5$

185 **(d)**

X-rays are electromagnetic in nature so they remains unaffected in electric and magnetic field

186 **(a)**

$\lambda_{\text{min}} = \frac{12375}{V}\text{Å} \Rightarrow V = \frac{12375}{0.4125} = 30\ kV$

187 **(a)**

$$E = \frac{hc}{\lambda} \Rightarrow E \propto \frac{1}{\lambda}$$

$\Rightarrow$ $\frac{E'}{E} = \frac{400}{300} = 1.33$

But $E = eV_s, V_s$ being stopping potential. Thus, stopping potential for photoelectrons from a surface becomes approximately 1.0 V greater.

188 **(b)**

Energy possessed by a photon is given by

$$E = hv = \frac{hc}{\lambda}$$

If power of each photon is P then energy given out in t second is equal to Pt. Let the number of photons be n, then

$$n = \frac{Pt}{E} = \frac{Pt}{(hc/\lambda)} = \frac{Pt\lambda}{hc}$$

For red light, $n_R = \frac{Pt\lambda_R}{hc}$

For violet light, $n_V = \frac{Pt\lambda_V}{hc}$

$\therefore$ $\frac{n_R}{n_V} = \frac{\lambda_R}{\lambda_V}$

As $\lambda_R > \lambda_V$

So, $n_R > n_V$

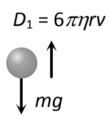
189 **(a)**

Mosley's law is $f = a(Z - b)^2$

191 **(c)**

In the absence of electric field ($i.e.$ E = 0)

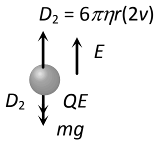
$mg = 6\pi\eta rv$



...(i)

In the presence of Electric field

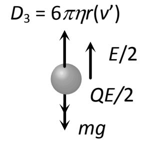
$mg + QE = 6\pi\eta r(2v)$



...(ii)

When electric field to reduced to $E/2$

$mg + Q(E/2) = 6\pi\eta r(v')$



...(iii)

After solving (i), (ii) and (iii)

We get $v' = \frac{3}{2}v$

193 **(c)**

Crystal structure is explored through the diffraction of waves having a wavelength comparable with the interatomatic spacing (10^{-10}m) in crystals. Radiation of larger wavelength cannot resolve the details of structure, while radiation of much shorter wavelength is diffracted through inconveniently small angles. Usually diffraction of X-rays is employed in the study of crystal structure as X-rays have wavelength comparable to interatomic spacing.

194 **(c)**

Linear momntum of an electron in n th orbit

$L = \frac{nh}{2\pi'}$

for $n = 2$ then $\quad L = \frac{h}{\pi}$

195 **(d)**

Current $\quad i = \frac{ne}{t}$

$\Rightarrow \quad \frac{n}{t} = \frac{i}{e} = \frac{3.2 \times 10^{-3}}{1.6 \times 10^{-19}} = 2 \times 10^6/\text{s}$

196 **(c)**

$\lambda = \frac{h}{\sqrt{2mE}} = \frac{h}{\sqrt{2m_\alpha Q_\alpha V}}$

On putting $Q_\alpha = 2 \times 1.6 \times 10^{-19}C$

$m_\alpha = 4m_p = 4 \times 1.67 \times 10^{-27}kg \Rightarrow \lambda = \frac{0.101}{\sqrt{V}}$Å

200 **(c)**

$m = \frac{m_0}{\sqrt{1 - v^2/c^2}} = \frac{m_0}{\sqrt{1 - (0.8c)^2/c^2}} = \frac{5m_0}{3}$

201 **(b)**

Number of photoelectrons emitted up to $t = 10\ sec$ are

$n = \frac{(\text{Number of photons/unit area/unit time}) \times (\text{Ar}}{10^6}$

$= \frac{1}{10^6}[(10)^{16} \times (5 \times 10^{-4}) \times (10)] = 5 \times 10^7$

At time $t = 10\ s$

Change on plate A; $q_A = +ne = 5 \times 10^7 \times 1.6 \times 10^{-19}$

$= 8 \times 10^{-12}C = 8\ pC$

and charge on plate, B; $q_B = 33.7 - 8 = 25.7\ pc$

Electric field between the plates

$E = \frac{(q_B - q_A)}{2\ \varepsilon_0 A} = \frac{(25.7 - 8) \times 10^{-12}}{2 \times 8.85 \times 10^{-12} \times 5 \times 10^{-4}}$

$= 2 \times 10^3 \frac{N}{C}$

202 **(b)**

The velocity of X-rays is always equal to that of light

203 **(c)**

$\lambda = \frac{h}{mv}$. Since v is increasing in case (i), but it is not changing in case (ii) hence, in the first case de-Broglie wavelength will change, but it second case, it remain the same

204 **(c)**

$W_0 \propto \frac{1}{\lambda} \Rightarrow \frac{\lambda_1}{\lambda_2} = \frac{(W_0)_2}{(W_0)_1} = \frac{4.5}{2.3} = \frac{2}{1}$

205 **(b)**

Energy of each photon $= \frac{hc}{\lambda}$

$= \frac{6.6 \times 10^{-34} \times 3 \times 10^8}{300 \times 10^{-9}}$

$= 6.6 \times 10^{-19}\ J$

Power of source is given by

$p = \text{intensity} \times \text{area}$

$= 1.0 \times 1.0 \times 10^{-4}\ W$

$= 10^{-4}W$

No. of photons per second

$= \frac{p}{e} = \frac{10^{-4}}{6.6 \times 10^{-19}}$

Now number of electron emitted

$= \frac{1}{100} \times \frac{10^{-4}}{6.6 \times 10^{-19}}$

$= 1.5 \times 10^{12}\ \text{s}^{-1}$

207 **(d)**

According to Einstein's photoelectric equation

$E = W_0 + K_{\max} \Rightarrow V_0 = \frac{hc}{e}\left[\frac{1}{\lambda} - \frac{1}{\lambda_0}\right]$

Hence if λ decreases V_0 increases

208 **(d)**

Given, $\quad m_\alpha = 6.4 \times 10^{-27}$kg

$q_\alpha = 3.2 \times 10^{-19}$ C, $E = 1.6 \times 10^5$ Vm^{-1}

Force on α-particle

$F = q_\alpha F = 3.2 \times 10^{-19} \times 1.6 \times 10^5$

$= 51.2 \times 10^{-15}$N

Now, acceleration of the particle

$$\alpha = \frac{F}{m_\alpha} = \frac{51.2 \times 10^{-15}}{6.4 \times 10^{-27}} = 0.8 \times 10^{13} \text{ ms}^{-2}$$

$\because$ Initial velocity, $u = 0$

$\therefore$ $v^2 = 2\alpha s$

$= 2 \times 8 \times 10^{12} \times 2 \times 10^{-2}$

$= 32 \times 10^{10}$

or $v = 4\sqrt{2} \times 10^5 \text{ms}^{-1}$

209 **(a)**

According to de-Broglie hypothesis

$$\lambda = \frac{h}{p}$$

Where, h is Planck's constant.

$\Rightarrow$ $p = \frac{h}{\lambda}$

Given, $h = 6.63 \times 10^{-34}$ J-s

$\lambda = 2\mu m = 2 \times 10^{-6}\ m$

$\therefore$ $p = \frac{6.63 \times 10^{-34}}{2 \times 10^{-6}}$

$=3.315\times 10^{-28}$ kg-ms^{-1}

210 **(c)**

$$\frac{e}{m} = \frac{E^2}{2VB^2} = \frac{(3.6 \times 10^4)^2}{2 \times 2.5 \times 10^3 \times (1.2 \times 10^{-3})^2}$$

$= 1.8 \times 10^{11} C/kg$

211 **(a)**

Intensity of light is inversely proportional to square of distance,

ie, $I \propto \frac{1}{r^2}$

or $\frac{I_2}{I_1} = \frac{(r_1)^2}{(r_2)^2}$

Given, $r_1 = 0.5$ m, $r_2 = 1.0$ m

Therefore, $\frac{I_1}{I_2} = \frac{(0.5)^2}{(1)^2} = \frac{1}{4}$

Now, since number of photoelectrons emitted per second is directly proportional to intensity, so number of electrons emitted would decrease by factor of 4.

212 **(b)**

From the graph stopping potential $|V_s| = -V$

Also $k_{max} = (|V_0|)eV = 4eV$

213 **(d)**

Millikan performed the pioneering oil-drop experiment for the precise measurement of the charge on the electron. He found that the charge on an oil-droplet was always an integral multiple of an elementary charge 1.602×10^{-19} C. This proved that charge is quantized.

214 **(b)**

$$\lambda = \frac{h}{\sqrt{2mE}} \Rightarrow \lambda \propto \frac{1}{\sqrt{E}} \Rightarrow \frac{\lambda_1}{\lambda_2} = \sqrt{\frac{E_2}{E_1}}$$

$$\Rightarrow \frac{10^{-10}}{0.5 \times 10^{-10}} = \sqrt{\frac{E_2}{E_1}} \Rightarrow E_2 = 4E_1$$

Hence added energy $= E_2 - E_1 = 3E_1$

215 **(c)**

In general X-rays have larger wavelength than that of gamma rays

216 **(c)**

When applied voltage is greater then enrgy of K-electron, continuous and all characteristic X-rays are emitted

217 **(d)**

The energy of X-ray photon is obtained from a coolidge tube by an electronic transition of target atom such as K_α line is obtained from transition from L orbit in K orbit

218 **(b)**

From Einstein's photoelectric effect concept the energy of these photons, for light of frequency ν is

$E = h\nu$

where h is Planck's constant.

Also, frequency $= \frac{\text{velocity}}{\text{wavelength}} = \frac{c}{\lambda}$

$\therefore$ $= \frac{hc}{\lambda}$

Energy of n photons is $E = \frac{nhc}{\lambda}$

Given, $E = 10^{-7}J, \lambda = 5000$ Å

$= 5000 \times 10^{-10}\ m$

$\Rightarrow$ $n = \frac{E\lambda}{hc}$

$= \frac{10^{-7} \times 5000 \times 10^{-10}}{6.6 \times 10^{-34} \times 3 \times 10^8}$

$= 2.5 \times 10^{11}$

219 **(b)**

$f = \frac{c}{\lambda} = \frac{c}{hc/E} = \frac{E}{h}$

$\therefore$ $f = \frac{1 \times 1.6 \times 10^{-13}}{6.6 \times 10^{-34}} = 2.4 \times 10^{20}$Hz

220 **(c)**

de-Broglie wavelength

Here $\lambda_e = \frac{h_c}{\sqrt{2m_e E}}$ and $\lambda_p = \frac{h_c}{\sqrt{2m_p E}}$

$$\frac{\lambda_e}{\lambda_p} = \sqrt{\frac{m_p}{m_e}}$$

221 **(a)**

Work function , $\phi = \frac{hc}{\lambda}$

$= \frac{6.6 \times 10^{-34} \times 3 \times 10^8}{3300 \times 10^{-10}} = 6.0 \times$

10^{-19}J

$$=\frac{6.0\times10^{-19}}{1.6\times10^{-19}}\text{ eV} = 3.75\text{ eV}$$

222 **(c)**

KE $= h\nu - h\nu_0$

$= 8\text{ eV} - \left(\frac{6\times10^{-34}\times1.6\times10^{15}}{1.6\times10^{-19}}\text{ eV}\right)$

= 8-6= 2 eV

223 **(d)**

Stopping potential depends upon the energy of photon

224 **(a)**

Because X-rays are electromagnetic (Neutral) in nature

225 **(b)**

$$\lambda_0 = \frac{12375}{W_{0(eV)}} = \frac{12375}{2} = 6187.5\text{Å} \simeq 620\ nm$$

226 **(a)**

As $q\ v\ B = mv^2/r$

or $m = \frac{qBr}{v} = \frac{(2\times1.6\times10^{-19})\times1\times1}{1.6\times10^{7}}$

$$= 2\times10^{-26}\text{kg} = \frac{2\times10^{26}}{1.66\times10^{-27}} = 12$$

Therefore, particle must be c^{++}

227 **(d)**

In photovoltaic cells photoelectric current produced is proportional to the intensity of incident light, so statement A is false.

The velocity of photoelectrons depends upon the maximum kinetic energy of photoelectrons, which depends on the frequency and hence on the wavelength of incident radiation, so statement B is true.

228 **(c)**

$$\lambda = \frac{h}{\sqrt{2mQV}} \Rightarrow \lambda \propto \frac{1}{\sqrt{mQ}} \Rightarrow \frac{\lambda_p}{\lambda_\alpha} = \sqrt{\frac{m_\alpha Q_\alpha}{m_p Q_p}}$$

$$= \sqrt{\frac{4m_p\times 2Q_p}{m_p\times Q_p}} = 2\sqrt{2}$$

229 **(c)**

The energy of X-ray photon, $E = \frac{hc}{\lambda}$

$$= \frac{6.6\times10^{-34}\times3\times10^{8}}{1\times10^{-10}}\text{ J} = \frac{1.98\times10^{-15}}{1.6\times110^{-19}}$$

$= 12.3$ keV

230 **(c)**

$$E = \frac{hc}{\lambda} \Rightarrow \frac{E_1}{E_2} = \frac{\lambda_2}{\lambda_1} \Rightarrow \frac{3.32\times10^{-19}}{E_2} = \frac{4000}{6000}$$

$\Rightarrow E_2 = 4.98\times10^{-19}J = 3.1\ eV$

231 **(b)**

The average energy of Planck oscillator is

$$\frac{h\nu}{(e^{hc/kT}-1)}$$

232 **(d)**

In a discharge tube ionization of enclosed gas is produced due to collisions between negative electrons and neutral atoms/molecules

233 **(d)**

$E \propto \frac{1}{\lambda}$; also $\lambda_{\text{infrared}} > \lambda_{\text{visible}}$ so $E_{\text{infrared}} < E_{\text{visible}}$

234 **(c)**

Einstein's photoelectric equation is given by

$$h\nu = h\nu_0 + \phi = h\nu_0 + eV$$

$$\Rightarrow \quad \nu = \nu_0 + \frac{eV_0}{h}$$

$$= (6\times10^{14}) + \frac{(1.6\times10^{-19})(3)}{(6.4\times10^{-34})}$$

$$= 13.5\times10^{14}\text{ s}^{-1}$$

235 **(d)**

$$p = \frac{h\nu}{c} \Rightarrow \nu = \frac{pc}{h} = \frac{3.3\times10^{-29}\times3\times10^{8}}{6.6\times10^{-34}}$$

$$= 1.5\times10^{13}Hz$$

236 **(c)**

Comparing Einstein's equation $K_{\max} = h\nu - h\nu_0$, with $y = mx + c$, we get slope, $m = h$

237 **(c)**

The saturation photocurrent (i) depends on intensity (I) of light *ie,*

$$i \propto I.$$

So, when intensity changes, the saturation current also changes. Hence the statement I false.

The maximum kinetic energy depends upon the frequency of light. So, the kinetic energy is doubled when frequency is doubled.

So, statement II is true.

238 **(b)**

Given, $E = 100\ eV = 100\times1.6\times10^{-19}$J

and $h = 6.662\times10^{-34}$J

$$E = h\nu$$

$$\nu = \frac{E}{h} = \frac{100\times1.6\times10^{-19}}{6.662\times10^{-34}}$$

$$= 0.24\times10^{17} = 2.4\times10^{16}\ Hz$$

239 **(a)**

$$\lambda = \frac{h}{mv} = \frac{h}{\sqrt{2mE}} \therefore E = \frac{h^2}{2m\lambda^2}$$

λ is same for all, so $E \propto \frac{1}{m}$. Hence energy will be maximum for particle with lesser mass

240 **(d)**

$$E_k = \frac{hc}{\lambda} - \frac{hc}{\lambda_0} = hc\left[\frac{\lambda_0 - \lambda}{\lambda_0\lambda}\right]$$

241 **(a)**

With the increase in potential difference between anode and cathode energy of striking electrons increases which in turn increses the energy (penetration power) of X-rays

242 **(a)**

If all of the kinetic energy carried by an electron is converted into radiation, the energy of the X-rays photon would be given by

$$E_{\max} = h\nu_{\max} = eV$$

Where h is Planck's constant, $\nu_{\max}$ the largest frequency, e charge of an electron and V the applied voltage.

This maximum energy or minimum wavelength is called the Duane-Hunt limit.

$\therefore \quad h\nu_{\max} = \frac{hc}{\lambda_{\min}} = eV$

$\Rightarrow \quad \lambda_{\min} = \frac{hc}{eV}$

243 **(b)**

Here, $\Delta v = \frac{0.005\times50}{100} = 0.0025\text{ms}^{-1}$

$\Delta x = \frac{h}{m\Delta v}$

$= \frac{1.034 \times 10^{-34}}{9.1 \times 10^{-31} \times 0.0025} = 4634 \times 10^{-5}\text{m}$

244 **(c)**

Given, $\quad \lambda = \frac{h}{mv} = \frac{h}{\sqrt{2mKE}}$

$\Rightarrow \quad KE = \frac{1}{2m\lambda^2}$

As λ is same for both electron and photon

So, $\quad KE \propto \frac{1}{m}$

Hence, kinetic energy will be maximum for particle with lesser mass, *ie*, electron.

245 **(c)**

For a charged particle in magnetic field $B, r = mv/qB$. The radius can be fixed for a charged particle if v and B both are fixed

246 **(a)**

Photoelectric current $(I) \propto$ Intensity of incident light and intensity $\propto \frac{1}{(\text{distance})^2}$

So, $I \propto \frac{1}{(\text{distance})^2}$. Hence $I' = I\left(\frac{1}{4}\right)^2 = \frac{I}{16}$

247 **(c)**

$\lambda_0 = \frac{hc}{W_0} = \frac{12400}{4} = 3100\text{Å} = 310\ nm$

248 **(d)**

By law of conservation of linear momentum

$$m_1v_1 = m_2v_2$$

So, $\quad m_1v_1 = m_2v_2$

Now, de-Broglie wavelength $\lambda = \frac{h}{mv}$

$\therefore \quad \frac{\lambda_1}{\lambda_2} = \frac{m_2v_2}{m_1v_1}$

$$\lambda_1 : \lambda_2 = 1 : 1$$

249 **(c)**

In the condition of no deflection $\frac{e}{m} = \frac{E^2}{2VB^2} \Rightarrow$ If m is increased by 208 times than B should be increased $\sqrt{208} = 14.4$ times

250 **(a)**

Given $\ k = 1.38 \times 10^{-23}\ \text{JK}^{-1}$

The energy of proton gas $=4.14 \times 10^{-14}$ J

$E = \frac{3}{2}kT$

$4.14 \times 10^{-14} = \frac{3}{2} \times 1.38 \times 10^{-23} \times T$

$T = 2 \times 10^9$ K.

251 **(c)**

$eV_0 = h\nu - h\nu_0$

$\therefore$ Threshold frequency,

$$\nu_0 = \nu - \frac{eV_0}{h}$$

$$= \frac{c}{\lambda} - \frac{eV_0}{h}$$

$\therefore \quad \nu_0 = \frac{3\times10^8}{2\times10^{-7}} - \frac{1.6\times10^{-19}\times2.5}{6.6\times10^{-34}}$

$$= 9.0 \times 10^{14}\ Hz$$

252 **(b)**

According to Bohr's quantisation of angular momentum

$$mvr = \frac{nh}{2\pi}$$

Or $\quad \frac{h}{mv} = \frac{2\pi r}{n} \quad ..(i)$

de-Broglie wavelength

$$\lambda = \frac{h}{mv} \quad ..(ii)$$

From Eqs. (i) and (ii), we get

Wavelength $\lambda = \frac{2\pi r}{n}$

$$= \frac{2\times\pi\times0.53\ \text{Å}}{1} = 3.33\text{Å}$$

253 **(d)**

Given, $K_{\max}$ =3 eV

$$h = 4.125 \times 10^{-15}\text{eV}$$

$$h\nu = K_{max} + W$$

$$4.125 \times 10^{-15} \times 10^{15} = 3 + W$$

or $\quad 4.125 = 3 + W$

or $\quad W = 1.125$

The threshold frequency

$$\nu_0 = \frac{W}{h}$$

$$\nu_0 = \frac{1.125}{4.125\times10^{-15}}$$

$$\nu_0 = \frac{1.125\times10^{15}}{4.125}$$

$$\nu_0 = 2.72 \times 10^{14}$$

254 **(c)**

$E = eV = h\nu_{\max} \Rightarrow \nu_{\max} = \frac{eV}{h}$

255 **(b)**

$\Delta p = \frac{\hbar}{\Delta x} = \frac{1.034 \times 10^{-34}}{10^{-10}}$

$= 1.034 \times 10^{-24}$ kg − ms^{-1}

256 **(c)**

It was found that when voltage applied to X-ray tube is changed, positions of spectral lines remain unchanged. However, when a different material is used as a target in X-ray tube, an entirely different set of spectral lines is obtained. Thus, the energy of characteristic X-ray is a consequence of transition in target atoms.

257 **(a)**

Momentum of striking electrons $p = \frac{h}{\lambda}$

∴ Kinetic energy of striking electrons

$$K = \frac{p^2}{2m} = \frac{h^2}{2m\lambda^2}$$

This is also, maximum energy of X-ray photons.

Therefore, $\frac{hc}{\lambda_0} = \frac{h^2}{2m\lambda^2}$

Or $\lambda_0 = \frac{2m\lambda^2 c}{h}$

258 **(d)**

$E = W_0 + K_{\max}; E = \frac{12375}{3000} = 4.125\ eV$

$\Rightarrow K_{\max} = E - W_0 = 4.125\ eV - 1\ eV = 3.125\ eV$

$\Rightarrow \frac{1}{2} m v_{\max}^2 = 3.125 \times 1.6 \times 10^{-19} J$

$\Rightarrow v_{\max} = \sqrt{\frac{2 \times 3.125 \times 1.6 \times 10^{-19}}{9.1 \times 10^{-31}}}$

$= 1 \times 10^6 m/s$

260 **(b)**

If intensity of X-ray is decreased by dI, when it passes through a length dx of absorbing material then, the amount of observed intensity is $\mu I\ dx$

Thus, $-dI = \mu I\ dx$ or $\frac{dI}{dx} + \mu I = 0$

On solving this equation $I = I_0 e^{-\mu x} = I_0 e^{-\mu d}$ $[x = d]$

262 **(a)**

According to Einstein's theory of photoelectric effect a single incident photon ejects a single electrons. Therefore, when intensity increases, the number of incident photons increases, so number of ejected electrons increases, hence, photocurrent increases.

263 **(d)**

Peaks on the graph represent characteristic X-ray spectrum. Every peak has a certain wavelength, which depends upon the transition of electron inside the atom of the targe. While $\lambda_{\min}$ depends upon the accelerating voltage [As $\lambda_{\min} \propto 1/V$]

264 **(b)**

The graph between stopping potential and frequency is a straight line, so stopping potential and hence, maximum kinetic energy of photoelectrons depends linearly on the frequency.

265 **(b)**

A cathode should have following properties

1. **Low work function** The substance selected as cathode should have low work function, so that electron emission takes place by applying small amount of heat energy, *ie*, at low temperature.

2. **High melting point** As electron emission takes place at very high temperatures (> 1500^0C) therefore the substance used as a cathode should have high melting point.

266 **(c)**

$v \propto (Z - b)^2 \Rightarrow v = a(Z - b)^2$

$Z =$ atomic number of element (a, b are constant)

267 **(a)**

By using $\lambda_{electron} = \frac{h}{m_e v} \Rightarrow v = \frac{h}{m_e \lambda_e}$

$= \frac{6.6 \times 10^{-34}}{9.1 \times 10^{-31} \times 10^{-10}} = 7.25 \times 10^6 m/s$

268 **(b)**

$\lambda_0 = \frac{c}{v_0} = \frac{3 \times 10^8}{5 \times 10^{14}} = 6 \times 10^{-7} m = 6000$ Å

270 **(d)**

$E = h\nu = hc/\lambda = mc^2$, hence $\lambda = h/mc = h/p$

271 **(c)**

KE of photoelectrons increases with increase in frequency of the incident light and is independent of the intensity of incident light.

Photoelectrons are emitted if the wavelength of the incident light is less than threshold wavelength, as $\phi_0 = \frac{hc}{\lambda_0}$

Photoelectric emission is an instantaneous process photoelectrons may not be emitted from a gas with ultraviolet light if the work function of that gas is large than the energy UV light

272 **(b)**

$\lambda_{\text{photon}} = \frac{hc}{E}$

and $\lambda_{\text{electron}} = \frac{h}{\sqrt{2mE}}$

$$\Rightarrow \qquad \frac{\lambda_{\text{photon}}}{\lambda_{\text{electron}}} = c\sqrt{\frac{2m}{E}}$$

$$\Rightarrow \qquad \frac{\lambda_{\text{photon}}}{\lambda_{\text{electron}}} \propto \frac{1}{\sqrt{E}}$$

273 **(c)**

Number of waves $= \frac{10^{-3}}{4000\times10^{-10}} = 0.25 \times 10^4$

274 **(d)**

From $E = W_0 + \frac{1}{2}mv_{\text{max}}^2$

$\Rightarrow 2hv_0 = hv_0 + \frac{1}{2}mv_1^2 \Rightarrow hv_0 = \frac{1}{2}mv_1^2$ ... (i)

and $5hv_0 = hv_0 + \frac{1}{2}mv_2^2 \Rightarrow 4hv_0 = \frac{1}{2}mv_2^2$ ...(ii)

Dividing equation (ii) by (i) $\left(\frac{v_2}{v_1}\right)^2 = \frac{4}{1}$

$\Rightarrow v_2 = 2v_1 = 2 \times 4 \times 10^6 = 8 \times 10^6 m/s$

275 **(c)**

$$\frac{\lambda_e}{\lambda_p} - \frac{\frac{h}{m_eV}}{\frac{h}{m_pV}} = \frac{m_p}{m_e}$$

$$= \frac{1.67 \times 10^{-27}}{9.1 \times 10^{-31}}$$

$= 0.18 \times 10^4 = 1836$

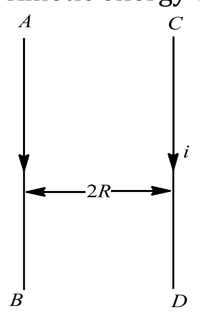
276 **(b)**

$$\lambda_0 = \frac{12375}{6.825} = 1813 \text{ Å} = 1800\text{Å}$$

277 **(b)**

Momentum of photon, $p = \frac{h}{\lambda}$

Kinetic energy of photon of mass M,



$$K = \frac{p^2}{2M}$$

or $$K = \frac{h^2}{2M\lambda^2}$$

278 **(c)**

Energy of a photon $E = \frac{hv}{\lambda}$; E is less if λ is longer

279 **(b)**

Peak of K_α in greater than peak of K_β line

280 **(b)**

For $\phi = 90^0$, $\cos\phi = 0$

So, $\lambda' = \lambda + \frac{h}{m_ec}$

$= 0.140\times 10^{-9} + \frac{6.63\times10^{-34}}{(9.1\times10^{-31})(3\times10^8)}$

$= (0.140 \times 10^{-9} + 2.4 \times 10^{-12})$ m = 0.142 nm

281 **(b)**

$E_k = E - \phi_0 = 6.2 - 4.2 = 2.0\text{eV}$

$= 2.0 \times 1.6 \times 10^{-19} = 3.2 \times 10^{-19}$ J

282 **(c)**

A photon is a particle which has zero charge and zero mass and is denoted by γ. The energy of photon is

$$E = hv$$

Here, v = frequency and h = Planck's constant. The momentum of photon is h/v and its velocity is the velocity of light (c).

So, the charge is not the property of photons.

283 **(a)**

Interatomic spacing in a crystal acts as a diffraction grating

284 **(d)**

$$\lambda = \frac{12375}{(40 \times 10^3)} = 0.309\text{Å} \approx 0.31\text{Å}$$

285 **(c)**

$$v = \sqrt{\frac{2eV}{m}}$$

Since e, and m are constant, $\frac{v_1}{v_2} = \sqrt{\frac{V_1}{V_2}}$

or $$v_2 = v_1\sqrt{\frac{V_1}{V_2}} = 3.2 \times 10^7 \sqrt{\frac{5824}{2912}}$$

$=4.525 \times 10^7 \text{m/s}$

286 **(d)**

$$W_0 = hv_0 \Rightarrow v_0 = \frac{W_0}{h} = \frac{2.51 \times 1.6 \times 10^{-19}}{6.6 \times 10^{-34}}$$

$= 6.08 \times 10^{14}$ *Cycles/s*

287 **(a)**

Momentum of photon $p = \frac{E}{c}$

$\Rightarrow$ Velocity of photon $c = \frac{E}{p}$

288 **(b)**

$E = 3\text{eV} = 3 \times 1.6 \times 10^{-19}$ J

$$\lambda = \frac{h}{\sqrt{2mE}}$$

$$= \frac{6.6 \times 10^{-34}}{\sqrt{2 \times 1.7 \times 10^{-27} \times 3 \times 1.6 \times 10^{-19}}}$$

$= 1.65 \times 10^{-11}$m

289 **(d)**

In Thomson's mass spectrograph $\vec{E}||\vec{B}$

290 **(d)**

Retarding potential $V_0 = \frac{h}{e}(v - v_0)$

291 **(d)**

$$\lambda_{\min} = \frac{hc}{eV} = \frac{6.6 \times 10^{-34} \times 3 \times 10^{8}}{1.6 \times 10^{-19} V} = \frac{12375}{V}$$

$$\approx \frac{12400}{V} \text{Å}$$

294 **(b)**

$\frac{QV}{l} - \frac{4}{3}\pi r^3 \rho g$

and

$\frac{Q'V'}{l} = \frac{4}{3}\pi(2r)^3 \rho g$

So, $\frac{Q'V'}{QV} = 8$

or $Q' = \frac{8QV}{V'} = 8Q \times \frac{800}{3200} = 2Q$

295 **(c)**

Maximum KE of the emitted photoelectrons

$= hv - hv_0$

296 **(b)**

The potential difference across the filament and target determines the energy and hence the penetrating power of X-rays

297 **(b)**

In equilibrium,

$$qE = mg$$

Also, $E = \frac{V}{d}$ and $q = ne$

$\therefore \quad ne \times \frac{V}{d} = mg$

$\Rightarrow \quad n = \frac{mgd}{eV}$

Given, $m = 1.8 \times 10^{-14}$ kg, $g = 10 \text{ms}^{-2}$,
$d = 0.9$ cm $= 0.9 \times 10^{-2}$ m,
$e = 1.6 \times 10^{-19}$ C,
$V = 2000$ V

$\therefore \quad n = \frac{1.8 \times 10^{-14} \times 10 \times 0.9 \times 10^{-2}}{1.6 \times 10^{-19} \times 2000}$

$n = \frac{81}{16} \approx 5$ electrons

298 **(b)**

$qE = mg$

or $E = \frac{mg}{q} = \frac{(50\times10^{-6})\times9.8}{5\times10^{-6}} = 98 \text{ NC}^{-1}$

Since the force due to electric field on charged particle should be opposite to the gravity pull and charge on the drop is negative, hence the electric field must act vertically downwards

299 **(d)**

$\lambda = \frac{h}{p} \Rightarrow \lambda = \frac{h}{mv}$

$r = \frac{mv}{qB} \Rightarrow mv = qrB \Rightarrow (2e)(0.83 \times 10^{-2})\left(\frac{1}{4}\right)$

$\lambda = \frac{6.6 \times 10^{-34} \times 4}{2 \times 1.6 \times 10^{-19} \times 0.83 \times 10^{-12}} \Rightarrow \lambda = 0.01$ Å

300 **(a)**

$4 \times 10^3 = 10^{20} \times hf$

$f = \frac{4\times10^3}{10^{20}\times6.023\times10^{-34}}$

$f = 6.64\times 10^{16}$ Hz

The obtained frequency lies in the band of X-rays.

301 **(c)**

$\lambda_{\min} = \frac{hc}{eV(\text{energy})}$; when KE (or eV) increases, λ decreases

302 **(a)**

$E = hv = h.\frac{v}{\lambda} \Rightarrow E \propto v$ [h and λ are constant]

$\frac{E_{ele.}}{E_{photon}} = \frac{v_{ele.}}{C(\text{velocity of light})}$

303 **(a)**

$E_k = \frac{hc}{\lambda} - \phi_0(\text{in eV})$

$= \frac{6.6 \times 10^{-34} \times 3 \times 10^{8}}{5000 \times 10^{-10} \times 1.6 \times 10^{-19}} - 1.9$

$= 2.48 - 1.9 = 0.58$ eV

304 **(d)**

Greater the number of electrons striking the anode, larger is the number of X-ray photons emitted

305 **(a)**

From $\lambda_0 = \frac{12375}{W_0}$

The maximum wavelength of light required for the photoelectron emission, $(\lambda_0)_{Li} = \frac{12375}{2.3} =$ 5380Å

Similarly $(\lambda_0)_{Cu} = \frac{12375}{4} = 3094$ Å

Since the wavelength 3094 Å does not in the visible region, but it is in the ultraviolet region. Hence to work with visible light, lithium metal will be used for photoelectric cell

306 **(a)**

Stopping potential is that negative potential for which photo electric current is zero

307 **(a)**

Number of photons emitted per sec,

$n = \frac{\text{Power}}{\text{Energy of photon}} = \frac{P}{hv}$

$= \frac{10000}{6.6 \times 10^{-34} \times 880 \times 10^{3}} = 1.72 \times 10^{31}$

308 **(c)**

Speed of photon is $3 \times 10^8 m/s$ in vacuum

309 **(c)**

$E = \frac{12375}{4000} = 3.09\ eV$ Photoelectrons emit if energy of incident light > work function

310 **(b)**

The energy of photon is

$$E = h\nu = \frac{hc}{\lambda}$$

Hence, energy of radio photon is

$$E = 6.6 \times 10^{-34} \times 2 \times 10^5 \text{ J}$$

$$\left(\because \nu = \frac{c}{\lambda} = \frac{3\times10^8}{1500} = 2 \times\right.$$

105 Hz

$\therefore \quad E = 1.32 \times 10^{-28}$ J

311 **(a)**

By changing the filament current with the help of rheostat, thermionic emission intensity of X-rays can be changed

312 **(b)**

$\frac{1}{2}mv_1^2 = 2\phi_0 - \phi_0 = \phi_0$ and $\frac{1}{2}mv_2^2 = 10\phi_0 - \phi_0 = 9\phi_0$

$$\therefore \frac{v_1}{v_2} = \sqrt{\frac{\phi_0}{9\phi_0}} = \frac{1}{3}$$

314 **(b)**

$$v = \frac{E}{B} = \frac{20}{0.5} = 40\ m/sec$$

315 **(c)**

The length of Crooke's dark space will be equal to the length of tube *ie*,15cm

316 **(c)**

Momentum, $p = mv = h/\lambda$

or $v = \frac{h}{m\lambda} = \frac{6.62\times10^{-34}}{9.1\times10^{-31}\times5.2\times10^{-7}}$

$= 1.4 \times 10^3 \text{ ms}^{-1} = 1400 \text{ ms}^{-1}$

317 **(b)**

Stopping potential does not depend on the relative distance between the source and the cell

318 **(b)**

$hc/\lambda = 10^3$ eV ...(i)

$h\nu = 10^6$eV ...(ii)

Dividing Eq.(ii) by Eq. (i) we get, $\nu = 10^3 c/\lambda$

$= 10^3 \times 3 \times 10^8/1.24 \times 10^{-9} = 2.4 \times 10^{20}$Hz

319 **(d)**

In equilibrium

$eE = mg$

$$E = \frac{mg}{e} = \frac{9.75 \times 10^{-15} \times 10}{30 \times 10^{-16}}$$

$= 32.5 \text{ Vm}^{-1}$

320 **(a)**

Intensity of X-rays depends upon the number of electron striking the target

321 **(b)**

$I_1 > I_2$ (given) $\Rightarrow i_1 > i_2$ [$\because i \propto I$]

and stopping potential does not depend upon intensity. So its value will be same (V_0)

322 **(c)**

A charged particle is deflected by electric and magnetic fields. If the cathode rays is deflected by electric and magnetic fields then this is the strong argument for the particle nature of cathode rays.

323 **(c)**

Using $\lambda = \frac{h}{\sqrt{2mE}} = \frac{h}{\sqrt{2mqV}} \Rightarrow \lambda \propto \frac{1}{\sqrt{mq}}$

$\Rightarrow \frac{\lambda_\alpha}{\lambda_p} = \sqrt{\frac{m_p q_p}{m_\alpha q_\alpha}} \because q_\alpha = 2q_p, m_\alpha = 4m_p, \lambda_p = \lambda$

[Given]

$$\Rightarrow \lambda_\alpha = \frac{\lambda}{2\sqrt{2}}$$

324 **(a)**

$\lambda = \frac{h}{p} = \frac{h}{\sqrt{2qVm}}$ *or* $\lambda \propto \frac{1}{\sqrt{qm}}$

$\frac{\lambda_p}{\lambda_\alpha} = \sqrt{\frac{q_\alpha}{q_p}.\frac{m_\alpha}{m_p}} = \sqrt{\frac{(2)(4)}{(1)(1)}}$=2.828

The nearest integer is 3.

326 **(c)**

$$W_0 = \frac{hc}{\lambda_0} = \frac{6.625 \times 10^{-34} \times 3 \times 10^8}{5000 \times 10^{-10}} J$$

$$= 4 \times 10^{-19} J$$

327 **(a)**

$\lambda_{X-ray} < \lambda_{UV-ray}$

328 **(c)**

$K = Q.V = 1e \times 1\ Volt = 1eV$

329 **(d)**

$q\ v\ B = mv^2/r$ or $mv = q\ r\ B$.

330 **(a)**

$$V_{\max} = \frac{12400 \times 10^{-10}}{10^{-11}} = 124kV \Rightarrow v < 124kV$$

331 **(a)**

e/m of the anode rays depend on the nature of the gas filled in the discharge tube

332 **(a)**

$$K_p = E_p - \phi_p = \frac{1240}{550} - 2.0 = 0.2545 \text{ eV}$$

$$K_q = E_q - \phi_q = \frac{1240}{450} - 2.5 = 0.255 \text{ eV}$$

$$K_r = E_r - \phi_r = \frac{1240}{350} - 3.0 = 0.543\text{eV}$$

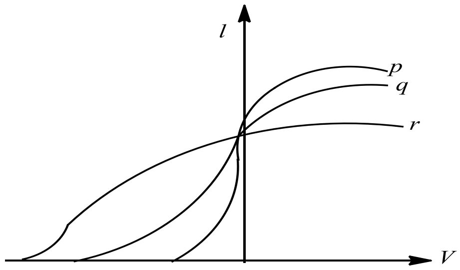
In the above equation K represents maximum kinetic energy of photoelectrons and E, the energy of incident right.

From the above values we can see that stopping potential,

$$|V_r| > |V_q| > |V_p|$$

Further, their intensities are equal, but energy of individual photon r is maximum. Hence, number of photons incident (per unit area per unit time) of r can be assumed to be least. Hence, saturation

current of r should be minimum.
Keeping these points in mind no option seems to be correct. The correct graph is shown below



∴ No choice is correct.

334 **(b)**

From Einstein's photoelectric equation the maximum kinetic energy of photoelectrons emitted from metal surface is E_K and W is work function, then

$$E_K = hv - W$$

If v_0 is threshold frequency, then

$$W = hv_0$$

∴ $E_K = hv - hv_0 = h(v - v_0)$

From the above equation, it is clear that maximum kinetic energy of electron will increases almost linearly with increase in the frequency of the incident light.

335 **(b)**

$$eV = \frac{1}{2}mv^2 \Rightarrow v^2 = \frac{2eV}{m} \Rightarrow v = \sqrt{\frac{2eV}{m}}$$

337 **(d)**

On the basis of dual nature of light, Lious de-Broglie suggested that the dual nature is not only of light, but each moving material particle has the dual nature. He assumed a wave to be associated with each moving material particle which is called the matter wave. The wavelength of this wave is determined by the momentum of the particle. If p is the momentum of the particle, the wavelength of the wave associated with it is

$$\lambda = \frac{h}{p}$$

Where h is Planck's constant.
Since, it is given that , alpha, beta and gamma rays carry same momentum, so they
will have same wavelength.

341 **(b)**

Work function is given by

$$\phi = \frac{hc}{\lambda}$$

or $$\phi \propto \frac{1}{\lambda}$$

∵ $$\frac{\phi_1}{\phi_2} = \frac{\lambda_2}{\lambda_1} = \frac{600}{300} = \frac{2}{1}$$

342 **(b)**

If v is the velocity attained by electron, then

$$\frac{1}{2}mv^2 = eV$$

$$v = \sqrt{\frac{2eV}{m}}$$

343 **(d)**

In 1905, Einstein explainedthe phenomenon of photoelectric effect on the basis of Planck's quantum theory. According to which light travels in the form of small bundles or packets of energy called quanta or photons. Newton's corpuscular theory explained, the rectilinear propagation of light. Wave nature of light was used to explain the interference effect of light. Bohr's gave a detailed theory explaining the structure of atom.

345 **(d)**

The cut-off voltage or stopping potential measure maximum kinetic energy of the electron. It depends on the frequency of incident light whereas the current depends on the number of photons incident. Hence, cut-off voltage will be 0.5 V. Now by inverse square law,

$$12 \propto \frac{1}{(0.2)^2} \text{ or } I \propto \frac{1}{(0.4)^2}$$

∴ $$\frac{I}{12} = \frac{(0.2)^2}{(0.4)^2} = \frac{1}{4}$$

or $$I = \frac{12}{4} = 3\text{mA}$$

346 **(b)**

$$\lambda \propto \frac{1}{Z^2} \Rightarrow \frac{c}{v} \propto \frac{1}{Z^2} \Rightarrow v \propto Z^2$$

347 **(a)**

$$\frac{1}{2}mv^2 = hv - \phi_0 = hv - hv_0$$

For minimum kinetic energy of emitted photoelectron,

$$v = v_0$$

$$\therefore \frac{1}{2}mv^2 = 0$$

348 **(c)**

$$\lambda = \frac{h}{mv} \Rightarrow \lambda \propto \frac{1}{m}$$

349 **(c)**

Using $Z^2 = k\left(\frac{q}{m}\right)y$; where $k = \frac{B^2LD}{E}$

For parabolas to coincide in the two photographs, the $\frac{kq}{m}$ should be same for the two cases

Thus, $\frac{B_1^2 LDe}{E_1 m_1} = \frac{B_2^2 LD(2e)}{E_2 m_2}$

$\Rightarrow \frac{m_1}{m_2} = \left(\frac{B_1}{B_2}\right)^2 \times \left(\frac{E_2}{E_1}\right) \times \frac{1}{2} = \frac{9}{4} \times \frac{2}{1} \times \frac{1}{2} = \frac{9}{4}$

350 **(b)**

The kinetic energy acquired by the particle is

$$KE = q\Delta V$$

Where q is charged and ΔV the change is potential difference.

Given, $q = e = 1.6 \times 10^{-19}$ C

$\Delta V = V_2 - V_1 = 70 - 50 = 20$ V

$\therefore$ $KE = 1.6 \times 10^{-19} \times 20 = 3.2 \times 10^{-18}$J

352 **(d)**

Photoelectric effect supports quantum nature of light because

1. There is minimum frequency of light below which no photoelectrons are emitted.

2. Maximum kinetic energy of photoelectrons depends only on the frequency of light and not on its intensity.

3. Even when metal surface is fainthy illuminated the photoelectrons leave the surface immediately.

353 **(c)**

$E = ev = hv_{\text{max}} = \frac{hc}{\lambda_{\text{min}}} \Rightarrow \lambda_{\text{min}} = \frac{hc}{eV}$

354 **(b)**

X-rays have high energy. They penetrate into the solid crystal and are used to find out the internal structure

355 **(b)**

$K_{\text{particle}} = \frac{1}{2} mv^2$ also $\lambda = \frac{h}{mv}$

$\Rightarrow K_{\text{particle}} = \frac{1}{2}\left(\frac{h}{\lambda v}\right).v^2 = \frac{vh}{2\lambda}$ ... (i)

$K_{\text{photon}} = \frac{hc}{\lambda}$ ... (ii)

$\therefore \frac{K_{\text{particle}}}{K_{\text{photon}}} = \frac{v}{2c} = \frac{2.25 \times 10^8}{2 \times 3 \times 10^8} = \frac{3}{8}$

356 **(d)**

Target should be of high atomic number and high melting point

357 **(a)**

$W_{0(eV)} = \frac{12375}{6500\text{Å}} = 1.9eV = 2eV$

358 **(c)**

De broglie wave length $\lambda = \frac{h}{mv}$

As both particle and electron having same wave length therefore their momentum will be equal

$m_p\, v_p = m_e v_e \Rightarrow v_p = \frac{m_e v_e}{m_p}$

$= \frac{9.1 \times 10^{-31} \times 3 \times 10^6}{10^{-6}}$

$\Rightarrow v_p = 2.7 \times 10^{-18}\, m/s$

359 **(a)**

Refer to threshold frequency

360 **(c)**

Let E_1 and E_2 be the KE of photoelectrons for incident light of frequency v and $2v$ respectively.

Then $hv = E_1 + \phi$ and $h2v = E_2 + \phi_0$

So, $2(E_1 + \phi_0) = E_2 + \phi_0$ or $E_2 = 2E_1 + \phi_0$

It means the KE of photoelectron becomes more than double

361 **(b)**

$E_k = eV = hv - \phi_0$

or $V = \frac{h}{e}\, v - \frac{\phi_0}{\text{e}}$

Slope of straight line between V and v is

$\frac{h}{e}$ $h = e \times$ slope of straight line.

362 **(a)**

Binding energy, $W = \frac{hc}{\lambda} - E$;

Where $E = R/\alpha$; Here, $\lambda = 4.9 \times 10^{-10} m$

$R_1 = 1.4cm, R_2 = 2.02cm$; $\alpha = 1cm/keV$

For cloud chamber, the range-energy relation is

$R = \alpha E$ or $E = R/\alpha$

$\therefore E_1 = \frac{R_1}{\alpha} = \frac{1.40}{1} = 1.40keV$

and $E_2 = \frac{R_2}{\alpha} = \frac{2.02}{1} = 2.02keV$

Energy of the incident photon

$hv = \frac{hc}{\lambda} = \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{4.9 \times 10^{-10}} J = 2.54\ keV$

From Einstein's Photoelectric equation

$hv = W + E$

$\therefore$ Binding energy, $W = hv - E$

$\Rightarrow W_1 = 2.54 - 1.40 = 1.14\ keV$

and $W_2 = 2.54 - 2.02 = 0.52\ keV$

363 **(a)**

de-Broglie wavelength

$\lambda = \frac{h}{mv}$ *or* $\lambda \propto \frac{1}{m}$

$\therefore$ $\lambda_e \propto \frac{1}{m}$, $\lambda_\alpha \propto \frac{1}{m_\alpha}$ *and* $\lambda_p \propto \frac{1}{m_p}$

As we know that $m_e < m_p < m_\alpha$

So, $\lambda_e > \lambda_p > \lambda_\alpha$

Or $\lambda_e > \lambda_\alpha$ or $\lambda_p > \lambda_\alpha$ or $\lambda_e > \lambda_p$

364 **(c)**

Specific charge on proton $=\left(\frac{e}{m}\right)_p$

$= 9.6 \times 10^7 \text{Ckg}^{-1}$ specific charge on $\propto$-particle,

$\left(\frac{q}{m}\right)_\propto = \frac{2e}{4m} = \frac{1}{2}\left(\frac{e}{m}\right)_p = \frac{1}{2} \times 9.6 \times 10^7$

$= 4.8 \times 10^7 \text{ Ckg}^{-1}$

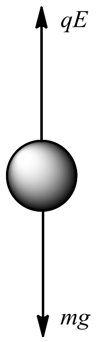
365 **(b)**

$a = \frac{F}{m}$

$= \frac{qE}{m}$

$= \frac{mg}{\text{m}}$

$\text{g} = 10 \text{ ms}^{-2}$



366 **(d)**

$E = W_0 + K_{\text{max}}$. From the given data E is 6.78 eV (for $\lambda = 1824$ Å) or 10.17 eV [for $\lambda = 1216$ Å]

$\therefore W_0 = E - K_{\text{max}} = 6.78 - 5.3 = 1.48\ eV$

or

$W_0 = 10.17 - 8.7 = 1.47\ eV$

367 **(a)**

$P = 2 \times 10^{-3}$ W

Energy of photon,

$E = hv$

$= 6.6 \times 10^{-34} \times 6 \times 10^{14}$ J

Where h being Planck's constant.

Number of photons emitted per second

$n = \frac{p}{E}$

$= \frac{2 \times 10^{-3}}{6.6 \times 10^{-34} \times 6 \times 10^{14}} = 5 \times 10^{15}$

368 **(a)**

Using Einstein's equation, $V_0 = \left(\frac{h}{e}\right)v - \frac{W_0}{e}$

Comparing this equation with $y = mx + c$

We get intercept on $-V_0$ axis $= \frac{W_0}{e}$

$\Rightarrow OB = \frac{W_0}{e} \Rightarrow W_0 = OB \times e$

369 **(a)**

$$eV = \frac{hc}{\lambda} = \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{1.5 \times 10^{-10}}$$

$$\Rightarrow V = \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{1.6 \times 10^{-19} \times 1.5 \times 10^{-10}} = 8280\ Volt$$

370 **(c)**

$E = \frac{1}{2}mv^2$

or $v = \sqrt{\frac{2E}{m}}$

$q\,v\,B = \frac{mv^2}{r}$

or $r = \frac{mv}{qB} = \frac{m}{qB} \times \sqrt{\frac{2E}{m}} = \frac{\sqrt{2Em}}{qB}$

or $r \propto \frac{\sqrt{m}}{q}$

$\frac{r_1}{r_2} = \left(\frac{m_{\text{He}}}{m_0}\right)^{1/2} \times \left(\frac{q_0}{q_{\text{He}}}\right)$

$= \left(\frac{4}{16}\right)^{1/2} \times \left(\frac{2e}{e}\right) = 1$

$= r_1 = r_2$

371 **(c)**

$E = \frac{1}{2}mv^2$ or $v^2 = 2E/m$;

If E' is the intensity of electric field applied then

$E'q = mv^2/r$

or $r = mv^2/E'q$

or $r = \frac{m(2E/m)}{E'q} = \frac{2}{q}\frac{E}{E'}$

$ie, r \propto 1/q$

so $\frac{r_e}{r_p} = \frac{e}{e} = 1\ \ ie, r_e = r_p$

372 **(b)**

For one second, distance = Velocity = $3 \times 10^4 m/sec$ and $Q = i \times 1 = 10^{-6} C$. Charge density $= \frac{\text{Charge}}{\text{Volume}}$

$= \frac{10^{-6}}{3 \times 10^4 \times 0.5 \times 10^{-6}} = 6.6 \times 10^{-5} C/m^3$

373 **(a)**

Saturation current is proportional to intensity while stopping potential increases with increase in frequency. Hence,

$v_a = v_b$ while $I_a < I_b$

374 **(a)**

The deflection suffered by charged particle in an electric field is

$y = \frac{qELD}{mu^2} = \frac{qELD}{p^2/m}\ \ [p = mu]$

$\Rightarrow y \propto \frac{qm}{p^2} \Rightarrow y_p : y_d : y_\alpha = \frac{q_p m_p}{p_p^2} : \frac{q_d m_d}{p_d^2} : \frac{q_\alpha m_\alpha}{p_\alpha^2}$

Since $p_\alpha = p_d = p_p$ [Given]

$m_p : m_d : m_\alpha = 1 : 2 : 4$ and $q_p : q_d : q_\alpha = 1 : 1 : 2$

$\Rightarrow y_p : y_d : y_\alpha = 1 \times 1 : 1 \times 2 : 2 \times 4 = 1 : 2 : 8$

375 **(b)**

$$\lambda_{k\alpha} \propto \frac{1}{(Z-1)^2} \Rightarrow \frac{\lambda_{Ni}}{\lambda_{Co}} = \left(\frac{Z_{Co}-1}{Z_{Ni}-1}\right)^2 = \left(\frac{27-1}{28-1}\right)^2$$

$$\Rightarrow \lambda_{Ni} = \left(\frac{26}{27}\right)^2 \times \lambda_{Co} = \left(\frac{26}{27}\right)^2 \times 179 = 165.9\, pm$$

$$< 179 pm$$

376 **(d)**

From Einstein equation $E = W_0 + \frac{1}{2}mv^2$

$$\sqrt{\frac{2(E-W_0)}{m}} = v$$

and a charged particle placed in uniform magnetic field experience a force

$$F = \frac{mv^2}{r} \Rightarrow evB = \frac{mv^2}{r} \Rightarrow r = \frac{mv}{eB}$$

$$\Rightarrow r = \frac{\sqrt{2m(E-W_0)}}{eB}$$

377 **(c)**

Cathode rays are composed of electrons, when they move in electric field a force

$$F = eE \quad ...(i)$$

Acts on them, this provides the necessary centripetal force to the particles

$$F = \frac{mv^2}{r} \quad ...(ii)$$

From Eqs. (i) and (ii), we get

$$eE = \frac{mv^2}{r}$$

$$\Rightarrow \quad r = \frac{mv^2}{eE} = \frac{m(10^6)^2}{e(300)} \quad ...(iii)$$

When velocity is doubled same circular path is followed, hence radius is same

$$r = \frac{m(2\times10^6)^2}{eE} \quad ...(iv)$$

Equating Eqs. (iii) and (iv), we get

$$m \times \frac{(10^6)^2}{300e} = \frac{m\times(2\times10^6)^2}{eE}$$

$$\Rightarrow \quad E = 300 \times 4 = 1200 \text{ V-cm}^{-1}$$

378 **(c)**

$$E(eV) = \frac{12375}{1.65} = 7500eV = 7.5\, keV$$

379 **(a)**

The wavelength of blue light is 4800Å, so material will emit photoelectrons when it is illuminated with light from a 40 W blue lamp.

380 **(a)**

$$p = \frac{hv}{c} = \frac{6.6\times10^{-34}\times1.5\times10^{13}}{3\times10^8}$$

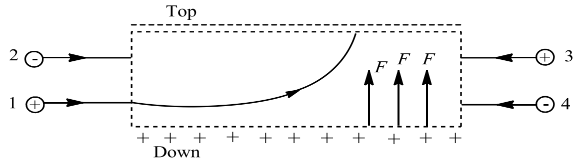
$$= 3.3\times10^{-29} kg - m/s$$

381 **(b)**

Positive rays were discovered by Goldstein

383 **(a)**

The figure shows the path of a +ve charged particle (1) through a rectangular region of uniform electric field.



Since, +ve charged particle moves as a parabolic path in electric field. It means the direction of electric field is upward. The direction of deflection of particle (2) which is –ve is downward. The direction of deflection of particle (3) which is +ve is upward and direction of deflection of particle (4) is downward.

384 **(a)**

Particle is photon and it travels with the velocity equal to light in vacuum

385 **(b)**

Kinetic energy is given by

$$K = \frac{1}{2}mv^2 = \frac{p^2}{2m} \qquad (\because p = mv)$$

$$\Rightarrow \quad p = \sqrt{2mK} ...(i)$$

Again de-Broglie wavelength is given by

$$\lambda = \frac{h}{p} ...(ii)$$

Substituting for p from Eq. (i) into Eq. (ii), we have

$$\lambda = \frac{h}{\sqrt{2mK}}$$

$$\Rightarrow \quad K = \frac{h^2}{2m\lambda^2}$$

Given, $h = 6.6\times10^{-34}$J-s, $m = 9.1\times10^{-3}$ kg

$\lambda = 0.3$ nm$=0.3\times10^{-9}$ m

$$\therefore \quad K = \frac{(6.6\times10^{-34})^2}{2\times9.1\times10^{-31}\times(0.3\times10^{-9})^2}$$

$$= \frac{26.6\times10^{-19}}{1.6\times10^{-19}} eV = 16.6 eV$$

388 **(b)**

From relation $\lambda = \frac{h}{\sqrt{2mqV}}$ or $\lambda \propto \frac{1}{\sqrt{mq}}$

Hence, $\frac{\lambda_p}{\lambda_\alpha} = \sqrt{\frac{m_\alpha}{m_p}\times\frac{q_\alpha}{q_p}}$

$$= \sqrt{\frac{4m_p\times2e}{m_p\times e}} = \sqrt{8}$$

389 **(d)**

Light consists of photons and cathode rays consists of electrons. However both effect the photographic plate

391 **(d)**

$$E = hv = mc^2 \Rightarrow m = \frac{hv}{c^2}$$

392 **(a)**

de-Broglie wavelength associated with a moving particle

$$\lambda = \frac{h}{mv}$$

Or $$\lambda = \frac{h}{p}$$

Where p is momentum of the particle.

393 **(a)**

Here, $u = 0, a = qE/m; s = l$ and $v = ?$

As $v^2 = u^2 + 2as$; so $v^2 = 0 + 2\frac{qEl}{m}$

or $v = \frac{\sqrt{2qEl}}{m}$

394 **(c)**

From Einstein's photoelectric equation, we have

$$E_k = hv - W$$

Where E_k is maximum kinetic energy of photoelectrons and W the work function $(=hv_0)$.

$\therefore$ $E_k = h(v - v0$ ...(i)

Where v_0 is threshold frequency.

For $hv' = 2hv$

$\therefore$ $2E_k = 2h(v - v_0)$ ...(ii)

From Eqs. (i) and (ii), we observe that kinetic energy of emitted electron will become more than doubled.

395 **(d)**

Nucleus of heavy atom captures electron of K-orbit. This is a radioactive process, so vacancy of this electron is filled by an outer electron and x-rays are produce

396 **(a)**

For an accelerating voltage V, the maximum X-ray photon energy is given by

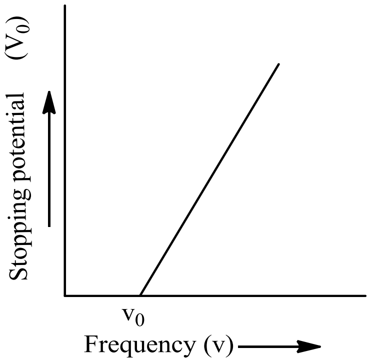
$$hv_{\text{max}} = eV$$

Also, $\gamma = \frac{c}{\lambda} = \frac{\text{velocity of light}}{\text{wavelength}}$

$$\therefore \quad \lambda_{\text{min}} = \frac{\text{ch}}{\text{eV}} = \frac{3 \times 10^8 \times 6.63 \times 10^{-34}}{1.6 \times 10^{-19} \times 40 \times 10^3}$$
$$= 0.31 \times 10^{-10} \text{ m} \approx 0.31 \text{ A}$$

397 **(d)**

The emission of photoelectron takes place only, when the frequency of the incident light is above a certain critical value, characteristic of that metal. The critical value of frequency is known as the threshold frequency for the metal of the emitting electrode.



Suppose that when light of certain frequency is incident over a metal surface, the photo-electrons are emitted. To take photoelectric current zero, a particular value of stopping potential will be needed. If we go on reducing the frequency of incident light, the value of stopping potential will also go on decreasing. At certain value of frequency v_0, the photoelectric current will become zero, even when no retarding potential is applied. This frequency v_0 corresponds to the threshold for the metal surface. The emission of photo-electrons does not take place, till frequency of incident light is below this value.

398 **(a)**

In 1927 at Bell Labs, Clinton Davisson and Lester Germer fined slow moving electrons at a crystalline nickel target. The angular dependence of the reflected electron intensity was measured and was determined to have the same difffraction pattern as those predicted by Bragg for X-rays. This experiment, proved the wave like nature of matter and completed the wave particle duality hypothesis, which was a fundamental step in quantum theory.

While Compton scattaering or Compton effect observed by Arthur Holly Compton in 1927, proved the particle nature of light.

400 **(a)**

$hv_0 = 6.2\ eV, \quad eV_0 = 5\ eV$

from Einstein's photoelectric equation

$$hv = hv_0 + eV_0 = 6.2 + 5$$
$$= 11.2\ eV$$

$$\Rightarrow \quad \frac{hc}{\lambda} = 11.2$$

$$\therefore \quad \lambda = \frac{hc}{11.2} = 1108.9\text{Å}$$

Which belongs to ultra-violet region.

401 **(c)**

$$\lambda \propto \frac{1}{p} \Rightarrow \frac{\Delta p}{p} = -\frac{\Delta\lambda}{\lambda} \Rightarrow \left|\frac{\Delta p}{p}\right| = \left|\frac{\Delta\lambda}{\lambda}\right|$$

$\Rightarrow \frac{p_0}{p} = \frac{0.25}{100} = \frac{1}{400} \Rightarrow p = 400\, p_0$

402 **(a)**

$E = hv = 6.6 \times 10^{-34} \times 10^{15} = 6.6 \times 10^{-19} J$

403 **(a)**

$|-4V| > |-2V|$

404 **(b)**

Required ionisation energy

$= \frac{hc}{\lambda} = \frac{6.6 \times 10^{-34} \times 3 \times 10^8}{1.54 \times 10^{-10}} J = 12.9 \times 10^{-16} J$

405 **(c)**

Light intensity $= 10^{-10} \text{W m}^{-2}$. So energy falling on area of point to be perceived

$= 10^{-10} \times 10^{-4} = nhc/\lambda$

or $n = \frac{10^{-14} \times 5.6 \times 10^{-7}}{6.6 \times 10^{-34} \times 3 \times 10^8} = 3 \times 10^4$

406 **(d)**

Because they are electromagnetic waves

407 **(a)**

Lorentz force is the force exerted on a charged particle in a electromagnetic field. The particle will experience force due to electric field qE, and due to magnetic field (B) is $q\text{v} \times \text{B}$.

$$F = qE + q\text{v} \times \mathbf{B} = qE + qv\, B \sin\theta$$

Where θ is angle between electric and magnetic field.

Since, the fields the parallel $\theta = 0$.

$\therefore F_m$ =force due to magnetic field is zero.

Hence, only electric force ($F_e = qE$) is exerted on the particle, so the particle move in a straight line with motion parallel to B.

408 **(d)**

The de-Broglie wavelength

$\lambda = \frac{hc}{E} = \frac{1240}{200 \times 10^6}$

$= 6.20 \times 10^{-6}$ nm = 6.20fm

409 **(a)**

Use Bragg's X-ray diffraction Law

$n\lambda = 2d \sin\theta$

$\therefore \lambda = \frac{2d \sin\theta}{n}$

For longest wavelength take $\sin\theta = 1$

$\therefore \lambda = \frac{2 \times 2.82 [\text{Å}]}{2} [\because n = 2 \text{ for second order}]$

$= 2.82$ Å

410 **(a)**

$E = \frac{12375}{\lambda} = \frac{12375}{5000} = 2.47\, eV = 2.5\, eV$

411 **(b)**

Force on the charged particle in magnetic field is

$\vec{\mathbf{F}} = q(v\hat{\mathbf{k}} \times B\hat{\mathbf{j}}) = qvB(\hat{\mathbf{k}} \times \hat{\mathbf{j}}) = qvB(-\hat{\mathbf{i}})$

412 **(b)**

When a high energy electron is incident on heavy metal, it produces X-rays

413 **(a)**

$\frac{1}{\lambda} \propto (Z-1)^2$

$\therefore \quad \frac{\lambda_1}{\lambda_2} = \left(\frac{Z_2 - 1}{Z_1 - 1}\right)^2$

or $\quad \frac{1}{4} = \left(\frac{Z_2 - 1}{11 - 1}\right)^2$

Solving this we get, $Z_2 = 6$

414 **(b)**

$2r = \frac{2mv}{qB} \Rightarrow 2r \propto \frac{m}{q} \Rightarrow \frac{m}{q}$ is maximum for C^+

415 **(b)**

Refer to the application of X-rays

416 **(c)**

Radius of circular path described by a charged particle in a magnetic field is given by

$r = \frac{\sqrt{2mK}}{qB}$; where K = Kinetic energy of electron $\Rightarrow K = \frac{q^2B^2r^2}{2m} = \left(\frac{e}{m}\right)\frac{eB^2r^2}{2}$

$= \frac{1}{2} \times 1.7 \times 10^{11} \times 1.6 \times 10^{-19} \times \left[\frac{1}{\sqrt{17}} \times 10^{-5}\right]^2 \times (1)^2$

$= 8 \times 10^{-20} J = 0.5\, eV$

By using $E = W_0 + K_{max}$

$\Rightarrow W_0 = E - K_{\max} = \left(\frac{12375}{2475}\right) eV - 0.5\, eV$

$= 4.5\, eV$

417 **(c)**

$v = \frac{E}{B}$; where $E = \frac{V}{d} = \frac{1000}{1 \times 10^{-2}} = 10^5 V/m$

$\Rightarrow v = \frac{10^5}{1} = 10^5 m/s$

418 **(d)**

Threshold wavelength $\lambda_0 = \frac{12375}{2.1} = 5892.8$ Å

419 **(c)**

In mass spectrograph, $\frac{Mv^2}{r} = qv\, B'$

and $qE = Bqv$ or $v = \frac{E}{B}$

or $r = \frac{Mv}{B'q} = \frac{M}{B'q}\left(\frac{E}{B}\right) = \frac{ME}{qBB'}$

so r is related with (q/M)

420 **(d)**

Electrostatic force on charged particle

$$F = qE$$

So, by Newton's law of motion

$$F = ma = qE \text{ or } a = \frac{qE}{m}$$

Velocity attained by particle $v = 0 + \frac{qE}{m} t$

So, kinetic energy $K = \frac{1}{2}mv^2$

$$K = \frac{1}{2}\frac{mq^2E^2}{m^2}\ t^2 = \frac{E^2q^2t^2}{2m}$$

421 **(b)**

From Einstein's photoelectric equation the maximum kinetic energy of photoelectrons emitted from metal surface is given by

$$E_k = hv_1 - W$$

Where W is work function of metal.

Given, $W = hv$ and $v_1 = 4v$

$\therefore \quad E_k = 4hv - hv = 3hv$

422 **(b)**

Threshold energy of A is

$$E_A = hv_A$$
$$= 6.6 \times 10^{-34} \times 1.8 \times 10^{14}$$
$$= 11.88 \times 10^{-20} J$$
$$= \frac{11.88\times10^{-20}}{1.6\times10^{-19}}\ eV$$
$$= 0.74\ eV$$

Similarly, $E_B = 0.91\ eV$

Since, the incident photons have energy greater than E_A but less than E_B.

So, photoelectrons will be emitted from metal A only.

423 **(b)**

Gained in KE $= q\ V = 2 \times 5 = 10$ eV

424 **(c)**

From Planck's hypothesis, the energy of a photon of frequency v is

$$E = hv = \frac{hc}{\lambda}$$

Where c is speed of light and λ the wavelength. In the visible part, red colour has maximum wavelength

$$\lambda = 8000\ \text{Å}$$

$$\therefore \quad E = \frac{6.6 \times 10^{-34} \times 3 \times 10^8}{8000 \times 10^{-10}}$$

Also, 1 eV= 1.6×10^{-19} J

$$\therefore \quad E = \frac{6.6 \times 10^{-34} \times 3 \times 10^8}{8000 \times 10^{-10} \times 1.6 \times 10^{-19}}$$
$$= 1.547 \text{ eV}$$

425 **(c)**

$$\frac{1}{2}mv^2 = eV$$

$$v = \sqrt{\frac{2eV}{m}} = \sqrt{2V \times \frac{e}{m}}$$

$$v = \sqrt{2 \times 0.91 \times 1.76 \times 10^{11}}$$
$$= 5 \times 10^5 \text{m/s}$$
$$= 500 \text{Km/s}$$

426 **(d)**

$$\frac{hc}{\lambda} = W_0 + \frac{1}{2}mv_{\max}^2$$

Assuming W_0 to be negligible in comparison to $\frac{hc}{\lambda}$

$i.e.\ v_{\max}^2 \propto \frac{1}{\lambda} \Rightarrow v_{\max} \propto \frac{1}{\sqrt{\lambda}}$

[On increasing wavelength λ to 4λ, $v_{\max}$ becomes half]

427 **(a)**

Wavelength of photon will be greater than that of electron because mass of photon is less than that of electron

$\Rightarrow \quad \lambda_{\text{ph}} > \lambda\text{el}$

428 **(c)**

As electron is moving parallel to both the fields, so magnetic force does not affect the electron's motion. But electric force (qE) acts opposite to motion of electron. Hence, electron will not be deflected but its speed decreases.

429 **(c)**

By using $I = \frac{P}{A}$; where P = radiation power

$$\Rightarrow P = I \times A \Rightarrow \frac{nhc}{t\lambda} = IA \Rightarrow \frac{n}{t} = \frac{IA\lambda}{hc}$$

Hence number of photons entering per sec the eye

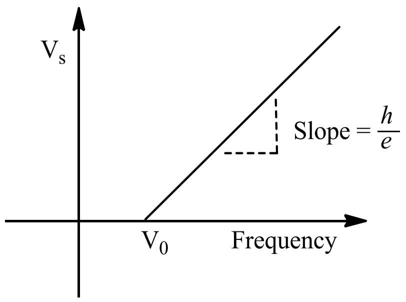
$$\left(\frac{n}{t}\right) = \frac{10^{-10} \times 10^{-6} \times 5.6 \times 10^{-7}}{6.6 \times 10^{-34} \times 3 \times 10^8} = 300$$

430 **(c)**

When light waves of differing frequencies are made incident on the same surface, the stopping potential (V_s) differ as is evidenced from Einstein's photoelectric equation given by

$$hv - hv_0 = eV_s$$

where h is Planck's constant, v, v_0 the frequencies and e the charge.



Hence, $V_s = \frac{hv}{e} - \frac{hv}{e}$ ...(i)

Comparing Eq. (i) with straight line equation

$$y = mx + c$$

$$\text{Slope } m = \frac{h}{e}$$

Where $h = 6.6 \times 10^{-34}\ Js, e = 1.6 \times 10^{-19}\ C.$

$$\therefore \quad m = \frac{6.6\times10^{-34}}{1.6\times10^{-19}} = 4.125 \times 10^{-15}$$

431 **(b)**

When the oil drop is falling freely under the effect of gravity is a viscous medium with terminal speed v, then

$mg = 6\pi \eta r v$ ...(i)

To move the oil drop upward with terminal velocity v if E is the electric field intensity applied, the

$Eq = mg + 6\pi\eta rv = mg + mg = 2mg$

So $E = 2\, mg/q$

432 **(b)**

From the given graph it is clear that if we extend the given graph for A and B, intercept of the line A on V axis will be smaller as compared to line B means work function of A is smaller than that of B

433 **(c)**

$\frac{1}{2}mv_{\max}^2 = \left[\frac{hc}{\lambda} - \phi_0\right]$ or $v_{\max}^2 = \frac{2}{m}\left[\frac{hc}{\lambda} - \phi_0\right]$

$= \frac{2}{9.1 \times 10^{-31}} \times \left[\frac{6.63 \times 10^{-34} \times 3 \times 10^8}{3.8 \times 10^{-7}} - 2.5 \times 1.6 \times 10^{-19}\right]$

$= 27.12 \times 10^{10}\,\mathrm{m^2s^{-2}}$

Now, $B = \frac{mv_{\max}}{eR_{\max}} = \frac{9.1\times10^{-31}\times5.21\times10^5}{1.6\times10^{-19}\times0.5}$

$= 6.32 \times 10^{-6}\,\mathrm{T}$

435 **(a)**

$\lambda_{\min} = \frac{hc}{eV} \Rightarrow \log.\lambda_{\min} = \log\frac{hc}{e} - \log V$

$\Rightarrow \log\lambda_{\min} = -\log V + \log\frac{hc}{e}$

This is the equation of straight line having slope (-1) and intercept $\log\frac{hc}{e}$ on $+\log_e \lambda_{\min}$ axis

437 **(b)**

The colour of the positive column in a discharge tube depends on the type of gas $e.g.$, for air, colour is purple red, for H_2 colour is Blue $e$tc

438 **(c)**

$v_{\max} \propto \frac{1}{\lambda_{\min}}$ Hard X-rays have high frequency and low wavelength

439 **(a)**

All the positive ions of same specific charge moving with different velocity lie on the same parabola

440 **(d)**

From Einstein's photoelectric equation

$$eV_0 = \frac{hc}{\lambda_0} - W_0$$

$$eV' = \frac{hc}{2\lambda_0} - W_0$$

Subtracting $e(V_0 - V') = \frac{hc}{\lambda_0}\left[1 - \frac{1}{2}\right] = \frac{hc}{2\lambda_0}$

or $V' = V_0 - \frac{hc}{2e\lambda_0}$

441 **(c)**

In discharge tube, the current is due to flow of positions ions and electrons. Moreover secondary emission of electrons is also possible. So, V $-I$ curve is non-linear, hence its resistance is non-ohmic.

443 **(b)**

$i = \frac{Q}{t} = \frac{ne}{t} = 1.8 \times 10^{14} \times 1.6 \times 10^{-19}$

$= 28.8 \times 10^{-6} A$

$= 29\, \mu A$

444 **(a)**

Penetrating power is greater for lower wavelength

445 **(a)**

The velocity of photoelectrons depends upon the frequency of the incident light

446 **(a)**

Here, No. of electrons

$n_e = 5 \times 10^7 \mathrm{cm^{-3}} = 5 \times 10^7 \times 10^6 \mathrm{m^{-3}}$

No. of positive ions, $n_p = 5 \times 10^7 \times 10^6$

$= 5 \times 10^{13} \mathrm{m^{-3}}$

$v = 0.4\mathrm{ms^{-1}}; J = 4 \times 10^{-6}\ \mathrm{Am^{-2}}; v_p =$? Use the relation

$J = n_e e\, v_e + n_p\, e\, v_p$ and solve it for v_p

$4 \times 10^{-6} = (5 \times 10^{13} \times 1.6 \times 10^{-19} \times 0.4) + (5 \times 10^{13} \times 1.6 \times 10^{-19} \times v_p)$

$v_p = \frac{4 \times 10^{-6} - 3.2 \times 10^{-6}}{8.0 \times 10^{-6}} = \frac{0.8 \times 10^{-6}}{8 \times 10^{-6}}$

$= 0.1\mathrm{ms^{-1}}$

447 **(c)**

Work required to move one electron (e) through a potential difference of 1 V, gives the unit of energy abbreviate as eV.

That is , Energy= eV

Given, $e = 1.6 \times 10^{-19}$ C, $V = 1$ volt

$\therefore$ Energy $= 1.6 \times 10^{-19} \times 1 = 1.6 \times 10^{-19}$ J

448 **(c)**

$eV_s = \frac{1}{2}mv_m^2$ or $V_s = \frac{mv_m^2}{2e} = \frac{v_m^2}{2(e/m)}$

$= \frac{(4.8)^2}{2 \times 17.6 \times 10^{11}} = 7 \times 10^{11}\ \mathrm{JC^{-1}}$

449 **(d)**

De Broglie wavelength, $\lambda = \frac{h}{p}$

Where p is the momentum of the particle

For electron $\lambda_e = \frac{h}{p_e}$

For proton $\lambda_p = \frac{h}{p_p}$

As $\lambda_e = \lambda_p$ [Given]

$\Rightarrow p_e = p_p$

Or Momentum of electron = Momentum of proton

450 **(b)**

The equation of curve between V_0 and v is

$\frac{hv}{e} - \frac{hv_0}{e} = V_0$

This is equation of a straight line with slope $= \frac{h}{e}$

451 **(c)**

Photoelectric current ∝ intensity of incident light. Therefore, the graph is a straight line having positive slope passing through origin

452 **(b)**

Continuous spectrum of X-rays consists of radiations of all possible wavelength range having a definite short wavelength limit

453 **(b)**

According to Bohr's theroy

$$mvr = \frac{nh}{2\pi}$$

$$2\pi r = \frac{nh}{mv}$$

$$2\pi r - n\lambda$$

For n=1, $\lambda = 2\pi r$

454 **(a)**

$E = W_0 + eV_0 \Rightarrow 4eV = 2eV + eV_0 \Rightarrow V_0 = 2\ volt$

455 **(b)**

$$E_k = \frac{hc}{e}\left(\frac{1}{\lambda} - \frac{1}{\lambda_0}\right) \text{(in eV)}$$

$$= \frac{6.6 \times 10^{-34} \times 3 \times 10^8}{1.6 \times 10^{-19}} \left(\frac{10^{10}}{1800} - \frac{10^{10}}{2300}\right)$$

$$= 1.5 \text{ eV}$$

456 **(c)**

The saturation photoelectric current is directly proportional to the intensity of incident radiation but it is independent of its frequency. Therefore, the saturation photoelectric current becomes double, when both intensity and frequency of the incident light are doubled

457 **(b)**

$$\Delta E = \frac{hc}{\lambda_1} - \frac{hc}{\lambda_2} = \frac{hc(\lambda_2 - \lambda_1)}{\lambda_1\lambda_2} \text{ (in eV)}$$

$$= \frac{6.62 \times 10^{-34} \times 3 \times 10^8 \times (5000 - 2500) \times 10^-}{2500 \times 5000 \times 10^{-20} \times 1.6 \times 10^{-19}}$$

$= 2.47$ eV

458 **(b)**

For ionisation, high energy electrons are required

460 **(b)**

According to Einstein's photo electric equation, Incident energy = work function + kinetic energy of emitted electron

$$hf = hf_0 + K$$

or $K = h(f - f_o)$

461 **(b)**

The wavelength of the γ-rays is shorter. However the main distinguishing feature is the nature of emission

462 **(a)**

From Planck's quantum theory, the maximum kinetic energy (E_k) of photoelectron emitted from the metal is

$$E_k = hv - W$$

Where W is work function of metal and hv is the energy of the photon absorbed by the metal.

Given, $hv = 2\ eV,\ W = 1.4\ eV$

$\therefore \quad E_k = 2 - 1.4 = 0.6\text{eV}$

Hence, stopping potential is , $V_s = \frac{E}{e} = \frac{0.6 \text{ eV}}{e} =$ 0.6 V.

463 **(a)**

Number of photo electrons

$(N) \propto \text{Intensity} \propto \frac{1}{d^2} \Rightarrow \frac{N_1}{N_2} = \left(\frac{d_2}{d_1}\right)^2$

$\Rightarrow \frac{N_1}{N_2} = \left(\frac{100}{50}\right)^2 = \frac{4}{1} \Rightarrow N_2 = \frac{N_1}{4}$

465 **(b)**

$v_{\max} = 4 \times 10^8\ cm/s = 4 \times 10^6\ m/sec$

$\therefore K_{\max} = \frac{1}{2}mv_{\max}^2 = \frac{1}{2} \times 9 \times 10^{-31} \times (4 \times 10^6)^2$

$= 7.2 \times 10^{-18} J = 45\ eV$

Hence, stopping potential $|V_0| = \frac{K_{\max}}{e} = \frac{45eV}{e} =$ $45volt$

466 **(b)**

$\lambda_{\min} = \frac{hc}{eV}$ where h, c and e are constants. Hence $\lambda_{\min} \propto \frac{1}{V}$

467 **(a)**

Time period of revolution of electron $T = \frac{2\pi}{\omega} = \frac{2\pi r}{v}$

Hence corresponding electric current $i = \frac{e}{T} = \frac{ev}{2\pi r}$

$\Rightarrow i = \frac{1.6 \times 10^{-19} \times 2 \times 10^6}{2 \times 3.14 \times 0.5 \times 10^{-10}} = 1mA$

469 **(d)**

$E = hv = mc^2$ or $m = hv/c^2$

470 **(d)**

Number of photoelectrons $\propto \frac{1}{(\text{Distance})^2}$

471 **(d)**

We know that, $\lambda = \frac{h}{\sqrt{2mkT}}$;

So, $\lambda \propto \frac{1}{\sqrt{T}}$

$\therefore \frac{\lambda_{27}}{\lambda_{927}} = \sqrt{\frac{927+273}{27+273}} = 2$

or $\lambda_{27} = 2\lambda_{927} = 2\lambda$

472 **(b)**

Using Einstein's realtion for relativistic mass

$m = \frac{m_0}{\sqrt{1-V^2/C^2}}$ [m_0 = rest mass]

$\Rightarrow \frac{m}{m_0} = \frac{1}{\sqrt{1-V^2/C^2}}$

Given $\frac{m}{m_0} = 2 = \frac{1}{\sqrt{1-V^2/C^2}}$

$\Rightarrow 1 - \frac{V^2}{C^2} = \frac{1}{4} \Rightarrow \frac{V^2}{C^2} = \frac{3}{4}$

$\Rightarrow \frac{V}{C} = \frac{\sqrt{3}}{2} \Rightarrow V = \frac{\sqrt{3}}{2}C$

473 **(c)**

KE of thermal neutron, $\frac{1}{2}mv^2 = \frac{3}{2}kT$

or $mv = \sqrt{3kmT}$; So, $\lambda = \frac{h}{p} = \frac{h}{\sqrt{3kmT}}$

474 **(b)**

$\frac{1}{\lambda_{K_\alpha}} = R(Z-b)^2\left[\frac{1}{1^2} - \frac{1}{2^2}\right]$

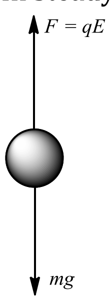
$\frac{1}{\lambda_{K_\beta}} = R(Z-b)^2\left(\frac{1}{1^2} - \frac{1}{3^2}\right)$

$\frac{\lambda_{K_\beta}}{\lambda_{K_\alpha}} = \frac{(3/4)}{(8/9)} = \frac{3}{4} \times \frac{9}{8} = \frac{27}{32}$

or $\lambda_{K_\beta} = \frac{27}{32} \times \lambda_{K_\alpha} = \frac{27}{32} \times 0.32 = 0.27$Å.

475 **(a)**

In steady state,



electric force on drop =weight of drop

$\therefore \qquad qE = mg$

$\Rightarrow \qquad q = \frac{mg}{E}$

$= \frac{9.9 \times 10^{-15} \times 10}{3 \times 10^4}$

$= 3.3 \times 10^{-18}$ C

476 **(c)**

Positive rays consist of positive ions

477 **(c)**

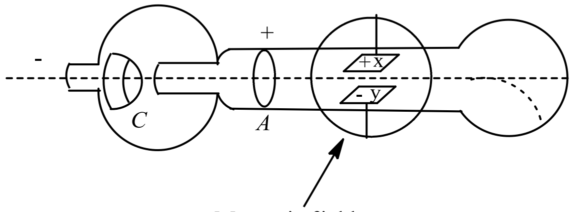
Energy of photon, $E = \frac{hc}{\lambda}$

$= \frac{6.6 \times 10^{-34} \times 3 \times 10^8}{3 \times 10^2}$

$= 6.6 \times 10^{-28}$J

478 **(c)**

In Thomson's experiment to determine the charge to mass ratio of an electron, his apparatus was as follows



A uniform magnetic field is created between X and Y, by applying a potential difference between them. In the same region and outside the tube is placed an electromagnet which produces a magnetic field perpendicular to the plane of paper. Thus, two fields are produced in the same region perpendicular to each other, also the two fields are perpendicular to the motion of electron.

479 **(d)**

Bragg's law, $2d\sin\theta = n\lambda$ or $\lambda = \frac{2d\sin\theta}{n}$

For maximum wavelength, $n_{\min} = 1, (\sin\theta)_{\max} = 1$

$\therefore \lambda_{\max} = 2d$ or $\lambda_{\max} = 2 \times 10^{-7} cm = 20$ Å

480 **(a)**

De-Broglie wavelength of a particle is given by

$\lambda = \frac{h}{mv}$ ...(i)

Where h is Planck's constant.

If kinetic energy of particle of mass m is v, then

$K = \frac{1}{2}mv^2$

$\Rightarrow \qquad v = \sqrt{\frac{2K}{m}}$...(ii)

Combining Eqs. (i) and (ii), we get

$\lambda = \frac{h}{m\sqrt{\frac{2K}{m}}} = \frac{h}{\sqrt{2mK}}$ ...(iii)

Given $\qquad m = 9.1 \times 10^{-31}$ kg

$K = 10\text{keV} = 10 \times 10^3 \times 1.6 \times 10^{-19}$ J

$h = 6.6 \times 10^{-34}$ J-s

Substituting the above values in Eq. (iii), we get

$\lambda = \frac{6.6 \times 10^{-34}}{\sqrt{2 \times 9.1 \times 10^{-31} \times 10 \times 10^3 \times 1.6 \times 10^{-19}}}$

$= 1.22 \times 10^{-11} \approx 0.12$Å

481 **(b)**

$\frac{1}{2}mv^2 = eV_0 = 1.68$ eV

$\Rightarrow \quad hv = \frac{hc}{\lambda} = \frac{1240 \text{ eV} - \text{nm}}{400 \text{ nm}}$

$= 3.1 = $ eV

$\Rightarrow \quad 3.1 \text{ eV} = W_0 + 1.6\text{eV}$

$W_0 = 1.42\text{eV}$

483 **(c)**

For K_α line $v \propto (Z-1)^2 \Rightarrow \lambda \propto \frac{1}{(Z-1)^2}$

i.e. the graph between λ and z will be (c)

484 **(a)**

$KE = eV = 1.6 \times 10^{-19} \times 100 = 1.6 \times 10^{-17}$ J

485 **(a)**

$\because x \propto \frac{1}{v^2}$. The ion whose deflection is less, its velocity will be more. From the curve $x_1 < x_2 < x_3 < x_4$, therefore $v_1 > v_2 > v_3 > v_4$

486 **(c)**

$eV = mv^2/r$; so $V \propto v^2$;

$\therefore \; V_2 = V_1 \left(\frac{v_2}{v_1}\right)^2 = 500\left(\frac{2v}{v}\right)^2 = 2000\text{V cm}^{-1}$

487 **(a)**

When **E**, **v** and **B** are all along same direction, then magnetic force experienced by electron is zero while electric force is acting opposite to velocity of electron, so velocity of electron will decrease.

488 **(a)**

As accelerating voltage V across X-rays tube increase, the value of minimum wavelength of X-rays, $\lambda_c = \frac{hc}{eV}$; decreases ; so the separation between λ_K and λ_c increases.

489 **(d)**

According to Mosley's law $v \propto (Z-b)^2$

For k_α line, $b = 1$, and it has maximum frequency so $v_{\max} \propto (Z-1)^2$

491 **(b)**

The momentum of the photon is energy/speed of light. In black holes the gravity pull is so high that even photons can't escape

492 **(c)**

If the intensity of light incident on photosensitive metal surface is changed it does not affect the maximum kinetic energy of the emitted electrons.

493 **(a)**

Energy of incident light $E(eV) = \frac{12375}{4000} = 3.09 \; eV$

Stopping potential is $-2V$ so $K_{\max} = 2 \; eV$

Hence by using $E = W_0 + K_{\max}$; $W_0 = 1.09 \; eV = 1.1 \; eV$

495 **(c)**

de- Broglie wavelength of electron is given by

$$\lambda = \frac{h}{mv} = \frac{h}{\sqrt{2mE}}$$

Substituting the value of E, we get

$$\lambda = \frac{h}{\sqrt{2meV}}$$

Here m=9.1×10^{-31} kg; $e = 1.6 \times 10^{-19}$C

and $\quad h = 6.6 \times 10^{-34}$Js

we get $\quad \lambda = \frac{12.27}{\sqrt{V}} \times 10^{-10} = \frac{12.27}{\sqrt{V}}$Å

The de-Broglie wavelength of electrons, when accelerated through a potential difference of 100 V will be

$$\lambda = \frac{12.27}{\sqrt{100}} = 1.227\text{Å}$$

Moreover, $\quad \lambda = \frac{h}{p}$

$\Rightarrow P = \frac{6.6 \times 10^{-34}}{1.227 \times 10^{-10}} = 5.5 \times 10^{-24}$ kg-ms^{-1}

496 **(a)**

$F = qE$

or $\quad ma = eE$

$\Rightarrow \quad a = \frac{qE}{m}$

or $\quad a = \frac{eE}{m}$ in the opposite direction of the field.

497 **(d)**

$E = hc/\lambda$ or $E \propto l/\lambda$; so $E_2 = E_1 \times \lambda_1/\lambda_2$

$= 3.2 \times 10^{-19} \times 6000/4000 = 4.8 \times 10^{-19}$ J

498 **(b)**

$$\frac{Power\ of\ S_2}{Power\ of\ S_1} = \frac{n_2\left(\frac{hc}{\lambda_2}\right)}{n_1\left(\frac{hc}{\lambda_1}\right)} = \frac{n_2\lambda_1}{n_1\lambda_2} = 1$$

499 **(b)**

For photoelectronic emission to take place wavelength of incident light must be less that the threshold value which is given as 5200Å.

The wavelength of infra-red light = 7800Å.

The wavelength of ultra-violet light = 4000Å.

Thus, it is obvious that wavelength of UV radiation is less than the threshold value. Hence, it can emit photoelectrons from the surface of metal.

500 **(c)**

$p = \frac{nhc}{\lambda t} \Rightarrow 100 = \frac{n \times 6 \times 10^{-34} \times 3 \times 10^8}{540 \times 10^{-9} \times 1} \Rightarrow n$

$= 3 \times 10^{20}$

501 **(c)**

Wave length of green light is threshold wave length. Hence for emission of electron, wave length of Indigo light < wavelength of green light

502 **(a)**

By using $\frac{hc}{\lambda} = W_0 + \frac{1}{2}mv^2$

$$\Rightarrow \frac{hc}{400 \times 10^{-9}} = W_0 + \frac{1}{2}mv^2 \quad ...(i)$$

and $\frac{hc}{250 \times 10^{-9}} = W_0 + \frac{1}{2}m(2v)^2 \quad ...(ii)$

On solving (i) and (ii)

$$\frac{1}{2}mv^2 = \frac{hc}{3}\left[\frac{1}{250 \times 10^{-9}} - \frac{1}{400 \times 10^{-9}}\right] \quad ...(iii)$$

From equation (i) and (iii) $W_0 = 2hc \times 10^6 J$

503 **(d)**

Number of ejected electrons ∝ (Intensity) $\propto \frac{1}{(\text{Distance})^2}$

Therefore an increment of distance two times will reduce the number of ejected electrons to $\frac{1}{4}th$ of the initial value

505 **(c)**

For similar parabola, $\frac{B^2 l Dq}{E\, m}$ must be same for both the ions.

So, $\frac{m_1}{m_2} = \left(\frac{B_1}{B_2}\right)^2 \times \left(\frac{q_1}{q_2}\right) \times \frac{E_2}{E_1} = \left(\frac{3}{2}\right)^2 \times \left(\frac{1}{2}\right) \times \left(\frac{2}{1}\right) = \frac{9}{4}$

506 **(b)**

Energy of photons corresponding to light of wavelength $\lambda_1 = 2475$ Å is $E_1 = \frac{12375}{2475} = 5\, eV$

and that corresponding to $\lambda_2 = 6000$ Å is

$$E_2 = \frac{12375}{6000} = 2.06\, eV$$

As $E_2 < W_0$ and $E_1 > W_0$. Photoelectric emission is possible with λ_1 only. Maximum kinetic energy of emitted photoelectrons $K = E - W_0 = 5 - 4.8 = 0.2\, eV$.

Photo electrons experience magnetic force and move along a circular path of radius

$$r = \frac{\sqrt{2mk}}{Q\, B} = \frac{\sqrt{2 \times 9 \times 10^{-31} \times 0.2 \times 1.6 \times 10^{-19}}}{1.6 \times 10^{-19} \times 3 \times 10^{-5}}$$

$= 0.05\, m = 5\, cm$

508 **(d)**

Cathode rays are steam of negatively charged particles, so they deflect in electric field

509 **(a)**

$$E = hv_0 + K_{\max} \Rightarrow h(4v_0) = hv_0 + K_{\max} \Rightarrow K_{\max} = 3hv_0$$

510 **(c)**

$$\lambda \propto \frac{1}{\sqrt{volt}}$$

511 **(b)**

$\frac{1}{2}mv_1^2 = 2hv_0 - hv_0 = hv_0$ and

$\frac{1}{2}mv_2^2 = 5hv_0 - hv_0 = 4\, hv_0$

So, $\frac{1}{2}mv_2^2 = 4 \times \frac{1}{2}mv_1^2$

or $v_2 = 2v_1 = 2 \times 4 \times 10^6 = 8 \times 10^6$ ms^{-1}

512 **(d)**

$$\frac{1}{2}mv^2 = \frac{hc}{\lambda} - \phi_0$$

$$= \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{(3 \times 10^{-7}) \times 1.6 \times 10^{-19}} - 1$$

$= 4.14 - 1 = 3.14$eV

or $v = \sqrt{\frac{2 \times 3.14 \times 1.6 \times 10^{-19}}{9.1 \times 10^{-31}}} = 10^6$ms^{-1}

513 **(b)**

Number of photoelectrons ∝ Intensity

Maximum kinetic energy is independent of intensity

514 **(b)**

G.P. Thomson experimentally confirmed the existence of matter waves (de-Broglie hypothesis)by demonstrating that electron beams are diffracted when they are scattered by the regular atomic arrays of crystals.

515 **(c)**

$E = \frac{hc}{\lambda}$ or $E \propto \frac{1}{\lambda}$ ∴ $\frac{E_2}{E_1} = \frac{\lambda_1}{\lambda_2}$

or $E_2 = E_1 \times \frac{\lambda_1}{\lambda_2} = 1.23 \times \frac{10{,}000}{5{,}000} = 2.46$ eV

Now, $hv - \phi_0 = \frac{1}{2}mv_{\max}^2 = eV_s$

or $\phi_0 = hv_2 - eV_s = E_2 - eV_s$

$= 2.46 - 1.36 = 1.10$ eV

516 **(c)**

Specific charge on electron,

$$\frac{e}{m} = 1.8 \times 10^{11} \text{ C Kg}^{-1}$$

Maximum kinetic energy of photoelectron

$$\frac{1}{2}mv_{\max}^2 = eV_s$$

Where V_s is the stopping potential.

$$\Rightarrow \quad V_s = \frac{mv_{\max}^2}{2e} = \frac{v_{\max}^2}{2(e/m)}$$

$$= \frac{(1.2 \times 10^6)^2}{2 \times 1.8 \times 10^{11}}$$

$$= 0.4 \times 10 = 4\text{V}$$

518 **(d)**

$$\frac{1}{2}mv^2 = \frac{hc}{\lambda} - \phi(\text{in eV})$$

$$= \frac{6.6 \times 10^{-34} \times 3 \times 10^8}{2000 \times 10^{-10} \times 1.6 \times 10^{-19}} - 4.2$$

$= 2\text{eV} = 2 \times 1.6 \times 10^{-19}$J

$v = \sqrt{2 \times 2 \times 1.6 \times 10^{-19}/9.1 \times 10^{-31}}$

$= \sqrt{6.4/9.1} = 10^6$ms^{-1}

519 **(c)**

In a cathode ray oscillograph the focusing of beam on the screen is achieved by electric potential. There are two plates X and Y. X plates consists two plates X_1 and X_2 in vertical plane while Y plates also consist two plates Y_1 and Y_2 in a horizontal plane. An electric is applied between the $X$and Yplates by an external source.

521 **(d)**

According to Einstein's photoelectric equation

$K_{\max} = hv - \phi_0$

$eV_s = \frac{hc}{\lambda} - \phi_0 \Rightarrow V_s = \frac{hc}{\lambda e} - \frac{\phi_0}{e}$

Where, $\lambda =$ Wavelength of incident light

$\phi_0 =$ Work function

$V_s =$ Stopping potential

According to given problem

$V_1 = \frac{hc}{\lambda e} - \frac{\phi_0}{e}$

$V_2 = \frac{hc}{\left(\frac{\lambda}{2}\right)e} - \frac{\phi_0}{e}$

$V_2 = \frac{2hc}{\lambda e} - \frac{\phi_0}{e} = \frac{2hc}{\lambda e} - \frac{2\phi_0}{e} + \frac{2\phi_0}{e} - \frac{\phi_0}{e}$

$= 2\left(\frac{hc}{\lambda e} - \frac{\phi_0}{e}\right) + \frac{\phi_0}{e}$

$V_2 = 2V_1 + \frac{\phi_0}{e}$ [Using (i)]

$\therefore V_2 > 2V_1$

522 **(b)**

If an electron and a photon propagates in the from of waves having the same wavelength, it implies that they have same momentum. This is according to de-Broglie equation, $p \propto \frac{1}{\lambda}$

523 **(c)**

$W_0(eV) = \frac{12375}{\lambda_0} \Rightarrow \lambda_0 = \frac{12375}{4.2} = 2945$ Å

524 **(b)**

In Milikan's experiment, the charges present on the oil drops are the integral multiples of electronic charge, so $2e$ and $10e(1.6 \times 10^{-18} C)$ charges are present

525 **(b)**

$\phi_0 = \frac{hc}{e\lambda_0}$ (in eV) $= \frac{6.6 \times 10^{-34} \times 3 \times 10^8}{6600 \times 10^{-10} \times 1.6 \times 10^{-19}}$

$= 1.87$ eV

527 **(c)**

If a charge particle of mass m and charge q is accelerated through a potential difference $V$and E is the energy acquired by the particle , then

$$E = qV$$

If $v$is velocity of particle, then

$$E = \frac{1}{2}mv^2$$

Or $$v = \sqrt{\left(\frac{2E}{m}\right)}$$

Now, de-Broglie wavelength of particle is

$$\lambda = \frac{h}{mv} = \frac{h}{m\sqrt{(2E/m)}}$$

Substituting the value of E, we get

$$\lambda = \frac{h}{\sqrt{2mqV}}$$

For electron, $\lambda_e = \frac{h}{\sqrt{2m_e eV}}$

For proton, $\lambda_p = \frac{h}{\sqrt{2m_p eV}}$

$\therefore$ $\frac{\lambda_e}{\lambda_p} = \sqrt{\left(\frac{m_p}{m_e}\right)}$

528 **(a)**

$v = E/B = 6 \times 10^4/8 \times 10^{-2} = 7.5 \times 10^5 \text{ms}^{-1}$

529 **(d)**

If electron oscillates with a frequency of 1 GHz, it does not radiate any energy which corresponds a definite wavelength. It only radiates when it jumps from one orbit to another orbit

530 **(c)**

The De-Broglie wavelength is

$\lambda = \frac{h}{|p|} = \frac{h}{|I|} \Rightarrow \lambda \propto \frac{1}{|I|}$

531 **(c)**

Work function is the intercept on $K.E.$ axis

$i.e.$ $2eV$

532 **(d)**

The photoelectric current is directly proportional to the intensity of illumination. Therefore a change in the intensity of the incident radiation will change the photocurrent also

533 **(a)**

The wave length of L_α line is given by

$\frac{1}{\lambda} = R(z - 7.4)^2\left(\frac{1}{2^2} - \frac{1}{3^2}\right)$

$\Rightarrow \lambda \propto \frac{1}{(Z - 7.4)^2}$

$\Rightarrow \frac{\lambda_1}{\lambda_2} = \frac{(z_2 - 7.4)^2}{(z_1 - 7.4)^2} \Rightarrow \frac{1.30}{\lambda_2} = \frac{(42 - 7.4)^2}{(78 - 7.4)^2}$

$\Rightarrow \lambda_2 = 5.41$ Å

534 **(b)**

$E = W_0 + K_{\max}$

$\Rightarrow hf = W_A + K_A$ ...(i)

and $2hf = W_B + K_B = 2W_A + K_B$ $\left[\because \frac{W_A}{W_B} = \right.$ *12* ...(ii)

Dividing equation (i) by (ii)

$\frac{1}{2} = \frac{W_A + K_A}{2W_A + K_B} \Rightarrow \frac{K_A}{K_B} = \frac{1}{2}$

535 **(d)**

According to Moseley's law, when $\sqrt{v}$ is plotted against Z, one gets a straight line. v is the frequency of the X-ray lines. $v \propto Z^2$ or $\sqrt{v} \propto Z$

536 **(c)**

When electron is accelerated through a potential difference of V volts, then

Kinetic energy $-eV$

ie. $\frac{1}{2}mv^2 = eV$

$\Rightarrow$ $v = \sqrt{\left(\frac{2eV}{m}\right)}$

$\therefore$ $v = \sqrt{\left(\frac{2\times1.6\times10^{-19}\times45.5}{9.1\times10^{-31}}\right)}$

$= 4\times10^6\ \text{ms}^{-1}$

537 **(a)**

$qV = \frac{1}{2}mv^2$ or $v = \frac{\sqrt{2qV}}{m}$

$ie, v = \frac{\sqrt{2qV}}{m}$ $\therefore$ $\frac{v_{He}}{v_H} = \sqrt{\frac{q_{He}}{q_H}\times\frac{m_H}{m_{He}}} = \sqrt{\frac{2e}{e}\times\frac{m}{4m}}$

$= \frac{1}{\sqrt{2}}$

538 **(d)**

$\lambda_{\min} = \frac{hc}{eV}$ or $\lambda_{\min} \propto \frac{1}{V}$ On increasing potential, $\lambda_{\min}$ decreases

539 **(a)**

From conservation of energy the electron kinetic energy equals the maximum photon energy (we neglect the work function ϕ because it is normally so small compared to eV_0).

$eV_0 = hv_{\max}$

or $eV_0 = \frac{hc}{\lambda_{\min}}$

$\therefore$ $V_0 = \frac{hc}{e\lambda_{\min}}$

or $V_0 = \frac{12400\times10^{-10}}{10^{-11}}$ =124 kv

Hence, accelerating voltage for electrons in X–ray machine should be less than 124 kv.

540 **(d)**

From the formula

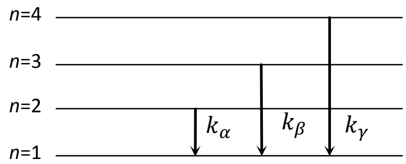
$V = \frac{12375}{\lambda_{\min}} = \frac{12375}{0.3094} = 39.99\ kV = 40\ kV$

541 **(d)**

According to Einstein's equation

$hv = hv_0 + K_{\max} \Rightarrow K_{\max} = hv - hv_0$ on comparing it with $y = mx + c$, it is clear that, this is the equation of straight line having positive slope (h) and negative intercept (hv_0) on KE axis

542 **(c)**



543 **(d)**

Penetration is directly proportional to the energy of radiations

544 **(d)**

de Broglie wavelength

$\lambda = \frac{h}{p} = \frac{h}{\sqrt{2mE}} \Rightarrow \lambda \propto \frac{1}{\sqrt{Em}}$

Now kinetic energy E gained by a charged particle under potential V is $E = qV$ given V is same for the given three paticles

$\therefore E_e = eV; E_p = eV$

$E_\alpha = 2eV \Rightarrow E_e = E_p < E_\alpha$ and $m_e < m_p < m_\alpha$

$\Rightarrow \lambda = \frac{h}{\sqrt{2m_eE_e}} > \frac{h}{\sqrt{2m_pE_p}} > \frac{h}{\sqrt{2m_\alpha E_\alpha}}$

$\lambda_e > \lambda_p > \lambda_\alpha$

545 **(c)**

Energy of photon $E = \frac{hc}{\lambda}$ (Joules) $= \frac{hc}{e\lambda}(eV)$

$\Rightarrow \frac{E}{(eV)} = \frac{6.6\times10^{-34}\times3\times10^8}{1.6\times10^{-19}\times\lambda_{(m)}\text{Å}} = \frac{12375}{\lambda(\text{Å})}$

$\Rightarrow E(keV) = \frac{12.37}{\lambda(\text{Å})} = \frac{12.4}{\lambda}$

546 **(c)**

By using $E = W_0 + K_{\max}$

$E = \frac{12375}{5000} = 2.475\ eV$ and $K_{\max} = eV_0 = 1.36\ eV$

So $2.475 = W_0 + 1.36 \Rightarrow W_0 = 1.1\ eV$

547 **(b)**

Light falling per second on the surface of sphere

$E = \frac{66}{100}\times100 = 66$ W

Momentum of the light falling per second on the surface of sphere $= \frac{E}{c}$

Momentum of the reflected light = 0; as the light is completely absorbed.

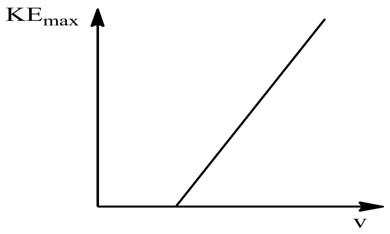
Force exerted by light, $F = \frac{E}{c} - 0 = \frac{E}{c}$

Pressure on surface, $P = \frac{F}{4\pi r^2} = \frac{E/c}{4\pi r^2}$

$= \frac{66/(3\times10^8)}{4\times(22/7)\times(0.10)^2} = 1.75\times10^{-6}$Pa

548 **(c)**

According to Einstein's photoelectric equation



$$KE_{\max} = hv - \phi_0$$

Comparing with the equation of straight line

$$y = mx + c$$

We get, slope of graph $= h$

549 **(b)**

In photoelectric effect for a given photosensitive material, there exists a certain minimum cut-off frequency, called the thershold frequency, below which no emission of photoelectrons takes place no matter how intense the light is.

551 **(d)**

Since the energy of incident electron, $E = 80$ keV. The minimum wavelength of X-rays produced is

$$\lambda = \frac{hc}{E} = \frac{6.6 \times 10^{-34} \times 3 \times 10^8}{80 \times 1000 \times 1.6 \times 10^{-19}}$$

$= 1.55 \times 10^{-10}$ m $= 0.155$ Å

Since the energy of K-shell electron is -72.5 keV, so the incident electron of energy 80 keV will not only produce continuous spectrum of minimum wavelength 0.155Å but shell also knock electron of K shell out of atom, resulting emission of characteristics X-rays

552 **(c)**

$$\lambda = \frac{h}{mv} = \frac{h}{\sqrt{2meV}}$$

$$= \frac{6.6 \times 10^{-34}}{\sqrt{2 \times (4 \times 1.66 \times 10^{-27}) \times (2 \times 1.6 \times 10^{-19}) \times V}}$$

$$= \frac{0.101}{\sqrt{V}}$$

553 **(b)**

In an electric field, a force opposite to the direction of electric field acts on negatively charged particles ($i.e.$ from lower potential to higher potential)

554 **(c)**

Range of X-rays is 0.1Å to 100 Å

555 **(c)**

We know

$$\lambda = \frac{h}{mv}$$

and $\quad K = \frac{1}{2}mv^2 = \frac{(mv)^2}{2m}$

$$mv = \sqrt{2mK}$$

Thus, $\quad \lambda = \frac{\mathrm{h}}{\sqrt{2\mathrm{mK}}}$

$\Rightarrow \quad \lambda \propto \frac{1}{\sqrt{K}}$

$\therefore \quad \frac{\lambda_2}{\lambda_1} = \frac{\sqrt{K_1}}{\sqrt{K_2}} = \frac{\sqrt{K_1}}{\sqrt{2K_1}} \qquad (\because K_2 = 2K_1)$

$\Rightarrow \quad \frac{\lambda_2}{\lambda_1} = \frac{1}{\sqrt{2}}$

$\therefore \quad \lambda_2 = \frac{\lambda_1}{\sqrt{2}}$

556 **(b)**

Photo current (i) is directly proportional to light intensity (I) falling on a photosensitive plate, $i.e., i \propto I$

557 **(a)**

By using $\lambda = \frac{h}{\sqrt{2mE}}$ $E = 10^{-32} J$ = Constant for both particles. Hence $\lambda \propto \frac{1}{\sqrt{m}}$ Since $m_p > m_e$ so $\lambda_p < \lambda_e$

558 **(d)**

Here, $x = \frac{DEql}{mv^2}$

or $\frac{q}{m} = \frac{xv^2}{DEl} = \frac{0.02 \times (10^6)^2}{0.21 \times (2 \times 10^4) \times (5 \times 10^{-2})}$

$= 9.52 \times 10^7 \mathrm{Ckg}^{-1}$

559 **(c)**

$$\lambda_0 = \frac{hc}{W_0} = \frac{12400}{4}$$

$= 3100$Å $= 310$ nm

560 **(c)**

$y = \frac{1}{2}at^2 = \frac{1}{2}\frac{eE}{m}\frac{x^2}{v^2}$ or $\frac{e}{m} = \frac{2yv^2}{Ex^2}$

$$= \frac{2 \times 1.5 \times 10^{-3} \times (3 \times 10^7)^2}{1800 \times (0.1)^2}$$

$= 1.5 \times 10^{11}$ Ckg^{-1}

561 **(b)**

$\lambda_{\text{photon}} = \frac{hc}{E}$ and $\lambda_{\text{electron}} = \frac{h}{\sqrt{2mE}}$

$$\Rightarrow \frac{\lambda_{\text{photon}}}{\lambda_{\text{electron}}} = c\sqrt{\frac{2m}{E}} \Rightarrow \frac{\lambda_{\text{photon}}}{\lambda_{\text{electron}}} \propto \frac{1}{\sqrt{E}}$$

562 **(b)**

With decrease in wavelength of incident photons, energy of photoelectrons increases

563 **(b)**

Vidicon is basically VID (eo) + $ICON$ (oscope). It is a small televison camera tube that forms a charge density image on a photoconductive surface for subsequent electron-beam scanning

564 **(a)**

$E = W + KE$

$KE = E - W$

$= \frac{hc}{\lambda} - \frac{hc}{\lambda_0}$

$=hc\left[\frac{1}{\lambda}-\frac{1}{\lambda_0}\right]=hc\left[\frac{\lambda_0-\lambda}{\lambda\lambda_0}\right]$

565 **(d)**

The production of X-rays is an atomic property whereas the production of γ-rays is a nuclear property

566 **(b)**

$$E(eV)=\frac{hc}{e\lambda}=\frac{6.6\times10^{-34}\times3\times10^8}{1.6\times10^{-19}\times1\times10^{-10}}$$
$$=12375\ eV$$

567 **(a)**

v varies from 0 to $v_{\max}$

568 **(c)**

KE of emitted electron is

$$E_K=hv-W$$
$$=6.2\ eV-4.2\ eV=2.0\ eV$$
$$=2\times1.6\times10^{-19}\ J$$
$$=3.2\times10^{-19}J$$

569 **(b)**

Momentum of photon

$$p=\frac{h}{\lambda}=\frac{6.6\times10^{-34}}{10^{-10}}=6.6\times10^{-24}kg-m/s$$

572 **(a)**

$$E=\frac{hc}{\lambda}$$
$$=\frac{6.62\times10^{-34}\times3\times10^8}{45\times10^{-12}}$$
$$=\frac{0.44\times10^{-14}}{1.6\times10^{-19}}=0.275\times10^5\text{ eV}=27500\text{ eV}$$

574 **(b)**

A charged particle moves along a straight line with acceleration, hence electric field should be parallel to the direction of motion of charged particle and no force should act on charged particle due to magnetic field. It will be so if charged particle is moving parallel to the direction of magnetic field

575 **(a)**

Kinetic energy $\propto$ Potential difference

576 **(b)**

The photoelectric effect is an instantaneous phenomenon (experimentally proved). It takes approx time of the order of 10^{-10}s.

578 **(b)**

$$W_0=\frac{12375}{\lambda_0}=\frac{12375}{5420}=2.28eV$$

579 **(a)**

Maximum KE $=hv-\phi_0$

$=6.63\times10^{-34}\times8\times10^{14}-3.2\times10^{-19}$

$=2.1\times10^{-19}$J

581 **(b)**

Let K and K' be the maximum kinetic energy of photoelectrons for incident light of frequency v and $2v$ respectively.

According to Einstein's photoelectric equation,

$K=hv-E_0$ ...(i)

and $K'=h(2v)-E_0$ ...(ii)

$=2hv-E_0=hv+hv-E_0$

$K'=hv+K$ [using (i)]

582 **(b)**

$E=hc/\lambda=6.6\times10^{-34}\times3\times10^8/5000\times10^{-19}$

$=3.973\times10^{-19}$ J

584 **(b)**

Here the velocity of electron increases, so as per Einstein's equation mass of the electron increases, hence the specific charge $\frac{e}{m}$ decreases

585 **(d)**

$r=\frac{mv}{qB}ie, r\propto m/q$

So, $\frac{r_1}{r_2}=\frac{m_1}{m_2}\times\frac{q_2}{q_1}=\frac{24\times2e}{22\times e}=\frac{24}{11}$

587 **(a)**

Momentum $p=\frac{E}{c}\Rightarrow E^2=p^2c^2$

589 **(a)**

$\lambda_{\min}=\frac{hc}{eV}\Rightarrow\lambda\propto\frac{1}{V}$

$\because\lambda_2>\lambda_1$ (see graph) $\Rightarrow V_1>V_2$

$\sqrt{v}=a(Z-b)$ Moseley's law

$v\propto(Z-1)^2\Rightarrow\lambda\propto\frac{1}{(Z-1)^2}\quad\left[\because v\propto\frac{1}{\lambda}\right]$

$\lambda_1>\lambda_2$ [see graph for characteristic lines]

$\Rightarrow Z_2>Z_1$

590 **(a)**

$$hf=hf_0+\frac{1}{2}mv^2$$

Hence, $v_1^2=\frac{2hf_1}{m}-\frac{2hf_0}{m}$

$v_2^2=\frac{2hf_2}{m}-\frac{2hf_0}{m}$

$\therefore\quad v_1^2-v_2^2=\frac{2h}{m}(f_1-f_2)$

591 **(c)**

$KE_{max}=hv-\phi$

Where $hv=$ energy of incident photon,

$\phi=$ work function

$KE_{\max}=6.6\times10^{-34}\times6\times10^{14}-2\times1.6\times10^{-19}$

$=3.96\times10^{-19}-3.2\times10^{-19}$

$=\frac{0.76\times10^{-19}}{1.6\times10^{-19}}$ eV=0.475 eV

592 **(a)**

Bragg's law states that $2d\sin\theta=n\lambda$ where $=1,2,3\ldots\ldots$ If $\lambda>2d$, then $\sin\theta$ will be greater than 1 for $n=1$, which is not possible

593 **(b)**

Work function $W_0 = \frac{hc}{\lambda_0}$

where λ_0 is the threshold wavelength or $W_0 \propto \frac{1}{\lambda_0}$

$\therefore \frac{W_0}{W_0'} = \frac{\lambda_0'}{\lambda_0}$ or $\frac{W_0}{W_0/2} = \frac{\lambda_0'}{\lambda_0}$ or $\lambda'_0 = 2\lambda_0$

594 **(d)**

Energy of photon is given by

$$E = \frac{hc}{\lambda} \quad ...(i)$$

Where h is the Planck's constant, c the velocity of light and λ its wavelength.

de-Broglie wavelength is given by

$$\lambda = \frac{h}{p}$$

Where p is being momentum of photon.

From Eqs. (i) and (ii), we get

$$E = \frac{hc}{h/p} = pc$$

Or $\quad p = E/c$

Given, $E = 1$ MeV $= 1 \times 10^6 \times 1.6 \times 10^{-19}$ J.

$$c = 3 \times 10^8 \text{ ms}^{-1}$$

Hence, after putting numerical values, we obtain

$$p = \frac{1\times10^6\times1.6\times10^{-19}}{3\times10^8}$$

$$= 5 \times 10^{-22} \text{ kg-ms}^{-1}$$

596 **(d)**

$KE_{\max} = 10eV$

$\phi = 2.75eV$

$E = \phi + KE_{\max} = 12.75eV$

= Energy difference between $n = 4$ and $n = 1$

⇒ value of $n = 4$

597 **(d)**

$K_{\max} = eV_0 \Rightarrow eV_0 = 4eV \Rightarrow V_0 = 4V$

599 **(a)**

When cathode rays strike the metal plate, they transfer their energy to plate

600 **(c)**

$$\lambda = \frac{h}{p} \Rightarrow \lambda - \frac{0.5}{100}\lambda = \frac{h}{p+\Delta p} \Rightarrow \frac{199\lambda}{200} = \frac{h}{p+\Delta p}$$

$$= \frac{199}{200}\frac{h}{p}$$

$$\Rightarrow p + \Delta p = \frac{200}{199}p \Rightarrow p = 199\,\Delta p$$

601 **(c)**

Kinetic energy of a particle at temperature TK is $E = \frac{3}{2}kT$. The de-Broglie wavelength associated with it is

$$\lambda = \frac{h}{\sqrt{2mE}} = \frac{h}{\sqrt{2m \times \frac{3}{2}kT}}$$

$$ie, \lambda \propto \frac{1}{\sqrt{T}}$$

$$\therefore \frac{\lambda_{927}}{\lambda_{27}} = \sqrt{\frac{27+373}{927+273}}$$

$$= \sqrt{\frac{300}{1200}} = \frac{1}{2}$$

or $\lambda_{927} = \frac{\lambda_{27}}{2} = \frac{\lambda}{2}$

602 **(c)**

From relation

$$eV_s = h(v - v_0)$$

or V_s = threshold or cut off voltage

$$= \frac{h}{e}(v - v_0)$$

$$= \frac{6.6\times10^{-34}}{1.6\times10^{-19}}(8.2 - 3.3) \times 10^{14}$$

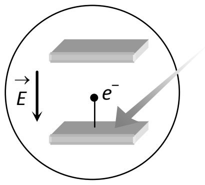
$$= \frac{6.6\times4.9\times10^{-1}}{1.6} = 2V$$

603 **(c)**

$$2\pi r = n\lambda \Rightarrow n = \frac{2\pi r}{\lambda} = \frac{2 \times 3.14 \times 5.3 \times 10^{-11}}{10^{-10}}$$

$$= 3$$

604 **(b)**



In electric field photoelectron will experience force and accelerate opposite to the field so it's $K.E.$ increases ($i.e.$, stopping potential will increase), no change in photoelectric current, and threshold wavelength

605 **(b)**

Number of electrons can be measured which are directly proportional to the intensity of radiation

606 **(d)**

Hard X-rays are of higher energy and the energy of X-rays depends on the potential difference between the cathode and the target

607 **(b)**

$\sqrt{v} \propto (Z - b)$

608 **(c)**

KE of photoelectron $= hv - W_0$

$$= \frac{hc}{\lambda} - W_0$$

$$= \frac{6.63\times10^{-34}\times3\times10^8}{300\times10^{-9}} - 2.54 \times 1.6 \times 10^{-19}$$

$$= 6.63 \times 10^{-19} - 4.064 \times 10^{-19}$$

$$= 2.566 \times 10^{-19}\, eV$$

If V_0 is the stopping potential, then KE of photoelectron $= eV_0$

or $V_0 = \frac{\text{KE of photo electron}}{e}$

$= \frac{2.566\times10^{-19}}{1.6\times10^{-19}} = 1.60\text{V}$

609 **(d)**

Intensity ∝ (No. of photons) ∝ (No. of photoelectrons)

610 **(b)**

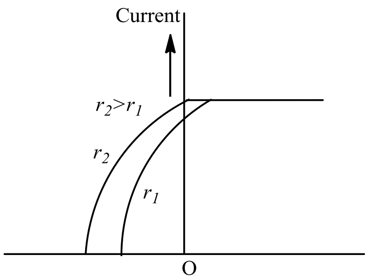
Stopping potential is same for a & b, hence their frequencies are same. Also maximum current values are different for a & b so they will have different intensities

611 **(b)**

For emission of electrons incident energy of each photon must be greater than work function (threshold energy)

612 **(c)**

The negative potential at which photoelectric current becomes zero is called stopping potential. If at the stopping potential light of frequency higher than before be made to fall on plate, then photoelectric current is re-established. On increasing the negative potential of other plate, the current again stops. Hence, higher the frequency of the incident light,higher will be the maximum kinetic energy of the emitted photoelectrons or higher will be the stopping potential.



613 **(b)**

For incident electron $\frac{1}{2}mv^2 = eV$ or $p^2 = 2meV$

∴ de-Broglie wavelength $\lambda_1 = \frac{h}{p} = \frac{h}{\sqrt{2meV}}$

Shortest X-ray wavelength $\lambda_2 = \frac{hc}{eV}$

$$\therefore \frac{\lambda_1}{\lambda_2} = \frac{1}{c}\sqrt{\left(\frac{V}{2}\right)\left(\frac{e}{m}\right)} = \frac{\sqrt{\frac{10^4}{2}\times 1.8\times 10^{11}}}{3\times 10^8} = 0.1$$

615 **(b)**

$\frac{n}{t} = \frac{IA\lambda}{hc}$

$= \frac{150\times10^{-3}\times4\times10^{-4}\times3\times10^{-7}}{6.6\times10^{-34}\times3\times10^{8}} = 9\times10^{13}\text{ s}$

616 **(b)**

$p = \frac{E}{c} = \frac{hv}{c} \Rightarrow v = \frac{pc}{h}$

617 **(a)**

$\lambda = \frac{hc}{eV} = \frac{12375}{59000} = 0.20\text{Å} \quad \left[\because \frac{hc}{e} = 12375\right]$

618 **(d)**

As $E_K = \frac{1}{2}mv^2$ or $mv = \sqrt{2m\,E_K}$

As per question;

or $m_p v_p = m_e v_e$

or $\sqrt{2m_p\,E_{K_p}} = \sqrt{2m_e\,E_{K_e}}$

or $\frac{E_{K_e}}{E_{K_p}} = \frac{m_p}{m_e} > 1$

or $E_{K_e} > E_{K_p}$

619 **(a)**

$K_{\max} = (|V_0|)eV = 2eV$

620 **(a)**

de-Broglie wavelength, $\lambda = \frac{h}{\sqrt{2mE_k}}$

$\frac{\lambda_\alpha}{\lambda_p} = \sqrt{\frac{m_p}{m_\alpha}}$

$= \sqrt{\frac{1}{4}} = \frac{1}{2}$

621 **(a)**

$hv_{\max} = eV \;\therefore v_{\max} = \frac{eV}{h} = \frac{1.6\times10^{-19}\times42000}{6.63\times10^{-34}}$

$= 10^{19}Hz$

622 **(c)**

According to law of conservation of energy, kinetic energy of α- particle

=potential energy of α-particle at distance of closest approach

ie, $\frac{1}{2}\text{mv}^2 = \frac{1}{4\pi\varepsilon_0}\frac{q_1q_2}{r}$

∴ 5MeV

$= \frac{9\times10^9\times(2e)\times(92e)}{r} \quad \left(\because \frac{1}{2}\text{mv}^2 = 5\text{MeV}\right)$

⇒ $r = \frac{9\times10^9\times2\times92\times(1.6\times10^{-19})^2}{5\times10^6\times1.6\times10^{-19}}$

∴ $r = 5.3\times10^{-14}\text{ m} = 10^{-12}\text{cm}$

623 **(c)**

Energy of photon,

$E = hv = \frac{hc}{\lambda}$ ...(i)

Where h is Planck's constant and c the speed of light.

Multiplying and dividing the RHS of above expression by m where m is mass,we have

$E = \frac{hmc}{m\lambda}$

Now, mc=p= momentum

$\therefore \qquad E = \frac{hp}{m\lambda}$

Given, $E_1 = E, \quad E_2 = 4E, \quad p_1 = p$

$$\frac{E_1}{E_2} = \frac{p_1}{p_2}$$

$\Rightarrow \quad p_2 = p_1 \frac{E_2}{E_1} = p \frac{4E}{E} = 4p$

Hence, momentum increases by a factor of 4.

624 **(b)**

$$v = \frac{c}{\lambda} = \frac{3 \times 10^8}{1 \times 10^{-10}} = 3 \times 10^{18} Hz$$

625 **(b)**

According to Einstein's mass energy equivalence $E = mc^2$

$\therefore$ Loss of mass per second $= \frac{(3.77 \times 10^{26})}{c^2} kg$

$$= \frac{(3.77 \times 10^{26})}{(3 \times 10^8)^2} kg = 0.419 \times 10^{10} kg$$

$$= 41.9 \times 10^8 kg$$

627 **(a)**

$$E = \frac{hc}{\lambda} \Rightarrow \lambda = \frac{hc}{E}$$

628 **(a)**

The value of threshold frequency v_0 for A is less than that for B, hence $\phi_A < \phi_B$

630 **(c)**

$\because E(K_\gamma) > E(K_\beta) > E(K_\alpha) \Rightarrow \lambda(K_\gamma) < \lambda(K_\beta) < \lambda(K_\alpha)$

631 **(b)**

We know that in Davisson-Germer experiment maximum intensity is observed at 54^0 and 50 V.

632 **(a)**

Specific charge=charge/mass. The positive rays are stream of positive ions. The mass of positive ion is much more than that of electrons, hence specific charge of positive ions is less

634 **(a)**

$$\frac{1}{2}mv^2 = E \Rightarrow mv = \sqrt{2mE} \;\; \therefore \lambda = \frac{h}{mv} = \frac{h}{\sqrt{2mE}}$$

635 **(b)**

de-Broglie wavelength, $\lambda = \frac{h}{mv}$

$$= \frac{6.6 \times 10^{-34}}{120 \times 10^{-3} \times 20}$$

$$= 2.75 \times 10^{-34} \text{ m}$$

636 **(c)**

When filament current is increased, more electrons are emitted from electron gun. Due to which the intensity of electrons increases.

As $\lambda_{\min} = \frac{hc}{eV}$, so as V decreases, $\lambda_{\min}$ increases.

637 **(c)**

de-Broglie wavelength of an electron is given by

$$\lambda = \frac{h}{mv} = \frac{h}{\sqrt{2mK}}$$

Or $\qquad \lambda \propto \frac{1}{\sqrt{K}}$

$\therefore \qquad \frac{\lambda'}{\lambda} = \frac{1}{\sqrt{3K}} \frac{\sqrt{K}}{1} = \frac{1}{\sqrt{3}}$

Or $\qquad \lambda' = \frac{\lambda}{\sqrt{3}}$

Hence, de-Broglie wavelength will change by factor $\frac{1}{\sqrt{3}}$.

638 **(b)**

Stopping potential

$$v_0 = \frac{hc}{e}\left(\frac{1}{\lambda} - \frac{1}{\lambda_0}\right)$$

Where λ_0= stopping potential

Ist case,

$4.8 = \frac{hc}{e}\left(\frac{1}{\lambda} - \frac{1}{\lambda_0}\right) \qquad$ ... (i)

IInd case,

$1.6 = \frac{hc}{e}\left(\frac{1}{2\lambda} - \frac{1}{\lambda_0}\right) \qquad$ ... (ii)

Dividing Eq. (i) by Eq. (ii)

$$3 = \frac{\left(\frac{1}{\lambda} - \frac{1}{\lambda_0}\right)}{\left(\frac{1}{2\lambda} - \frac{1}{\lambda_0}\right)}$$

$$\frac{3}{2\lambda} - \frac{3}{\lambda_0} = \frac{1}{\lambda} - \frac{1}{\lambda_0}$$

$$\frac{1}{\lambda_0} - \frac{3}{\lambda_0} = \frac{1}{\lambda} - \frac{3}{2\lambda}$$

$$\frac{-2}{\lambda_0} = \frac{2-3}{2\lambda}$$

$$\frac{2}{\lambda_0} = \frac{1}{2\lambda}$$

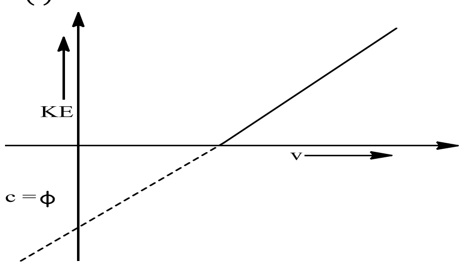
$$\lambda_0 = 4\lambda$$

639 **(d)**

Einstein's photoelectric equation is

$$\text{KE}_{max} = hv - \phi$$

...(i)



The equation of line is

$$y = mx + c$$

...(ii)

Comparing above two equations

$$m = h, c = -\phi$$

Hence, slope of graph is equal to Planck's constant (non-variable) and does not depend on intensity of radiation.

640 **(b)**

$$\frac{1}{2}mv^2 = eV \Rightarrow \frac{e}{m} = \frac{v^2}{2V} = \frac{(8.4 \times 10^6)^2}{2 \times 200}$$
$$= 1.76 \times 10^{11} \frac{C}{kg}$$

641 **(c)**

Applied voltage must be greater than binding enegy

642 **(d)**

$$\because \quad \lambda = \frac{h}{p} \Rightarrow \lambda \propto \frac{1}{p}$$

ie, when λ increases, p decreases.

643 **(c)**

According to Einstein's photoelectric equation

$$\frac{hc}{\lambda} = \phi + \frac{1}{2}mv^2 \Rightarrow v = \left[\frac{2(hc - \lambda\phi)}{m\lambda}\right]^{1/2}$$

644 **(a)**

$\lambda_r > \lambda_y > \lambda_g$. Here threshold wavelength $< \lambda_y$

645 **(c)**

Acceleration, $a = \frac{F}{m} = \frac{qvB}{m}$

$$= \frac{2 \times 1.6 \times 10^{-19} \times 6 \times 10^5 \times 0.2}{6.65 \times 10^{-27}}$$

$= 5.77 \times 10^{12} \text{ms}^{-2}$

647 **(c)**

The energy of photon

$$E = \frac{hc}{\lambda}$$

and work function of metal

$$W = \frac{hc}{\lambda_0}$$

For photoelectric effect

$$E > W$$
$$\frac{hc}{\lambda} > \frac{hc}{\lambda_0}$$
$$\because \quad \lambda \leq \lambda_0$$

648 **(a)**

Here, $u = 0; a = \frac{eE}{m}; v = ?; t = t$

$$\therefore \; v = u + at = 0 + \frac{eE}{m}t$$

de-Broglie wavelength,

$$\lambda = \frac{h}{mv} = \frac{h}{m(eEt/m)} = \frac{h}{eEt}$$

Rate of change of de-Broglie wavelength

$$\frac{d\lambda}{dt} = \frac{h}{eE}\left(-\frac{1}{t^2}\right) = \frac{-h}{eEt^2}$$

649 **(c)**

The graph between V_0 and v cuts the v-axis at v_0

For the given graphs $(v_0)_{(iv)} > (v_0)_{(iii)} > (v_0)_{(ii)} > (v_0)_{(i)}$

$\therefore (W_0)_{(\text{iv})} > (W_0)_{(\text{iii})} > (W_0)_{(\text{ii})} > (W_0)_{(\text{i})}$

650 **(d)**

$$eV = \frac{1}{2}mv^2$$

or $v = \sqrt{\frac{2eV}{m}} = \sqrt{2 \times (1.8 \times 10^{11}) \times 9} = 1.8 \times 10^6 \text{ms}^{-1}$

651 **(b)**

Momentum of photon, $p = \frac{h}{\lambda}$

Therefore, wavelength of photon, $\lambda = \frac{h}{p}$

652 **(b)**

Given $E/c = 3.3 \times 10^{-13} \text{kg ms}^{-1}$;

So, $E = 3.3 \times 10^{-13} \times c = 3.3 \times 10^{-13} \times 3 \times 10^8$
$= 9.9 \times 10^{-5}$ J

653 **(d)**

$\lambda = \frac{h}{p}$ or $L = \frac{h}{p} ie, L \propto \frac{1}{p}$. The curve (d) is correct.

655 **(d)**

In photoelectric effect particle nature of electron is shown. While in electron microscope, beam of electron is considered as electron wave

658 **(a)**

When light falls on a metallic surface, ejection of photoelectron results. In this process, conservation of energy holds.

Thus, from law of conservation of energy, the energy imparted by the photon

=maximum kinetic energy of the emitted electron

+work function of the metal.

Or $hv = (\text{KE})_{\text{max}} + \phi$

but $\phi = hv_0, v_0$ being threshold frequency.

$\therefore \quad (KE)_{\text{max}} = hv - hv_0$

or $\quad (KE)max \propto v - v_0$

659 **(b)**

Foe electro, $p = \frac{h}{\lambda}$; and for photon, $E = \frac{hc}{\lambda}$

$$\therefore \frac{E}{p} = \frac{hc/\lambda}{h/\lambda} = c = 3 \times 10^8 \text{ ms}^{-1}$$

660 **(d)**

$$QE = mg \Rightarrow mg = \frac{QV}{d}$$

661 **(c)**

de-Broglie wavelength $\lambda = \frac{h}{mv_{rms}}$

rms velocity of a gas particle at the given temperature (T) is given as

$$\frac{1}{2}mv_{rms}^2 = \frac{3}{2}kT \Rightarrow v_{rms} = \sqrt{\frac{3kT}{m}} \Rightarrow mv_{rms}$$
$$= \sqrt{3mk\,T}$$
$$\therefore \lambda = \frac{h}{mv_{rms}} = \frac{h}{\sqrt{3mkT}}$$

$$\Rightarrow \frac{\lambda_H}{\lambda_{He}} = \sqrt{\frac{m_{He}T_{He}}{m_H T_H}} = \sqrt{\frac{4(273+127)}{2(273+27)}} = \sqrt{\frac{8}{3}}$$

662 **(b)**

de-Broglie wavelength, $\lambda = \frac{h}{\sqrt{2meV}}$

X-ray wavelength, $\lambda_2 = \frac{hc}{eV}$

$$\therefore \frac{\lambda_1}{\lambda_2} = \frac{eV}{c\sqrt{2meV}} = \frac{1}{c}\sqrt{\frac{1}{2}\left(\frac{e}{v}\right)V}$$

$$= \frac{1}{3\times 10^8}\sqrt{\frac{1}{2}\times 1.8\times 10^{11}\times 10^4} = \frac{1}{10}$$

663 **(a)**

The de-Broglie wavelength (λ) is given by

$$\lambda = \frac{h}{p} \quad \text{...(i)}$$

Where h is Planck's constant, p the momentum.

Also, $p = mv = \frac{m_0}{\sqrt{1-\frac{v^2}{c^2}}}$ ...(ii)

Where m_0 is rest mass, v the velocity and c the speed of light.

From Eqs. (i) and (ii), we get

$$\lambda = \frac{h\sqrt{1-\frac{v^2}{c^2}}}{m_0 v}$$

Given, $v = c$ $\quad \therefore \lambda = 0$

664 **(a)**

$$E_e = \frac{1}{2}mv^2 = \frac{1}{2}(mv)v = \frac{1}{2}\left(\frac{h}{\lambda}\right)v$$

and $E_p = \frac{hc}{\lambda}$;

$$\therefore \frac{E_e}{E_p} = \frac{v}{2c}$$

$p_e = mv = h/\lambda$ and $p_h = \frac{h}{\lambda}$

$$\therefore \frac{p_e}{p_h} = 1$$

665 **(a)**

According to Millikan's oil drop experiment, electronic charge is given by

$$q = \frac{6\pi\eta r(v_1+v_2)}{E}$$

Which is independent of g.

So, $\frac{\text{electronic charge on the moon}}{\text{electronic charge on the earth}} = 1$

666 **(c)**

$$\frac{e}{m} = \frac{1.6\times 10^{-19}}{9.1\times 10^{-31}} = 1.76\times 10^{11} C/kg$$

667 **(d)**

Using Bragg's formula,

$$2d\sin\theta = \lambda$$

Given, $d = 2$A

For maximum wavelength

$$\lambda_{max} = 2d = 2\times 2A = 4A$$

668 **(d)**

When current through the filament increases, number of emitted electrons also increases. Hence intensity of X-ray increases but no effect on penetration power

669 **(a)**

$$E = \frac{hc}{\lambda} = \frac{6.62\times 10^{-34}\times 3\times 10^8}{450\times 10^{-9}} = 4.4\times 10^{-19} J$$

670 **(b)**

$$\lambda = \frac{h}{\sqrt{2mK}} \Rightarrow \frac{\lambda_1}{\lambda_2} = \sqrt{\frac{K_2}{K_1}} = \sqrt{\frac{16K}{K}} = 4$$

$$\frac{\lambda_1}{\lambda_2} = 4 \Rightarrow \lambda_2 = \frac{\lambda_1}{4} = \frac{100}{4} = 25$$

$4\lambda = 100 - 25 = 75\%$

671 **(c)**

Energy incident over $1\text{cm}^2 = 1.0\times 10^{-4}$ J;

Energy required to produce photoelectrons $= 1.0\times 10^{-4}\times 10^{-2} = 10^{-6}$ J.

Number of photoelectrons ejected = number of photons which can produce photoelectrons = energy required for producing electron/energy of photon.

$$= \frac{10^{-6}}{hc/\lambda} = \frac{10^{-6}\times 300\times 10^{-9}}{6.6\times 10^{-34}\times 3\times 10^8}$$

$= 1.51\times 10^{12}\ \text{s}^{-1}$

672 **(a)**

In discharge tube cathode rays (a beam of nregative particles) and canal rays (positive rays) move opposite to each other. They will experience a magnetic force in the same direction, if a normal magnetic field is applied