24. Electron, Photon, Photoelectric Effect and X-rays – Multiple Choice Questions

1. Cathode Rays and Positive Rays

1. The charge on electron was discovered by

(a) J.J. Thomson (b) Neil Bohr

(c) Millikan (d) Chadwick

2. 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

3. 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*

4. 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

5. In Millikan's oil drop experiment, an oil drop of mass 16×10^{-6} *kg* is balanced by an electric field of 10^6 *V/m*. The charge in coulomb on the drop, assuming $g=10\ m/s^2$ is

(a) 6.2×10^{-11} (b) 16×10^{-9}

(c) 16×10^{-11} (d) 16×10^{-13}

6. 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) $q\frac{V}{d}$

7. In Millikans oil drop experiment, a charged drop of mass $1.8\times10^{-14}kg$ 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

8. The ratio of momenta of an electron and an α – particle which are accelerated from rest by a potential difference of 100 *V* is

(a) 1 (b) $\sqrt{\frac{2m_e}{m_\alpha}}$

(c) $\sqrt{\frac{m_e}{m_\alpha}}$ (d) $\sqrt{\frac{m_e}{2m_\alpha}}$

9. An electron initially at rest, is accelerated through a potential difference of 200 *volt*, so that it acquires a velocity $8.4\times10^6 m/s$. The value of *e/m* of electron will be

(a) $2.76\times10^{12}C/kg$ (b) $1.76\times10^{11}C/kg$

(c) $0.76\times10^{12}C/kg$ (d) None of these

10. Which of the following have highest specific charge

(a) Positron (b) Proton

(c) *He* (d) None of these

11. 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*

12. 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 $1.6\times10^{-19}C$. The maximum anode current is

(a) $2.7\mu A$ (b) $29\mu A$

(c) $72\mu A$ (d) 29 *mA*

13. 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

14. The electron of a hydrogen atom revolves round the proton in a circular n^{th} orbit of radius $r_n = \frac{\varepsilon_0 n^2 h^2}{(\pi m e^2)}$ with a speed $\upsilon_n = \frac{e^2}{2\varepsilon_0 nh}$. The current due to the circulating charge is proportional to

(a) e^2 (b) e^3

(c) e^5 (d) e^6

15. Photon of wavelength λ is incident on a metal. The most energetic electrons ejected from the metal are bent into a circular arc of radius R by a perpendicular magnetic field having a magnitude B. The work function of the metal is (where symbols have their usual meanings)

(a) $\frac{hc}{\lambda} - m_e + \frac{e^2B^2R^2}{2m_e}$ (b) $\frac{h\nu}{\lambda} + 2m_e\left(\frac{eBR}{2m_e}\right)^2$

(c) $\frac{hc}{\lambda} - m_ec^2 - \frac{e^2B^2R^2}{2m_e}$ (d) $\frac{h\nu}{\lambda} - 2m_e\left(\frac{eBR}{2m_e}\right)^2$

2. Matter Waves

1. de-Broglie hypothesis treated electrons as

(a) Particles (b) Waves

(c) Both 'a' and 'b' (d) None of these

2. If alpha particle, proton and electron move with the same momentum, then their respective de Broglie wavelengths $\lambda_\alpha, \lambda_p, \lambda_e$ are related as

(a) $\lambda_\alpha = \lambda_p = \lambda_e$ (b) $\lambda_\alpha < \lambda_p < \lambda_e$

(c) $\lambda_\alpha > \lambda_p > \lambda_e$ (d) $\lambda_p > \lambda_e > \lambda_\alpha$

(e) $\lambda_p < \lambda_e < \lambda_\alpha$

3. The de Broglie wavelength and kinetic energy of a particle is 2000 Å and 1 *eV* respectively. If its kinetic energy becomes 1 *MeV*, then its de Broglie wavelength becomes

(a) 1 Å (b) 2 Å

(c) 5 Å (d) 10 Å

4. 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

5. The energy that should be added to an electron, to reduce its de-Broglie wavelength from 10^{-10} *m* to 0.5×10^{-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

6. The kinetic energy of an electron with de-Broglie wavelength of 0.3 nanometer is

(a) 0.168 *eV* (b) 16.8 *eV*

(c) 1.68 *eV* (d) 2.5 *eV*

7. 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) $\frac{1}{2\sqrt{2}}:1$

8. 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

9. 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}

10. 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}

11. A proton, a neutron, an electron and an α-particle have same energy. Then, their de-Broglie wavelengths compare as

(a) $\lambda_p = \lambda_n > \lambda_e > \lambda_\alpha$ (b) $\lambda_\alpha < \lambda_p = \lambda_n < \lambda_e$

(c) $\lambda_e < \lambda_p = \lambda_n > \lambda_\alpha$ (d) $\lambda_e = \lambda_p = \lambda_n = \lambda_\alpha$

12. An electron is moving with an initial velocity $\vec{v} = v_0\hat{i}$ and is in a magnetic field $\vec{B} = B_0\hat{j}$. Then, it's de-Broglie wavelength

(a) Remains constant

(b) Increase with time

(c) Decreases with time

(d) Increases and decreases periodically

13. The de-Broglie wavelength of a particle moving with a velocity 2.25×10^8 *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 3×10^8 *m/s*)

(a) 1/8 (b) 3/8

(c) 5/8 (d) 7/8

14. A particle is dropped from a height H. The de-Broglie wavelength of the particle as a function of height is proportional to

(a) H (b) $H^{1/2}$

(c) H^0 (d) $H^{-1/2}$

15. An electron (mass m) with an initial velocity $\vec{v} = v_0\hat{i}$ ($v_0 > 0$) is in an electric field $\vec{E} = -E_0\hat{i}$ ($E_0 = \text{constant} > 0$). It's de-Broglie wavelength at time t is given by

(a) $\frac{\lambda_0}{\left(1 + \frac{eE_0}{m}\frac{t}{v_0}\right)}$ (b) $\lambda_0\left(1 + \frac{eE_0t}{mv_0}\right)$

(c) λ_0 (d) $\lambda_0 t$

16. An electron (mass m) with an initial velocity $\vec{v} = v_0\hat{i}$ is in an electric field $\vec{E} = E_0\hat{j}$. If $\lambda_0 = h/mv_0$, It's de-Broglie wavelength at time t is given by

(a) λ_0

(b) $\lambda_0\sqrt{1+\frac{e^2E_0^2t^2}{m^2v_0^2}}$

(c) $\frac{\lambda_0}{\sqrt{1+\frac{e^2E_0^2t^2}{m^2v_0^2}}}$

(d) $\frac{\lambda_0}{\left(1+\frac{e^2E_0^2t^2}{m^2v_0^2}\right)}$

17. Photons of energy $7\,eV$ are incident on two metals A and B with work functions $6\,eV$ and $3\,eV$ respectively. The minimum de Broglie wavelengths of the emitted photoelectrons with maximum energies are λ_A and λ_B respectively where λ_A/λ_B is nearly

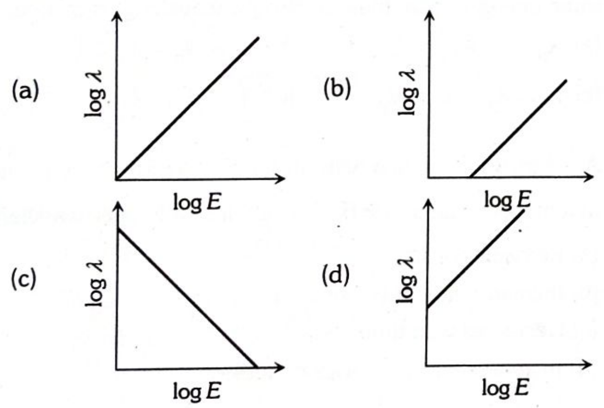
(a) 0.5

(b) 1.4

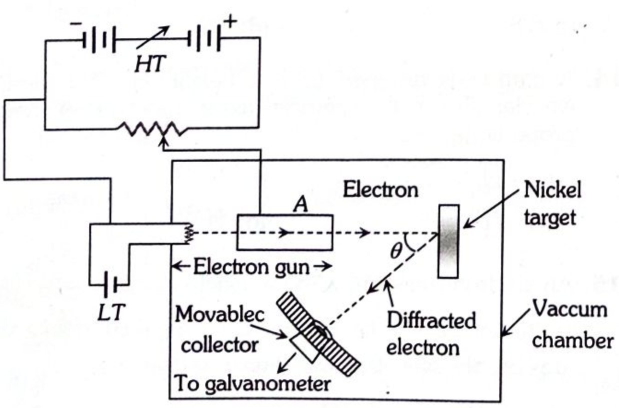
(c) 4.0

(d) 2.0

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



19. Consider figure given below, Suppose the voltage applied to A is increased. The diffracted beam will have the maximum at a value of θ that



(a) Will be larger than the earlier value

(b) Will be the same as the earlier value

(c) Will be less than the earlier value

(d) Will depend on the target

20. The sun radiates energy at the rate of $3.77\times10^{26}\,J/s$. The loss of mass it suffers per seconds is

(a) $41.9\times10^{18}\,g$

(b) $41.9\times10^{8}\,kg$

(c) $1.29\times10^{16}\,kg$

(d) $1.29\times10^{10}\,kg$

3. Photon and Photoelectric Effect

1. Which of the following is incorrect statement regarding photon

(a) Photon exerts no pressure

(b) Photon energy is $h\upsilon$

(c) Photon rest mass is zero

(d) None of these

2. 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

3. Consider the two following statements A and B and identify the correct choice given in the answers

(A) In photovoltaic cells the photoelectric current produced is not proportional to the intensity of incident light

(B) In gas filled photoemissive cells, the velocity of photoelectrons depends on the wavelength of the incident radiation

(a) Both A and B are true

(b) Both A and B are false

(c) A is true but B is false

(d) A is false B is true

4. The momentum of a photon is 3.3×10^{-29} $kg\text{–}m/sec$. Its frequency will be

(a) $3\times10^3\,Hz$

(b) $6\times10^3\,Hz$

(c) $7.5\times10^{12}\,Hz$

(d) $1.5\times10^{13}\,Hz$

5. A photon of wavelength 4400 Å is passing through vacuum. The effective mass and momentum of the photon are respectively

(a) $5\times10^{-36}kg,\ 1.5\times10^{-27}\,kg\text{-}m/s$

(b) $5\times10^{-35}kg,\ 1.5\times10^{-26}\,kg\text{-}m/s$

(c) Zero, $1.5\times10^{-26}\,kg\text{-}m/s$

(d) $5\times10^{-36}kg, 1.67\times10^{-43}kg\text{-}m/s$

6. 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

7. Calculate the linear momentum of a 3 MeV photon

(a) $0.01 eV - s/m$ (b) $0.02 eV - s/m$

(c) $0.03 eV - s/m$ (d) $0.04 eV - s/m$

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

(a) 2.126×10^{-23} kg-m/s (b) 6.626×10^{-22} kg-m/s

(c) 3.456×20^{-25} kg-m/s (d) 3.313×10^{-22} kg-m/s

9. A monochromatic source of light emits photons of frequency $6\times10^{14} Hz$. The power emitted by the source is $8\times10^{-3} W$. Calculate the number of photons emitted per second (Take $h = 6.63\times10^{-34} J-s$)

(a) 6×10^{14} (b) 4×10^{15}

(c) 2×10^{16} (d) 1×10^{17}

10. The minimum intensity of light to be detected by human eye is $10^{-10} W/m^2$. The number of photons of wavelength $5.6\times10^{-7} m$ 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

11. An electron and a photon have wavelength of $10^{-9} m$. If E is the energy of the photon and p is the momentum of electron, the magnitude of E/p in SI unit is

(a) 1.00×10^{-9} (b) 1.50×10^{8}

(c) 3.00×10^{8} (d) 1.20×10^{7}

12. The energy of a photon of light of wavelength 450 nm is

(a) $4.4\times10^{-19} J$ (b) $2.5\times10^{-19} J$

(c) $1.25\times10^{-17} J$ (d) $2.5\times10^{-17} J$

13. 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

14. A light whose frequency is equal to $6\times10^{14} Hz$ is incident on a metal whose work function is 2 eV.

$[h = 6.63\times10^{-34} Js,\ 1eV = 1.6\times10^{-19} J)$. 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

15. 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

16. 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 ($h = 6.6\times10^{-34} Js,\ e = 1.6\times10^{-19} C,\ c = 3\times10^{8} ms^{-1}$)

(a) 1.1 (b) 2.0

(c) 2.2 (d) 3.1

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

(a) Double the earlier value (b) Unchanged

(c) More than doubled (d) Less than doubled

18. 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

19. 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 substance

(d) Is independent of the intensity of the incident light

20. 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

21. 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

22. If the energy of a photon corresponding to a wavelength of 6000 Å is $3.32\times10^{-19} J$, 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

23. If the work function of a photometal is 6.825 eV. Its threshold wavelength will be ($c = 3\times10^{8} m/s$)

(a) 1200 Å (b) 1800 Å

(c) 2400 Å (d) 3600 Å

24. 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

25. The wavelength of a photon needed to remove a proton from a nucleus which is bound to the nucleus with $1 MeV$ energy is nearly

(a) $1.2 nm$ (b) $1.2\times10^{-3} nm$
(c) $1.2\times10^{-6} nm$ (d) $1.2\times10 nm$

26. 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) $E = 12.4 h\nu$ (b) $E = 12.4 h/\lambda$
(c) $E = 12.4/\lambda$ (d) $E = h\nu$

27. The threshold frequency for a certain photosensitive metal is ν_0. When it is illuminated by light of frequency $\nu = 2\nu_0$, the maximum velocity of photoelectrons is υ_0. What will be the maximum velocity of the photoelectrons when the same metal is illuminated by light of frequency $\nu = 5\nu_0$

(a) $\sqrt{2}\upsilon_0$ (b) $2\upsilon_0$
(c) $2\sqrt{2}\upsilon_0$ (d) $4\upsilon_0$

28. A photon of energy E ejects a photoelectron 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) $\frac{\sqrt{2m(E-W_0)}}{eB}$

29. 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 frequency of B)

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

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

(a) $2\ hc\times10^6\ J$ (b) $1.5\ hc\times10^6\ J$
(c) $hc\times10^6\ J$ (d) $0.5\ hc\times10^6\ J$

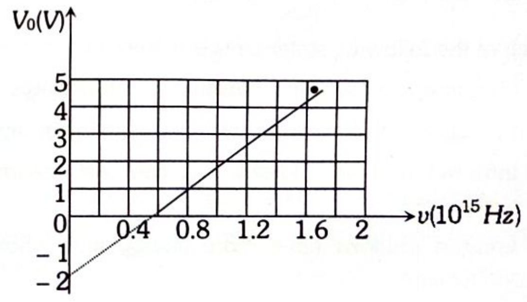
31. Consider a beam of electrons (each electron with energy E_0) incident on a metal surface kept in an evacuated chamber. Then,

(a) No electrons will be emitted as only photons can emit electrons
(b) Electrons can be emitted but all with an energy, E_0
(c) Electrons can be emitted with any energy, with a maximum of $E_0 - \phi$ (ϕ is the work function)
(d) Electrons can be emitted with any energy, with a maximum of E_0

32. Photoelectric emission is observed from a metallic surface for frequencies f_1 and f_2 of the incident light rays $(f_1 > f_2)$. 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) $\frac{f_1 - f_2}{k-1}$ (b) $\frac{kf_1 - f_2}{k-1}$
(c) $\frac{kf_2 - f_1}{k-1}$ (d) $\frac{f_2 - f_1}{k}$

33. In a photocell circuit the stopping potential, V_0, is a measure of the maximum kinetic energy of the photoelectrons. The following graph shows experimentally measured values of stopping potential versus frequency υ of incident light. The values of Plank's constant and the work function as determined from the graph are (taking the magnitude of electronic charge to be $e = 1.6\times10^{-19} C$)

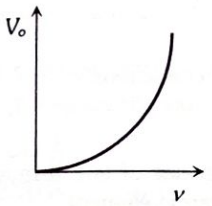


(a) $6.4\times10^{-34} Js, 2.0 eV$ (b) $6.0\times10^{-34} Js, 2.0 eV$
(c) $6.4\times10^{-34} Js, 3.2 eV$ (d) $6.0\times10^{-34} Js, 3.2 eV$

34. When ultraviolet radiation of certain frequency falls on a potassium target, the photoelectrons released can be stopped completely by a retarding potential of $0.6 V$. If the frequency of the radiation is increased by 10%, this stopping potential rises to $0.9 V$. The work function of potassium is

(a) $2.0 eV$ (b) $2.4 eV$
(c) $3.0 eV$ (d) $2.8 eV$

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

(a)


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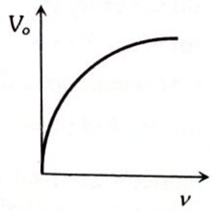

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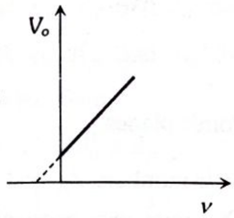

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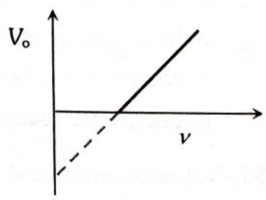
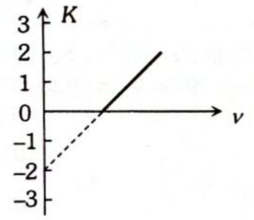


36. Figure represents a graph of kinetic energy (K) of photoelectrons (in eV) and frequency (ν) for a metal used as cathode in photoelectric experiment. The work function of metal is



(a) 1 eV

(b) 1.5 eV

(c) 2 eV

(d) 3 eV

37. A caesium photocell, with a steady potential difference of 60V across, is illuminated by a bright point source of light 50cm 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 carries one quarter of their previous momentum

(d) Each carries one quarter of their previous energy

38. When a monochromatic point source of light is at a distance 0.2m from a photoelectric cell, the saturation current and cut-off voltage are 12.0mA and 0.5V. If the same source is placed 0.4m away from the photoelectric cell, then the saturation current and the stopping potential respectively are

(a) 4mA and 1V (b) 12mA and 1V

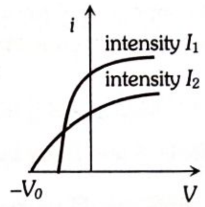
(c) 3mA and 0.5V (d) 12mA and 0.5V

39. A stream of photons having energy 3 eV each impinges on a potassium surface. The work function of potassium is 2.3 eV. The emerging photo – electrons are slowed down by a copper plate placed 5 mm away. If the potential difference between the two metal plates is 1V, the maximum distance the electrons can move away from the potassium surface before being turned back is

(a) 3.5 mm (b) 1.5 mm

(c) 2.5 mm (d) 5.0 mm

40. 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)


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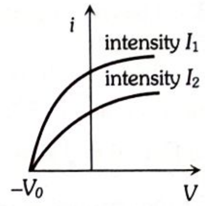

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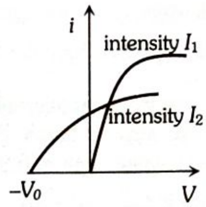
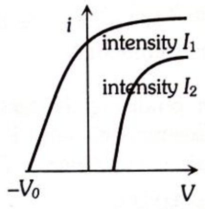


(d)


4. X-Rays

1. 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

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

(a) Detect bone fractures

(b) Treat cancer by controlled exposure

(c) Detect heart diseases

(d) Detect fault in radio receiving circuits

3. 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

4. X–ray beam can be deflected by

(a) Magnetic field (b) Electric field

(c) Both (a) and (b) (d) None of these

5. The structure of solid crystals is investigated by using

(a) Cosmic rays (b) X–rays

(c) Infrared radiations (d) γ–rays

6. The essential distinction between X-rays and γ – rays is 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

7. 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

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

(a) Steel (b) Copper

(c) Aluminium (d) Tungsten

9. 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

10. 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

11. 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) $\frac{h}{eV}$

12. 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

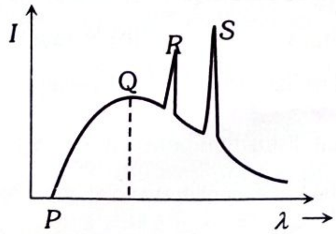
(c) $1 : 25\times10^6$ (d) 25×10^6

13. 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

14. 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 decrease

(d) (b) and (c) both are correct

15. 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 form

(a) Continuous

(b) White X-rays

(c) Continuous and all series of characteristic

(d) None of these

16. 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

17. Two elements A and B with atomic numbers Z_A and Z_B are used to produce characteristic $X-rays$ with frequencies f_A and f_B respectively. If $Z_A : Z_B = 1:2$, then $f_A : f_B$ will be

(a) $1:\sqrt{2}$ (b) $1:8$

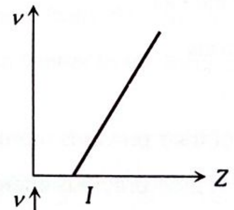
(c) $4:1$ (d) $1:4$

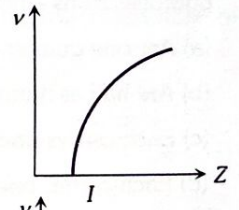
18. X-rays are produced by accelerating electrons by voltage V and let they strike a metal of atomic number Z. The highest frequency of X-rays produced is proportional to

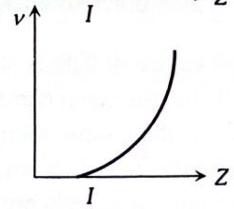
(a) V (b) Z

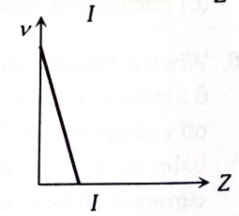
(c) $(Z-1)$ (d) $(Z-1)^2$

19. The graph that correctly represents the relation of frequency ν of a particular characteristic X-ray with the atomic number Z of the material is

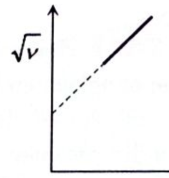
(a) 

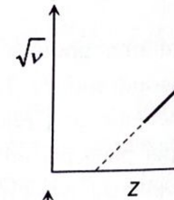
(b) 

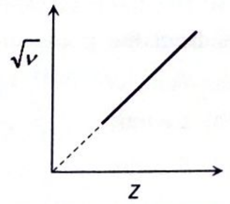
(c) 

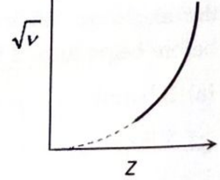
(d) 

20. 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) 

21. 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 $n = 1$

22. The X-ray wavelength of $L\alpha$ line of platinum (Z=78) is 1.30Å. The X –ray wavelength of $L\alpha$ line of Molybdenum (Z=42) is

(a) 5.41 Å (b) 4.20 Å

(c) 2.70 Å (d) 1.35 Å

23. Let λ_α , λ_β 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) $\frac{1}{\lambda_\alpha} + \frac{1}{\lambda_\beta} = \frac{1}{\lambda'_\alpha}$

24. A photon of wavelength λ is absorbed by an electron confined to a box of length $\sqrt{35h\lambda/8mc}$. As a result, the electron makes a transition from state $k=1$ to the state n. Subsequently the electron transits from the state n to the state m by emitting a photon of wavelength $\lambda = 1.75\lambda$. then

(a) $n=4:m=2$ (b) $n=5:m=3$

(c) $n=6:m=4$ (d) $n=3:m=1$

25. Bragg's equation will have no solution if

(a) $\lambda > 2d$ (b) $\lambda < 2d$

(c) $\lambda < d$ (d) $\lambda = d$

5. IIT-JEE/AIEEE

1. If g_E and g_m are the accelerations due to gravity on the surfaces of the earth and the moon respectively and if 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 **[2007]**

(a) 1(b) 0

(c) g_E / g_m (d) g_m / g_E

2. A tiny spherical oil drop carrying a net charge q is balanced in still air with a vertical uniform electric field of strength $\frac{81\pi}{7} \times 10^5\ Vm^{-1}$. When the field is switched off, the drop is observed to fall with terminal velocity $2 \times 10^{-3}\ ms^{-1}$. Given $g = 9.8\ ms^{-2}$, viscosity of the air $= 1.8 \times 10^{-5}\ Nsm^{-2}$ and the density of oil = 900 $kg\ m^{-3}$, the magnitude of q is **[2010]**

(a) $1.6 \times 10^{-19}\ C$ (b) $3.2 \times 10^{-19}\ C$

(c) $4.8 \times 10^{-19}\ C$ (d) $8.0 \times 10^{-19}\ C$

3. As an electron makes a transition from an excited state to the ground state of a hydrogen – like atom/ion **[2015]**

(a) Its kinetic energy increases but potential energy and total energy decrease

(b) Kinetic energy, potential energy and total energy decrease

(c) Kinetic energy decreases, potential energy increases but total energy remains same

(d) Kinetic energy and total energy decreases but potential energy increases

4. If the kinetic energy of a free electron doubles, its de-Broglie wavelength changes by the factor **[2005]**

(a) $1/\sqrt{2}$ (b) $\sqrt{2}$

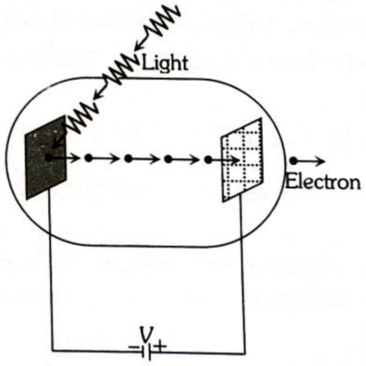
(c) 1/2 (d) 2

5. A photon and an electron have equal energy E. $\lambda_{photon} / \lambda_{electron}$ is proportional to **[2004]**

(a) $\sqrt{E}$ (b) $1/\sqrt{E}$

(c) $1/E$ (d) Does not depend upon E

6. Light of wavelength λ_{ph} falls on a cathode plate inside a vacuum tube as shown in the figure. The work function of the cathode surface is ϕ and the anode is a wire mesh of conducting material kept at a distance d from the cathode. A potential difference V is maintained between the electrodes. If the minimum de Broglie wavelength of the electrons passing through the anode is λ_e, which of the following statement(s) is(are) true **[2016]**



(a) For large potential difference $(V \gg \phi/e)$, λ_e is approximately halved if V is made four times

(b) λ_e increases at the same rate as λ_{ph} for $\lambda_{ph} < hc/\phi$

(c) λ_e is approximately halved, if d is doubled

(d) λ_e decreases with increase in ϕ and λ_{ph}

7. A particle of mass M at rest decays into two particles of masses m_1 and m_2, having non-zero velocities. The ratio of the de-Broglie wavelengths of the particles, λ_1 / λ_2 is **[1999]**

(a) m_1 / m_2 (b) m_2 / m_1

(c) 1.0 (d) $\sqrt{m_2} / \sqrt{m_1}$

8. A photoelectric material having work-function ϕ_0 is illuminated with light of wavelength $\lambda\left(\lambda < \frac{hc}{\phi_0}\right)$. The fastest photoelectron has a de Broglie wavelength λ_d. A change in wavelength of the incident light by $\Delta\lambda$ results in a change $\Delta\lambda_d$ in λ_d. Then the ratio $\frac{\Delta\lambda_d}{\Delta\lambda}$ is proportional to **[2017]**

(a) $\frac{\lambda_d^3}{\lambda^2}$ (b) $\frac{\lambda_d^3}{\lambda}$

(c) $\frac{\lambda_d^2}{\lambda^2}$ (d) $\frac{\lambda_d}{\lambda}$

9. An election from various excited states of hydrogen atom emits radiation to come to the ground state. Let λ_n, λ_g be the de Broglie wavelength of the electron in the n^{th} state and the ground state respectively. Let Λ_n be the wavelength of the emitted photon in transition from the n^{th} state to the ground state. For large n, (A, B are constants) **[2018]**

(a) $\wedge_n \approx +\lambda_n^2$ (b) $\wedge_n \approx \lambda$

(c) $\wedge_n \approx \wedge + \frac{B}{\lambda_n^2}$ (d) $\wedge_n \approx +\lambda_n$

10. The momentum of a photon of energy hf will be **[2007]**

(a) hf (b) hf/c

(c) hfc (d) h/f

11. A pulse of light of duration 100 ns is absorbed completely by a small object initially at rest. Power of the pulse is $30mW$ and the speed of light is $3\times10^8 ms^{-1}$. The final momentum of the object is **[2013]**

(a) $0.3\times10^{-17} kg\,ms^{-1}$ (b) $1.0\times10^{-17} kg\,ms^{-1}$

(c) $3.0\times10^{-17} kg\,ms^{-1}$ (d) $9.0\times10^{-17} kg\,ms^{-1}$

12. If a source of power $4kW$ produces 10^{20} photons/second, the radiation belongs to a part of the spectrum called **[2010]**

(a) γ -rays (b) X-rays

(c) Ultraviolet rays (d) Microwaves

13. 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) **[2009]**

(a) 3.09 eV (b) 1.41 eV

(c) 1.51 eV (d) 1.68 eV

14. If a photon has velocity c and frequency ν, then which of following represents its wavelength **[2002]**

(a) $\frac{hc}{E}$ (b) $\frac{h\nu}{c}$

(c) $\frac{h\nu}{c^2}$ (d) $h\nu$

15. The time taken by a photoelectron to come out after the photon strikes is approximately **[2006]**

(a) 10^{-10} s (b) 10^{-16} s

(c) 10^{-1} s (d) 10^{-4} s

16. 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 **[1998]**

(a) 540 nm (b) 400 nm

(c) 310 nm (d) 220 nm

17. The maximum kinetic energy of photoelectrons emitted from a surface when photons of energy 6 eV fall on it is 4 eV. The stopping potential in *volts* is **[1997]**

(a) 2 (b) 4

(c) 6 (d) 10

18. Light of two different frequencies whose photons have energies $1eV$ and $2.5eV$ respectively, successively illuminates a metal of work function $0.5eV$. The ratio of maximum kinetic energy of the emitted electron will be **[2002]**

(a) 1 : 5 (b) 1 : 4

(c) 1 : 2 (d) 1 : 1

19. Sodium and copper have work functions 2.3 eV and 4.5 eV respectively. Then the ratio of their threshold wavelengths is nearest to **[2002]**

(a) 1: 2 (b) 4 : 1

(c) 2 : 1 (d) 1 : 4

20. Two identical photo-cathodes receive light of frequencies f_1 and f_2. If the velocities of the photo electrons (of mass m) coming out are respectively v_1 and v_2, then **[2003]**

(a) $v_1 - v_2 = \left[\frac{2h}{m}(f_1 - f_2)\right]^{1/2}$ (b) $v_1^2 - v_2^2 = \frac{2h}{m}(f_1 - f_2)$

(c) $v_1 + v_2 = \left[\frac{2h}{m}(f_1 + f_2)\right]^{1/2}$ (d) $v_1^2 + v_2^2 = \frac{2h}{m}(f_1 + f_2)$

21. 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 **[2006]**

(a) Infra-red region (b) Visible region

(c) X-ray region (d) Ultra-violet region

22. The threshold wavelength for photoelectric emission from a material is 5200 Å. Photo-electrons will be emitted when this material is illuminated with monochromatic radiation from a **[1982]**

(a) 50 watt infrared lamp (b) 1 watt infrared lamp

(c) 50 watt ultraviolet lamp (d) 1 watt ultraviolet lamp

(e) Both (c) and (d)

23. The radiation corresponding to $3 \rightarrow 2$ transition of hydrogen atom falls on a metal surface to produce photoelectrons. These electrons are made to enter a magnetic field of $3 \times 10^{-4}\ T$. If the radius of the largest circular path followed by these electrons is 10.0 mm, the work function of the metal is close to **[2014]**

(a) 1.8 eV (b) 1.1 eV

(c) 0.8 eV (d) 1.6 eV

24. A metal surface is illuminated by light of two different wavelengths 248 nm and 310 nm. The maximum speeds of the photoelectrons corresponding to these wavelengths are u_1 and u_2 respectively. If the ratio $u_1 : u_2 = 2:1$ and hc=1240 $eV\ nm$, the work function of the metal is nearly **[2014]**

(a) 3.7 eV (b) 3.2 eV

(c) 2.8 eV (d) 2.5 eV

25. In a historical experiment to determine Planck's constant, a metal surface was irradiated with light of different wavelengths. The emitted photoelectron energies were measured by applying a stopping potential. The relevant data for the wavelength (λ) of incident light and the corresponding stopping potential (v_0) are given below

$\lambda (\mu m)$	v_0 (Volt)
0.3	2.0
0.4	1.0
0.5	0.4

Given that $c = 3 \times 10^8 ms^{-1}$ and $e = 1.6 \times 10^{-19} C$, Planck's constant (in units of $J\ s$) found from such an experiment is **[2016]**

(a) 6.0×10^{-34} (b) 6.4×10^{-34}

(c) 6.6×10^{-34} (d) 6.8×10^{-34}

26. 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 **[2016]**

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

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

(c) Less than $v\,(4/3)^{1/2}$

(d) Greater than $v\,(4/3)^{1/2}$

27. 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 **[2005]**

(a) 2 (b) 1

(c) $\sqrt{2}$ (d) $\frac{1}{\sqrt{2}}$

28. 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 **[2005]**

(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

29. According to Einstein's photoelectric equation, the plot of the kinetic energy of the emitted photo electrons from a metal versus the frequency, of the incident radiation gives a straight line whose slope **[2004]**

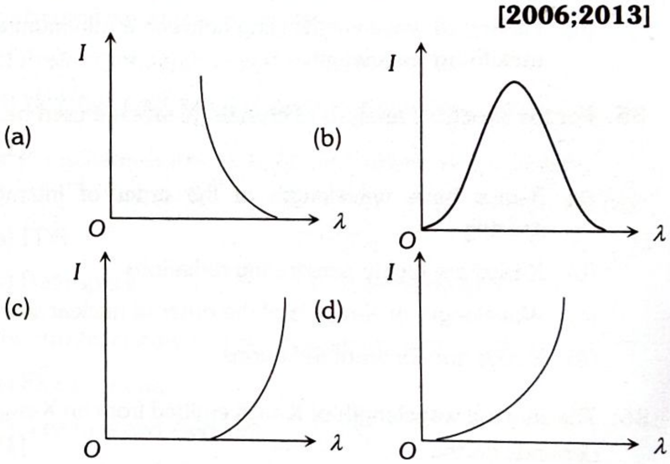
(a) Is the same for all metals and independent of the intensity of the radiation

(b) Depends on the intensity of the radiation

(c) Depends both on the intensity of the radiation and the metal used

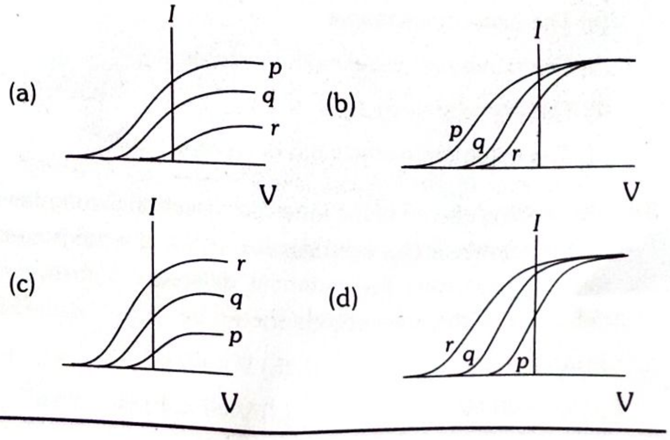
(d) Depends on the nature of the metals used

30. 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 **[2006;2013]**



31. 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 $\phi_r = 3.0\,eV$, 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. **[2009]**

[Take $hc = 1240\,eV\ nm$]



32. 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 **[2005]**

(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

33. When a point source of monochromatic light is at a distance of 0.2 *m* from a photoelectric cell, the cut-off voltage and the saturation current are 0.6 *volt* and 18 *mA* respectively. If the same source is placed 0.6 *m* away from the photoelectric cell, then **[1992]**

(a) The stopping potential will be 0.2 *V*

(b) The stopping potential will be 0.6 *V*

(c) The saturation current will be 6 *mA*

(d) The saturation current will be 18 *mA*

34. The X–ray beam coming from an X-ray tube will be **[1985]**

(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

35. For the structural analysis of crystals, X-rays are used because **[1992]**

(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

36. The shortest wavelength of X-rays emitted from an X-ray tube depends on the **[1982]**

(a) Current in the tube

(b) Voltage applied to the tube

(c) Nature of gas in the tube

(d) Atomic number of target material

37. The potential difference applied to an X-ray tube is increased. As a result, in the emitted radiation **[1988]**

(a) The intensity increases

(b) The minimum wavelength increases

(c) The intensity decreases

(d) The minimum wavelength decreases

38. 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 **[1985]**

(a) $V < 40\ kV$ (b) $V \le 40\ kV$

(c) $V > 40\ kV$ (d) V >/< 40 *kV*

39. In above question the energy of the characteristic X-rays given out is **[1985]**

(a) Less than 40 *keV* (b) More than 40 *keV*

(c) Equal to 40 *keV* (d) ≥ 40 *keV*

40. The potential difference applied to an X-ray tube is 5*kV* and the current through it is 3.2 *mA*. Then the number of electrons striking the target per second is **[2002]**

(a) 2×10^{16} (b) 5×10^{16}

(c) 1×10^{17} (d) 4×10^{15}

41. Arrange the following electromagnetic radiations per quantum in the order of increasing energy **[2016]**

A : Blue light B : Yellow light

C : X-ray D : Radiowave

(a) A, B, D, C (b) C, A, B, D

(c) B, A, D, C (d) D, B, A, C

42. Which one of the following statement is **WRONG** in the context of X-rays generated from a X-ray tube **[2008]**

(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 the X-ray tube

43. 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 **[2007]**

(a) $\lambda_0 = \dfrac{2mc\lambda^2}{h}$ (b) $\lambda_0 = \dfrac{2h}{mc}$

(c) $\lambda_0 = \dfrac{2m^2c^2\lambda^3}{h^2}$ (d) $\lambda_0 = \lambda$

44. X-rays are produced in X-ray tube operating at a given accelerating voltage. The wavelength of the continuous X-rays has values from **[1998]**

(a) 0 to ∞

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

(c) 0 to λ_{max}, where $\lambda_{max} < \infty$

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

45. The wavelength of K_α X-rays produced by an X-ray tube is 0.76 Å. The atomic number of the anode material of the tube is **[1996]**

(a) 20 (b) 60

(c) 40 (d) 80

46. Electrons with energy 80 keV are incident on the tungsten target of an X-ray tube. K shell electrons of tungsten have ionization energy 72.5 keV. X-rays emitted by the tube contain only **[2000]**

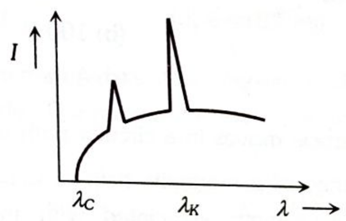
(a) A continuous X-ray spectrum (Bremsstrahlung) with a minimum wavelength of ~ 0.155Å

(b) A continuous X-ray spectrum (Bremsstrahlung] with all wavelengths

(c) The characteristic X-rays spectrum of tungsten

(d) A continuous X-ray spectrum (Bremsstrahlung) with a minimum wavelength of ~ 0.155Å and the characteristic X-ray spectrum of tungsten

47. The intensity of X-rays from a Coolidge tube is plotted against wavelength as shown in the figure. The minimum wavelength found is λ_c and the wavelength of the K_α line is λ_k. As the accelerating voltage is increased **[2001]**



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

48. The K_α X-ray emission line of tungsten occurs at λ=0.021nm. The energy difference between K and L levels in this atom is about **[1997]**

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

49. 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 **[2005]**

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

6. NEET/AIPMT

1. Gases begin to conduct electricity at low pressure because **[1994]**

(a) At low pressure, gases turn to plasma

(b) Colliding electrons can acquire higher kinetic energy due to increased mean free path leading to ionisation of atoms

(c) Atoms break up into electrons and protons

(d) The electrons in atoms can move freely at low pressure

2. Which of the following is not the property of a cathode ray **[2002]**

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

3. A beam of cathode rays is subjected to crossed Electric (E) and Magnetic fields (B). The fields are adjusted such that the beam is not deflected. The specific charge of the cathode rays is given by **[2010]**

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

4. In the phenomenon of electron discharge through gases at low pressure, the coloured glow in the tube appears as a result of **[2008]**

(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

5. In a discharge tube ionization of enclosed gas is produced due to collisions between **[2006]**

(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

6. In a discharge tube at 0.02 mm, there is a formation of **[1996]**

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

7. The current conduction in a discharged tube is due to **[1999]**

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

8. 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 **[2000]**

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

9. 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 become **[1999]**

(a) $v/2$
(b) v
(c) $3v/2$
(d) $2v$

10. The kinetic energy of an electron which is accelerated through a potential of 100 *volts* is **[1997]**

(a) $1.602\times10^{-17} J$ (b) 418.6 *calories*

(c) $1.16\times10^{4} K$ (d) $6.626\times10^{-34} W\text{-}sec$

11. A proton and an alpha particle both enter a region of uniform magnetic field B, moving at right angles to field B. If the radius of circular orbits for both the particles is equal and the kinetic energy acquired by proton is 1 *MeV* the energy acquired by the alpha particle will be **[2015]**

(a) 0.5 *MeV* (b) 1.5 *eV*

(c) 1 *MeV* (d) 4 *MeV*

12. Consider 3rd orbit of He^{+} (Helium), using non-relativistic approach, the speed of electron in this orbit will be [given $K = 9\times10^{9}$ constant, $Z = 2$ and h (Plank's constant) $= 6.6\times10^{-34} Js$] **[2015]**

(a) $1.46\times10^{6} m/s$ (b) $0.73\times10^{6} m/s$

(c) 3.0×10^{8} (d) $2.92\times10^{6} m/s$

13. A particle of mass 1 *mg* has the same wavelength as an electron moving with a velocity of $3\times10^{6} ms^{-1}$. The velocity of the particle is **[2008]**

(a) $3\times10^{-31} ms^{-1}$ (b) $2.7\times10^{-21} ms^{-1}$

(c) $2.7\times10^{-18} ms^{-1}$ (d) $9\times10^{-2} ms^{-1}$

(Mass of electron $= 9.1\times10^{-31} kg$)

14. 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 **[1995]**

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

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

15. If particles are moving with same velocity, then maximum de-Broglie wavelength will be for **[2002]**

(a) Neutron (b) Proton

(c) β-particle (d) α -particle

16. If an electron and a photon propagate in the form of waves having the same wavelength, it implies that they have the same **[1995]**

(a) Energy (b) Momentum

(c) Velocity (d) Angular momentum

17. The wavelength λ_e of an electron and λ_p of a photon of same energy E are related by **[2013]**

(a) $\lambda_p \propto \lambda_e$ (b) $\lambda_p \propto \lambda_e^2$

(c) $\lambda_p \propto \sqrt{\lambda_e}$ (d) $\lambda_p \propto \frac{1}{\sqrt{\lambda_e}}$

18. 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 **[2011]**

(a) Increase by 4 times (b) Increase by 2 times

(c) Decrease by 2 times (d) Decrease by 4 times

19. If the kinetic energy of the particle is increased to 16 times its previous value, the percentage change in the de-Broglie wavelength of the particle is **[2014]**

(a) 60 (b) 50

(c) 25 (d) 75

20. 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 **[2012]**

(a) P_0 (b) $100\ P_0$

(c) $400\ P_0$ (d) $4\ P_0$

21. 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 **[2012]**

(a) 1 Å (b) 0.1 Å

(c) 10 Å (d) 0.01 Å

22. The de-Broglie wavelength of neutrons in thermal equilibrium at temperature T is **[2013]**

(a) $\frac{3.08}{\sqrt{T}}$ Å (b) $\frac{0.308}{\sqrt{T}}$ Å

(c) $\frac{0.0308}{\sqrt{T}}$ Å (d) $\frac{30.8}{\sqrt{T}}$ Å

23. An electron of mass m and a photon have same energy E. The ratio of de-Broglie wavelengths associated with them is **[2016]**

(a) $\frac{1}{c}\left(\frac{E}{2m}\right)^{\frac{1}{2}}$ (b) $\left(\frac{E}{2m}\right)^{\frac{1}{2}}$

(c) $c(2mE)^{\frac{1}{2}}$ (d) $\frac{1}{xc}\left(\frac{2m}{E}\right)^{\frac{1}{2}}$

24. In the Davisson and Germer experiment, the velocity of electrons emitted from the electron gun can be increased by **[2011]**

(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

25. The de-Broglie wavelength of a neutron in thermal equilibrium with heavy water at a temperature T (Kelvin) and mass m, is **[2017]**

(a) $\frac{h}{\sqrt{mkT}}$ (b) $\frac{h}{\sqrt{3mkT}}$

(c) $\frac{2h}{\sqrt{3mkT}}$ (d) $\frac{2h}{\sqrt{mkT}}$

26. Which of the following shows particle nature of light **[2001]**

(a) Refraction (b) Interference

(c) Polarization (d) Photoelectric effect

27. The momentum of a photon is 2×10^{-16} $gm\text{-}cm/sec$. Its energy is **[1974;2006]**

(a) 0.61×10^{-26} erg (b) 2.0×10^{-26} erg

(c) 6×10^{-6} erg (d) 6×10^{-8} erg

28. A radio transmitter operates at a frequency of 880 kHz and a power of 10 kW. The number of photons emitted per second are **[1990]**

(a) 1.72×10^{31} (b) 1327×10^{34}

(c) 13.27×10^{34} (d) 0.075×10^{-34}

29. A 200W sodium street lamp emits yellow light of wavelength 0.6 μm. Assuming it to be 25% efficient in converting electrical energy to light, the number of photons of yellow light it emits per second is **[2012]**

(a) 1.5×10^{20} (b) 6×10^{18}

(c) 62×10^{20} (d) 3×10^{19}

30. 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 **[2010]**

(a) 0.98 (b) 1.00

(c) 1.02 (d) 1.04

31. 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 **[2010]**

(a) N and $2T$ (b) $2N$ and T

(c) $2N$ and $2T$ (d) N and T

32. Wavelength of a 1 keV photon is $1.24\times10^{-9}m$. What is the frequency of 1 MeV photon **[1993]**

(a) $1.24\times10^{15}Hz$ (b) $2.4\times10^{20}Hz$

(c) $1.24\times10^{18}Hz$ (d) $2.4\times10^{23}Hz$

33. The electrons are emitted in the photoelectric effect from a metal surface **[2011]**

(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

34. The work function of a metal is 4.2 eV, its threshold wavelength will be **[1999]**

(a) 4000 Å (b) 3500 Å

(c) 2955 Å (d) 2500 Å

35. Ultraviolet radiations of $6.2\,eV$ falls on an aluminium surface (work function $4.2\ eV$). The kinetic energy in joules of the fastest electron emitted is approximately **[1993]**

(a) 3.2×10^{-21} (b) 3.2×10^{-19}

(c) 3.2×10^{-17} (d) 3.2×10^{-15}

36. For photoelectric emission from certain metal the cut off frequency is ν. If radiation of frequency 2ν impinges on the metal plate, the maximum possible velocity of the emitted electron will be (m is the electron mass) **[2013]**

(a) $2\sqrt{h\nu/m}$ (b) $\sqrt{h\nu/(2m)}$

(c) $\sqrt{h\nu/m}$ (d) $\sqrt{2h\nu/m}$

37. Light of wavelength 5000 Å falls on a sensitive plate with photoelectric work function of 1.9 eV. The kinetic energy of the photoelectron emitted will be **[1998]**

(a) 0.58 eV (b) 2.48 eV

(c) 1.24 eV (d) 1.16 eV

38. When light of wavelength 300 nm (nanometer) falls on a photoelectric emitter, photoelectrons are liberated. For another emitter, however light of 600 nm wavelength is sufficient for creating photoemission. What is the ratio of the work functions of the two emitters **[1993]**

(a) 1 : 2 (b) 2 : 1

(c) 4 : 1 (d) 1 : 4

39. 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 **[2011]**

(a) 4.9 V (b) 3.0 V

(c) 2.0 V (d) 1.0 V

40. In photoelectric effect, the electrons are ejected from metals if the incident light has certain minimum **[2011]**

(a) Wavelength (b) Frequency

(c) Amplitude (d) Angle of incidence

41. When photons of energy $h\nu$ 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 **[2006]**

(a) K (b) $K + h\nu$

(c) $K + E_0$ (d) $2K$

42. 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 **[2011]**

(a) 3 eV (b) 1.2 eV

(c) 0.6 eV (d) 1.4 eV

43. When ultraviolet rays are incident on metal plate, then photoelectric effect does not occur. It occurs by the incidence of **[2002]**

(a) X-rays (b) Radio wave

(c) Infrared rays (d) Green house effect

44. 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 4×10^6 m/s. When the photon energy is increases to $5h\nu_0$ then maximum velocity of photo electron will be **[2005]**

(a) 2×10^6 m/s (b) 2×10^7 m/s

(c) 8×10^5 m/s (d) 8×10^6 m/s

45. 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 **[2005]**

(a) None of these (b) A only

(c) A and B only (d) All the three metals

46. When the energy of the incident radiation is increased by 20%, the kinetic energy of the photoelectrons emitted from a metal surface increased from 0.5 eV to 0.8 eV. The work function of the metal is **[2014]**

(a) 1.3 eV (b) 1.5 eV

(c) 0.65 eV (d) 1.0 eV

47. A photoelectric surface is illuminated successively by monochromatic light of wavelength λ and $\frac{\lambda}{2}$. If the maximum kinetic energy of the emitted photoelectrons in the second case is 3 times that in the first case, the work function of the surface of the material is (h = Planck's constant, c = speed of light) **[2015]**

(a) $\frac{hc}{\lambda}$ (b) $\frac{2hc}{\lambda}$

(c) $\frac{hc}{3\lambda}$ (d) $\frac{hc}{2\lambda}$

48. The work function of a metallic surface is 5.01 eV. The photo-electrons are emitted when light of wavelength 2000Å falls on it. The potential difference applied to stop the fastest photo-electrons is $[h = 4.14\times10^{-15}$ eV sec$]$ **[2010]**

(a) 1.2 $volts$ (b) 2.24 $volts$

(c) 3.6 $volts$ (d) 4.8 $volts$

49. An electron in the hydrogen atom jumps from 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 **[2011]**

(a) 5 (b) 2

(c) 3 (d) 4

50. Light of wavelength 500nm is incident on a metal with work function 2.28eV. The de Broglie wavelength of the emitted electron is **[2015]**

(a) $< 2.8\times10^{-9}m$ (b) $\geq 2.8\times10^{-9}m$

(c) $\leq 2.8\times10^{-12}m$ (d) $< 2.8\times10^{-10}m$

51. A certain metallic surface is illuminated with monochromatic light of wavelength λ. The stopping potential for photoelectric current for this light is $3V_0$. If the same surface is illuminated with light of wavelength 2λ, The stopping potential is V_0. The threshold wavelength for this surface for photoelectric effect is **[2015]**

(a) 4λ (b) $\frac{\lambda}{4}$

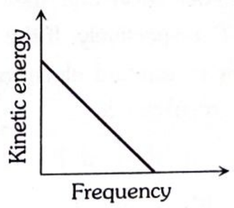
(c) $\frac{\lambda}{6}$ (d) 6λ

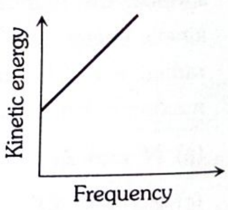
52. When a metallic surface is illuminated with radiation of wavelength λ, the stopping potential is V. If the same surface is illuminated with radiation of wavelength 2λ, the stopping potential is $\frac{V}{4}$. The threshold wavelength for the metallic surface is **[2016]**

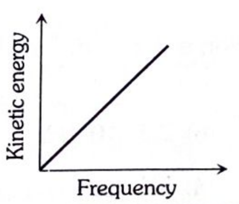
(a) 4λ (b) 5λ

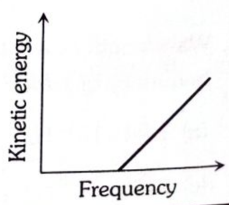
(c) $\frac{5}{2}\lambda$ (d) 3λ

53. According to Einstein's photoelectric equation, the graph between the kinetic energy of photoelectrons ejected and the frequency of incident radiation is **[1996]**

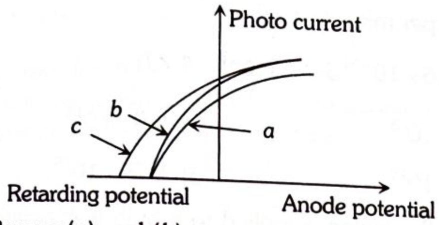
(a)


(b)


(c)


(d)


54. The figure shows a plot of photo current versus anode potential for a photo sensitive surface for three different radiations. Which one of the following is a *correct* statement **[2009]**



(a) Curves (a) and (b) represent incident radiations of different frequencies and different intensities

(b) Curves (a) and (b) represent 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

55. The number of photo-electrons emitted per second from a metal surface increases when **[1993]**

(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

56. 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 **[2003]**

(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

57. A source of light is placed at a distance of 50 cm from a photo cell and the stopping potential is found to be V_0. If the distance between the light source and photo cell is made 25 cm, the new stopping potential will be **[2013]**

(a) $V_0/2$ (b) V_0

(c) $4V_0$ (d) $2V_0$

58. 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 $h\nu > W_2$) **[1992]**

(a) $I_1 = I_2$ (b) $I_1 < I_2$

(c) $I_1 > I_2$ (d) $I_1 < I_2 < 2I_1$

59. A photo-cell employs photoelectric effect to convert **[2006]**

(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

60. The photoelectric threshold wavelength of silver is $3250 \times 10^{-10} m$. The velocity of the electron ejected from a silver surface by ultraviolet light of wavelength $2536 \times 10^{-10} m$ is **[2017]**

(Given $h = 4.14 \times 10^{-15} eVs$ and $c = 3 \times 10^8 ms^{-1}$)

(a) $\approx 6 \times 10^5 ms^{-1}$ (b) $\approx 0.6 \times 10^6 ms^{-1}$

(c) $\approx 61 \times 10^3 ms^{-1}$ (d) $\approx 0.3 \times 10^6 ms^{-1}$

61. When the light of frequency $2\upsilon_0$ (where υ_0 is threshold frequency), is incident on a metal plate, the maximum velocity of electrons emitted is υ_1. When the frequency of the incident radiation is increased to $5\upsilon_0$, the maximum velocity of electrons emitted from the same plate is υ_2. The ratio of υ_1 to υ_2 is **[2018]**

(a) 1 : 2 (b) 1 : 4

(c) 4 : 1 (d) 2 : 1

62. Photons with energy 5 eV are incident on a cathode C in a photoelectric cell. The maximum energy of emitted photoelectrons is 2 eV. When photons of energy 6 eV are incident on C, no photoelectrons will reach the anode A, if the stopping potential of A relative to C is **[2016]**

(a) – 1 V (b) – 3 V

(c) + 3 V (d) + 4 V

63. The most penetrating radiation out of the following is **[1997]**

(a) X-rays (b) β-rays

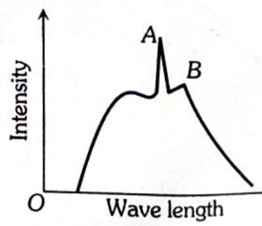
(c) α – particles (d) γ – rays

64. The energy of the e-m waves is of the order of 15 keV. To which part of the spectrum does it belong **[2015]**

(a) Infra-red rays (b) Ultraviolet rays

(c) γ – rays (d) X-ray

65. 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 **[1995]**



(a) Band spectrum (b) Continuous spectrum

(c) Characteristic radiations (d) White radiations

66. Electrons of mass m with de-Broglie wavelength λ fall on the target in an X-ray tube. The cut-off wavelength (λ_0) of the emitted X-ray is **[2016]**

(a) $\lambda_0 = \dfrac{2m^2c^2\lambda^3}{h^2}$ (b) $\lambda_0 = \lambda$

(c) $\lambda_0 = \dfrac{2mc\lambda^2}{h}$ (d) $\lambda_0 = \dfrac{2h}{mc}$

7. AIIMS

1. A charged oil drop of mass $2.5\times10^{-7}\,kg$ is in space between the two plates, each of area $2\times10^{-2}\,m^2$ of a parallel plate capacitor. When the upper plate has a charge of $5\times10^{-7}\,C$ 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) **[2010]**

(a) $9\times10^{-1}C$ (b) $9\times10^{-6}C$

(c) $8.85\times10^{-13}C$ (d) $1.8\times10^{-14}C$

2. An electron is accelerated through a p.d. of 45.5 *volt*. The velocity acquired by it is (in ms^{-1}) **[2004]**

(a) 4×10^6 (b) 4×10^4

(c) 10^6 (d) Zero

3. Particle nature and wave nature of electromagnetic waves and electrons can be shown by **[2000]**

(a) Electron has small mass, deflected by the metal sheet

(b) X-ray is diffracted, reflected by thick metal sheet

(c) Light is refracted and diffracted

(d) Photoelectricity and electron microscopy

4. The speed of an electron having a wavelength of $10^{-10}m$ is **[2002]**

(a) $7.25\times10^6\ m/s$ (b) $6.26\times10^6\ m/s$

(c) $5.25\times10^6\ m/s$ (d) $4.24\times10^6\ m/s$

5. If Alpha, Beta and Gamma rays carry same momentum, which has the longest wavelength **[2006]**

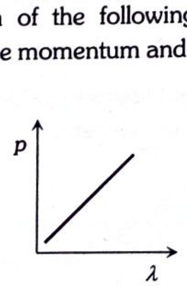
(a) Alpha rays

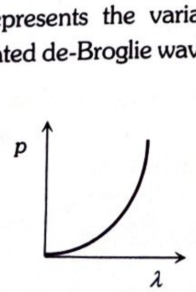
(b) Beta rays

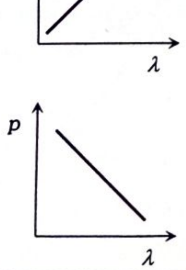
(c) Gamma rays

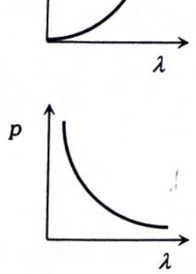
(d) None, all have same wavelength

6. Which of the following figure represents the variation of particle momentum and the associated de-Broglie wavelength **[1982]**

(a)


(b)


(c)


(d)


7. 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 Å then how many photons are received on the earth per cm^2 per min **[2007]**

$(h = 6.6\times10^{-34}\,J-s, 1\ \text{cal} = 4.2J)$.

(a) 1.5×10^{13} (b) 2.9×10^{13}

(c) 2.3×10^{19} (d) 1.75×10^{19}

8. If 5% of the energy supplied to a bulb is irradiated as visible light, how many quanta are emitted per second by a 100 *W* lamp (Assume wavelength of visible light as $5.6\times10^{-5}cm$) **[2010]**

(a) 1.4×10^{19} (b) 3×10^3

(c) 1.4×10^{-19} (d) 3×10^4

9. 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 **[2011]**

(a) 10 *m/s* (b) $1\times10^3\ m/s$

(c) $1\times10^4\ m/s$ (d) $1\times10^6\ m/s$

10. 4 *eV* is the energy of the incident photon and the work function is 2*eV*. What is the stopping potential **[2004]**

(a) 2*V* (b) 4*V*

(c) 6*V* (d) $2\sqrt{2}V$

11. Which of the following is dependent on the intensity of incident radiation in a photoelectric experiment **[1998]**

(a) Work function of the surface

(b) Amount of photoelectric current

(c) Stopping potential will be reduced

(d) Maximum kinetic energy of photoelectrons

12. When cathode rays strike a metal target of high melting point with very high velocity, then **[1999]**

(a) X-rays are produced

(b) Alpha-rays are produced

(c) UV waves are produced

(d) Ultrasonic waves are produced

13. What is the difference between soft and hard X-rays **[2002]**

(a) Velocity (b) Intensity

(c) Frequency (d) Polarization

14. Characteristic X-rays are produced due to **[2003]**

(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

15. A beam of 35.0 keV electrons strikes a molybdenum target, generating the X–rays. What is the cut-off wavelength **[2007]**

(a) 35.5 pm (b) 40.0 pm

(c) 15.95 pm (d) 18.2 pm

16. Hard X-rays 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 **[2006]**

(a) < 124.2 kV

(b) > 124.2 kV

(c) Between 60 kV and 70 kV

(d) = 100 kV

17. 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 **[2007]**

$$h=6.63\times10^{-34} J-s\ , e=1.6\times10^{-19} J.$$

(a) 0.52 KeV (b) 0.75 eV

(c) 0.52 eV (d) 0.75 keV

18. 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 **[2005]**

(a) $f\propto\sqrt{Z}$ (b) $f\propto Z^2$

(c) $f\propto Z$ (d) $f\propto Z^{3/2}$

8. Assertion & Reason

Read the assertion and reason carefully to mark the correct option out of the options given below:

(a) If both assertion and reason are true and the reason is the correct explanation of the assertion.

(b) If both assertion and reason are true but reason is not the correct explanation of the assertion.

(c) If assertion is true but reason is false.

(d) If the assertion and reason both are false.

(e) If assertion is false but reason is true.

1. Assertion : The energy (E) and momentum (p) of a photon are related by $p=E/c$

Reason : The photon behaves like a particle

2. Assertion : Photoelectric effect demonstrates the wave nature of light.

Reason : The number of photoelectrons is proportional to the frequency of light.

3. Assertion : When the speed of an electron increases its specific charge decreases.

Reason : Specific charge is the ratio of the charge to mass.

4. Assertion : X-rays travel with the speed of light.

Reason : X-rays are electromagnetic rays.

5. Assertion : Mass of moving photon varies inversely as the wavelength.

Reason : Energy of the particle $=\text{Mass}\times(\text{Speed of light})^2$

6. Assertion : Kinetic energy of photo electrons emitted by a photosensitive surface depends upon the intensity of incident photon.

Reason : The ejection of electrons from metallic surface is possible with frequency of incident photon below the threshold frequency.

7. Assertion : Separation of isotope is possible because of the difference in electron numbers of isotope.

Reason : Isotope of an element can be separated by using a mass spectrometer.

8. Assertion : The specific charge of positive rays is not universal constant.

Reason : The mass of ions varies with speed.

9. Assertion : Photosensitivity of a metal is high if its work function is small.

Reason : Work function $=hf_0$ where f_0 is the threshold frequency.

10. Assertion : The de-Broglie wavelength of a molecule varies inversely as the square root of temperature.

Reason : The root mean square velocity of the molecule depends on the temperature.

11. Assertion : Electric conduction in gases is possible at normal pressure.

Reason : The electric conduction in gases depends only upon the potential difference between the electrodes.

12. Assertion : The photoelectrons produced by a monochromatic light beam incident on a metal surface have a spread in their kinetic energies.

Reason : The work function of the metal varies as a function of depth from the surface.

13. Assertion : The specific charge for positive rays is a characteristic constant.

Reason : The specific charge depends on charge and mass of positive ions present in positive rays.

14. Assertion : In the process of photoelectric emission, all the emitted photoelectrons have the same kinetic energy.

Reason : The photon transfers its whole energy to the electron of the atom in photoelectric effect.

15. Assertion : Standard optical diffraction can not be used for discriminating between different X-ray wavelengths.

Reason : The grating spacing is not of the order of X-ray wavelengths.

16. Assertion : The threshold frequency of photoelectric effect supports the particle nature of sunlight.

Reason : If frequency of incident light is less than the threshold frequency, electrons are not emitted from metal surface.

17. Assertion : X-rays can penetrate through the flesh but not through the bones.

Reason : The penetrating power of X-rays depends on voltage.

18. Assertion : Penetrating power of X-rays increases with the increasing the wavelength.

Reason : The penetrating power of X-rays increases with the frequency of X -rays.

19. Assertion : Davisson-Germer experiment established the wave nature of electrons.

Reason : If electrons have wave nature, they can interfere and show diffraction.

24. Electron, Photon, Photoelectric Effect and X-rays – Answers Keys

1. Cathode Rays and Positive Rays

1	c	2	a	3	c	4	b	5	c
6	d	7	c	8	d	9	b	10	a
11	c	12	b	13	a	14	c	15	d

2. Matter Waves

1	c	2	a	3	b	4	c	5	b
6	b	7	c	8	a	9	c	10	b
11	b	12	a	13	b	14	d	15	a
16	c	17	d	18	c	19	c	20	b

3. Photon and Photoelectric Effect

1	a	2	c	3	d	4	d	5	a
6	a	7	a	8	b	9	c	10	c
11	c	12	a	13	d	14	c	15	b
16	a	17	c	18	b	19	d	20	a
21	d	22	c	23	b	24	b	25	b
26	c	27	b	28	d	29	b	30	a
31	b	32	b	33	b	34	b	35	d
36	c	37	a	38	c	39	a	40	b

4. X-Rays

1	a	2	b	3	a	4	d	5	b
6	b	7	c	8	d	9	d	10	a
11	c	12	b	13	a	14	d	15	c
16	c	17	d	18	d	19	c	20	b
21	d	22	a	23	c	24	c	25	a

5. IIT-JEE/AIEEE

1	a	2	d	3	a	4	a	5	b
6	a	7	c	8	a	9	c	10	b
11	b	12	b	13	b	14	a	15	a
16	c	17	b	18	b	19	c	20	b
21	d	22	e	23	b	24	a	25	b
26	d	27	c	28	c	29	a	30	a
31	a	32	d	33	b	34	c	35	a
36	b	37	d	38	c	39	a	40	a
41	d	42	b	43	a	44	b	45	c
46	d	47	a	48	c	49	a		

6. NEET/AIPMT

1	b	2	d	3	a	4	a	5	d
6	b	7	d	8	b	9	c	10	a
11	c	12	a	13	c	14	b	15	c
16	b	17	b	18	c	19	d	20	c
21	d	22	d	23	a	24	b	25	b
26	d	27	c	28	a	29	a	30	b
31	b	32	b	33	a	34	c	35	b
36	d	37	a	38	b	39	c	40	b
41	b	42	c	43	a	44	d	45	c
46	d	47	d	48	a	49	d	50	b
51	a	52	d	53	d	54	b	55	d
56	d	57	b	58	a	59	d	60	ab
61	a	62	b	63	d	64	d	65	c
66	c								

7. AIIMS

1	c	**2**	a	**3**	d	**4**	a	**5**	d
6	d	**7**	c	**8**	a	**9**	d	**10**	a
11	b	**12**	a	**13**	c	**14**	b	**15**	a
16	a	**17**	a	**18**	b				

8. Assertion & Reason

1	a	**2**	d	**3**	b	**4**	a	**5**	b
6	d	**7**	e	**8**	b	**9**	b	**10**	a
11	d	**12**	c	**13**	b	**14**	e	**15**	a
16	b	**17**	b	**18**	e	**19**	a		