WAVES AND PARTICLES

1. De Broglie wavelength associated with the charges particles –
   (i) The energy of a charged particle accelerated through potential difference
   $E = \frac{1}{2} = mv^2 = qV$ q = charge on the particel
   (ii) Momentum of particle $p = mv = \sqrt{2mE} = \sqrt{2mqV}$
   (iii) The De Broglie wavelength associated with charges particles

$$\lambda = \frac{h}{p} = \frac{h}{\sqrt{2mE}} = \frac{h}{\sqrt{2mqV}}$$

   (iv) For an electron m = 9.1 x 10^{-31} kg q = 1.6 x 10^{-19} coulomb, h = 6.62 x 10^{-34} Joule-sec.
   ∴ De Broglie wavelength associated with electron

$$\lambda = \frac{12.27}{\sqrt{V}}\ A^0$$

   (v) i.e $\lambda \propto \frac{1}{\sqrt{V}}$
   (vi) The potential difference required to bring an electron of wavelength $\lambda\ A^0$ to rest $V = \frac{150.6}{\lambda^2}\ volt$
   (vii) For a proton m_p = 1.67 x 10^{-27} kg

$$\lambda = \frac{0.286\ x\ 10^{-10}}{\sqrt{V}} \quad m = \frac{0.286}{\sqrt{V}} A^0$$

   (viii) For a deutron m = 2 x 1.67 x 10^{-27} kg.

$$\lambda = \frac{0.202}{\sqrt{V}}\ A^0$$

   (ix) For α - particles
   q = 2 1.6 x 10^{-19}, m= 4 x 1.67 x 10^{-27} kg

$$\lambda = \frac{0.101}{\sqrt{V}}\ A^0$$

2. De Broglie wavelength associated with uncharged particles
   (i) Wave length associated with the particle

$$\lambda = \frac{h}{p} = \frac{h}{mv} = \frac{h}{\sqrt{2mE}}$$

   (ii) For a neutron – m = 1.67 x 10^{-27} kg

$$\lambda = \frac{0.286}{\sqrt{E\ (eV)}}\ A^0$$

   (iii) Energy of thermal neutrons at ordinary temperatures E = kT

$$\therefore\ \lambda = \frac{h}{\sqrt{2mkT}}$$

$$\lambda = \frac{30.835}{\sqrt{T}}\ A^0$$

   De Broglie wavelength associated with gas molecules $\lambda = \frac{h}{mc_{rms}}$
   c_{rms} = R.M.S. Velocity of gas molecules

   (iv) Energy of gas molecules at temperature $T^{0\ K}$ – $E = \frac{3}{2}\ kT$

$$\therefore\ \lambda = \frac{h}{\sqrt{3mkT}}$$

3. Explanation of Bohr quantization condition—
   (i) Only those circular orbits in an atom are possible for electrons whose circumference is an integral multiple of De Broglie wavelength associated with the electron.

$$2\pi r = n\lambda$$

$$mvr = \frac{nh}{2\pi}$$

SOLVED EXAMPLES

1. An electron and a proton are accelerated through the same potential difference. The ration of their De Broglie wave length will be --

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

   Solution -- $\because \ \lambda \ \alpha \ \frac{1}{\sqrt{m}}$

   $$\lambda_e \ \alpha \ \frac{1}{\sqrt{m_e}}$$

   $$\lambda_p \ \alpha \ \frac{1}{\sqrt{m_p}}$$

   $$\therefore \frac{\lambda_e}{\lambda_p} = \sqrt{\frac{m_p}{m_e}}$$

   Hence the correct answer will be (1).

2. What potential must be applied on an electron microscope so that it may produce an electron of
   wavelength 1 $\dot{A}$?

   (a) 50 V (b) 100 V (c) 150 V (d) 200 V

   Solution -- $\lambda \sqrt{\frac{150}{V}} \ A^0$

   $$\because \ \lambda = 1 \ A^0$$

   $$1 = \sqrt{\frac{150}{V}}$$

   V = 150 V

   Hence the correct answer will be (3).

3. The momentum of photon of wavelength 0.01 A^0 will be –

   (a) h (b) $10^{-2}\ h$ (c) $10^{12}\ h$ (d) $10^2\ h$

   Solution -- $p = \frac{h}{\lambda} = \frac{h}{0.01 \ x \ 10^{-10}} = 10^{12} \ h$

   Hence the correct answer will be (3).

4. The kinetic energies of an electron and proton are same. The ratio of De Broglie wavelengths associated with them will be –

   (a) 1 : $(1836)^2$ (b) $\sqrt{1836}$: 1 (c) 1836 : 1 (d) $(1836)^2$: 1

   Solution – $\lambda \ \alpha \ \frac{1}{\sqrt{m}}$

   $$\frac{\lambda_e}{\lambda_p} = \sqrt{\frac{m_p}{m_e}} = \sqrt{\frac{1836}{1}}$$

   Hence the correct answer will be (2).

5. A particle with rest mass m_0 is moving with speed C. The De Broglie wavelength associated with it will be –

(a) Zero (b) ∞ (c) $\frac{hv}{m_o c}$ (d) $\frac{m_o c}{h}$

Solution –

$$\lambda = \frac{h}{m_o v}\sqrt{1-\frac{v^2}{c^2}} \quad \because vc$$

$$\therefore \lambda = 0$$

Hence the correct answer will be (1).

6. The effective mass of a photon of energy hv will be

(a) Zero (b) ∞ (c) $\frac{hv}{c^2}$ (d) m_0

Solution –

$E = hv$ and $E = mc^2$

Therefore $m = \frac{hv}{c^2}$

Hence the correct answer will be (3).

7. The momentum of photon of frequency 10^9 Hz will be ----

(a) 31 kg-m/s (b) 7.3×10^{-29} kg-m/s

(c) 2.2×10^{-33} kg-m/s (d) 6.6×10^{-26} kg-m/s

Solution – $p = \frac{hv}{c} = \frac{6.62 \times 10^{-34} \times 10^{9}}{3 \times 10^8}$

$= 2.2 \times 10^{-33}$ kg-m/s

Hence the correct answer will be (3).

8. The De Broglie wavelength of an atom at absolute temperature T^0K will be –

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

Solution – $\lambda = \frac{h}{\sqrt{2mE_k}}$

$$\because E_k = \frac{3}{2}kT$$

$$\lambda = \frac{h}{\sqrt{3mKT}}$$

Hence the correct answer will be (2).

9. The wavelength of a photon of momentum 6.6×10^{-24} kg-m/s will be ---

(a) 1 A^0 (b) 10 A^0 (c) 100 A^0 (d) 1000A^0

Solution – $\lambda = \frac{h}{p} = \frac{6.62 \times 10^{-34}}{6.6 \times 10^{-24}} = 10^{-10}\ m\ 1\ A^0$

Hence the correct answer will be (2).

10. The wavelength of an electron of energy 100 eV will be ---
(a) 1.2 A^0 (b) 10 A^0 (c) 100 A^0 (d) 1 A^0

Solution – $\lambda = \frac{12.27\ A^0}{\sqrt{100}} = 1.2\ A^0$

Hence the correct answer will be (1).

11. The ratio of wavelengths of deuteron and photon accelerated through the same potential difference will be ---
(a) $\frac{1}{\sqrt{2}}$ (b) $\sqrt{\frac{2}{1}}$ (c) $\frac{1}{2}$ (d) $\frac{2}{1}$

Solution – $\lambda = \frac{h}{\sqrt{2m\ eV}}$

or $\lambda\ \alpha\ \frac{1}{\sqrt{m}}$

$\therefore\ \frac{\lambda_d}{\lambda_p} = \sqrt{\frac{m_p}{m_d}}$

or $\frac{\lambda_d}{\lambda_p} = \frac{1}{\sqrt{2}}$

Hence the correct answer will be (1).

12. Through what potential difference should an electron be accelerated so that its De Broglie wavelength becomes 0.4 $\dot{A}$
(a) 9410 V (b) 94.10 V (c) 9.140 V (d) 941.0 V

Solution -- $\lambda = \frac{12.27\ A^0}{\sqrt{V}}$

$0.4\ \dot{A} = \frac{12.27}{\sqrt{V}}$

or $V = \frac{122.7\ x\ 122.7}{16} = 941.0$ V volt

Hence the correct answer will be (4).

13. The De Broglie wavelength of thermal neutrons at 27^0 C will be –
(a) 1.77 A^0 (b) 1.77 m (c) 1.77 cm (d) 1.77 mm

Solution -- $\lambda_n = \frac{30.8\ A^0}{\sqrt{T}} = \frac{30.8}{\sqrt{300}} = 1.77\ A^0$

Hence the correct answer will be (1).

14. The De Broglie wave present in the fifth Bohr orbit is

(a) 

(b) 

(c) 

(d) 

Solution –
The number of De Broglie waves in the fifth orbit of hydrogen atom is 5.

Hence the correct answer will be (4).

15. The De Broglie wavelength associated with electron in nth Bohr orbit is --

(a) $\frac{2\pi r}{n} A^0$ (b) $2\ \pi n\ A^0$ (c) $\frac{1}{n}\ A^0$ (d) $n\ A^0$

Solution -- $\because\ 2\pi r\ =\ n\,\lambda$

$$\therefore\ \lambda\ =\ \frac{2\pi r}{n}\ A^{\,0}$$

Hence the correct answer will be (1).

16. The De Broglie wavelength associated with a material particle when it is accelerated through a potential difference of 150 volt is 1 $\dot{A}$. The De Broglie wavelength associated with the same particle when it is accelerated through a potential difference of 1350 V will be –

(a) $\frac{1}{4} A^0$ (b) $\frac{1}{3}\ A^0$ (c) $1\ A^0$ (d) 0

Solution -- $\frac{\lambda_2}{\lambda_1} = \sqrt{\frac{V_1}{V_2}}$

$$\frac{\lambda_2}{1A^0}\ =\ \sqrt{\frac{150}{1350}}$$

$$\lambda_2 = \frac{1}{3}\ \ A^0$$

Hence the correct answer will be (2).

17. If E and P are the energy and the momentum of a photon respectively then on reducing the wavelength of photon---

(a) p and E both will decrease (b) p and E both will increase

(c) p will increase and E will decrease (d) p will decrease and E will increase

Solution – $\lambda\ =\ \frac{hc}{E} = \frac{h}{p}$

On decreasing λ, both p and E will increase.

Hence the correct answer will be (2).

18. If ∝ - particle, proton, electron and neutron are moving with the same velocity then maximum De Broglie wavelength will be of

(a) ∝ particles (b) neutron (c) proton (d) electron

Solution – $\lambda = \frac{h}{mv}$

$$\because\ \ v\ = constant$$

$$\therefore\ \lambda\ \alpha\ \frac{1}{m}$$

Because the mass of electron is minimum , hence its wavelength will be maximum.

Hence the correct answer will be (4).

19. The De Broglie wavelength associated with electrons revolving round the nucleus in a hydrogen atom in ground state, will be –

(a) 0.3 A^0 (b) 3.3 A^0 (c) 6.62 A^0 (d) 10 A^0

Solution – $\lambda = \frac{h}{\sqrt{2m\,E_1}}$

or $\lambda = \frac{6.62 \ x\ 10^{-34}}{\sqrt{2 \ x\ 9.1 \ x\ 10^{-31} \ x\ 13.6 \ x\ 1.6 \ x\ 10^{-19}}}$

$= 3.3 \ \mathrm{x} \ 10^{-10} \ \mathrm{m}$

$= 3.3 \ A^0$

II nd method

$\lambda = \frac{12.27}{\sqrt{V}} A^0$

or $\lambda = \frac{12.27}{\sqrt{13.6}}$

$= 3.3 \ A^0$

Hence the correct answer will be (2).

20. An electron is accelerated from rest, between two points at which the potentials are 20 V and 40 V respectively. The De Broglie wavelength associated with the electron will be –

(a) 0.75 A^0 (b) 7.5 A^0 (c) 2.75 A^0 (d) 2.75 m

Solution – $\lambda = \frac{12.27\, A^0}{\sqrt{V}}$

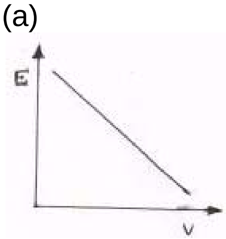
$\mathrm{V} = 40 - 20 = 20$ volt

$\lambda = \frac{12.27\, A^0}{\sqrt{20}} = 2.75\, A^0$

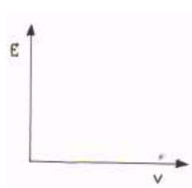
Hence the correct answer will be (3).

21. The curve between the energy and frequency of photon will be –

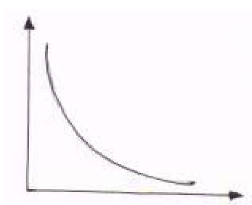
(a)



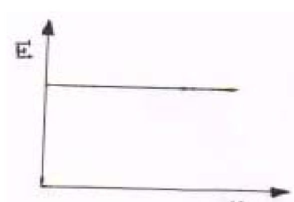
(b)



(c)



(d)



Solution— $E \ \alpha \ v$

$\therefore \ E - v$ curve will be a straight line

Hence the correct answer will be (3).

22. Relation between wavelength of electron and photon of same energy is -
(a) $\lambda_{ph} > \lambda_e$ (b) $\lambda_e > \lambda_{ph}$
(c) $\lambda_{ph} = \lambda_e$ (d) none of these

Solution –

$$\lambda_{ph} = \frac{hc}{E} \ or \ \lambda_e = \frac{h}{\sqrt{2mE}} \ \Rightarrow \frac{\lambda_{ph}}{\lambda_e^2} = \frac{hc \ 2mE}{Eh^2} = \frac{2mc}{h}$$

$$\Rightarrow \frac{\lambda_{ph}}{\lambda_e^2} = \frac{2mc\lambda_e}{h}$$

$$= \frac{2 \ x \ 9 \ x \ 10^{-31} \ x \ 3 \ x \ 10^{8} \ x \ 10^{-10}}{6.6 \ x \ 10^{-34}} > 1$$

$$\therefore \lambda_{ph} > \lambda_e$$

Hence the correct answer will be (1).

23. De-Broglie wavelength (λ) depends upon mass 'm' and energy 'E' according to the relation represented as
(a) $mE^{1/2}$ (b) $m^{1/2}E$ (c) $m^{-1/2} E^{-1/2}$ (d) $m^{-1/2} E^{1/2}$

Solution –

Wavelength

$$(\lambda) = \frac{h}{p} = \frac{h}{\sqrt{2mE}} \ \alpha \ \frac{1}{\sqrt{E}}$$

$$\alpha \ m^{-1/2}E^{-1/2}$$

Hence the correct answer will be (3).

24. 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 refracted and defracted
(d) Photoelectricity and electron microscopy

Hence the correct answer will be (4).

25. De Broglie wavelength of a body of mass m and kinetic energy E is given by :
(a) $\frac{h}{\sqrt{2mE}}$ (b) $\frac{h}{2mE}$ (c) $\frac{\sqrt{2mE}}{h}$ (d) $\lambda = \frac{h}{mE}$

Solution –

$$\lambda = \frac{h}{mv}$$

But $E = \frac{1}{2} mv^2 = \frac{m^2v^2}{2m}$

$$\therefore \ \lambda = \frac{h}{\sqrt{2mE}}$$

Hence the correct answer will be (1).

26. 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 the kinetic energy of the proton

(d) greater then the kinetic energy of the proton

Hence the correct answer will be (4).

27. The energy that should be added to an electron to reduce its de Broglie wavelength from

10^{-10} m to 0.5 x 10^{-10} m will be

(a) Thrice the initial energy (b) twice the initial energy

(c) equal to the initial energy (d) four times the initial energy

Hence the correct answer will be (1).

28. The formula for the wavelength associated with a particle having momentum p is

(a) $\frac{p}{h}$ (b) *ph* (c) (*p* + *h*) (d) $\frac{h}{p}$

Solution –

According to De Brogli's formula the wavelength of matter wave associated with a particle $\lambda = \frac{h}{p}$

Hence the correct answer will be (4).

29. The kinetic energy of electron and proton is 10^{-32} J. Then relation between their De-Broglie wavelength is –

(a) $\lambda_p < \lambda_r$ (b) $\lambda_p = \lambda_e$

(c) $\lambda_p > \lambda_e$ (d) $\lambda_p = 2\lambda_e$

Solution –

$$\lambda = \frac{h}{\sqrt{2mE}}$$

$$\therefore \lambda \, \alpha \, \frac{1}{\sqrt{m}}$$

$$\therefore \frac{\lambda_p}{\lambda_e} = \sqrt{\frac{m_e}{m_p}} \quad \because m_e < m_p$$

$$\therefore \lambda_p > \lambda_e$$

Hence the correct answer will be (1).

30. Photon and electron are given same energy (10^{-20} J). The wavelength associated with it are λ_{ph} and λ_{el} respectively. Then, which statement is true—

(a) $\lambda_{ph} > \lambda_{el}$ (b) $\lambda_{ph} < \lambda_{el}$ (c) $\lambda_{ph} = \lambda_{el}$ (d) $\frac{\lambda_{el}}{\lambda_{ph}} = c$

Solution –

$$\frac{\lambda_{ph}}{\lambda_{el}} = \frac{\left(\frac{hc}{E}\right)}{\left(\frac{h}{\sqrt{2mE}}\right)} = \sqrt{\frac{2mc^2}{E}}$$

$$\frac{\sqrt{2 \ x \ 9 \ x \ 10^{-31} \ x \ 9 \ x \ 10^{16}}}{10^{-20}} > 1$$

$\therefore\ \lambda_{ph} > \lambda_{el}$

Hence the correct answer will be (1).

31. For a moving cricket ball, the correct de Broglie wavelength is –
(a) It is not applicable for such a big particle
(b) $\frac{h}{\sqrt{2mE}}$ (c) $E\sqrt{\frac{h}{2m}}$ (d) $\frac{h}{2mE}$

Solution –
De Broglie wavelength

$$\lambda = \frac{h}{mv} = \frac{h}{\sqrt{2mE}}$$

$$\left(\therefore \quad E = \frac{1}{2}mv^2\right)$$

Hence the correct answer will be (2).

32. The de-Broglie wavelength of an electron having 80 eV of energy is nearly
($1eV = 1.6 \times 10^{-19}$ J;
Mass of the electron $= 9 \times 10^{-31}$ kg;
Plank's constant $= 6.6 \times 10^{-34}$ Js)
(a) 140 A^0 (b) 0.14 A^0 (c) 14 A^0 (d) 1.4 A^0

Solution –
De Broglie wavelength for electrons

$$\lambda = \frac{h}{\sqrt{2mE}} = \frac{12.27}{\sqrt{V}} = \frac{12.27}{\sqrt{80}} \approx 1.4\ A^0$$

Hence the correct answer will be (1).

33. A positron and a proton are accelerated by the same accelerating potential. Then the ratio of the associated wavelengths of positron and proton will be :
(M = Mass of proton, m – mass of positron)
(a) $\frac{M}{m}$ (b) $\sqrt{M/m}$ (c) $\frac{m}{M}$ (d) $\sqrt{m/M}$

Solution –

$$\frac{\lambda_{prsitron}}{\lambda_{proton}} = \sqrt{\frac{Mass\ of\ proton}{Mass\ of\ positron}}$$

$$= \sqrt{M/m}$$

Hence the correct answer will be (2).

34. Which of the following has maximum wavelength of matter waves. (Velocity is the same) –
(a) Proton (b) Neutron (c) $\alpha -$ particle (d) $\alpha -$particle

Hence the correct answer will be (4).

35. The wave nature of electron is verified by—
(a) Thomson's experiment (b) Davisson and Germer experiment
(c) de Broglie law (d) Planck's law

Hence the correct answer will be (2).

36. The de Broglie λ associated with proton changes by 0.25% if its momentum is changes by p_o. The initial momentum was

(a) 100 p_o (b) p_o / 400 (c) 401 p_o (d) p_o / 100

Solution—

$$\lambda = \frac{h}{p}$$

$$\therefore \frac{\lambda_2 - \lambda_1}{\lambda_1} \ x \ 100 = \frac{\frac{h}{p_2} - \frac{h}{p_1}}{\frac{h}{p_1}} \ x \ 100$$

$$= \left(\frac{p_1}{p_2} - 1\right) \ x\ 100 \quad or \ \frac{p_2}{p_1} = \frac{400}{401}$$

$$or \ \frac{p_2 - p_1}{p_1} = \frac{400 - 401}{401} = - \ \frac{1}{401}$$

$$or \quad p_1 = 401 \ p_0$$

Hence the correct answer will be (3).

37. Wavelength of neutron at 27^0 C is λ . The wavelength of neutron at 92.7^0 C is

(a) $\lambda/3$ (b) $\lambda/2$ (c) $\lambda/4$ (d) $\lambda/\sqrt{3}$

Solution—

$$\lambda \ \alpha \ \frac{1}{\sqrt{T}} \qquad \therefore \ \frac{\lambda_1}{\lambda_2} \ \sqrt{\frac{T_2}{T_1}}$$

$$or \ \frac{\lambda}{\lambda_2} = \sqrt{\frac{1200}{300}} \quad or \quad \lambda_2 = \frac{\lambda}{2}$$

Hence the correct answer will be (2).

38. The de-Broglie wavelength of a particle moving with a velocity 2.25 x 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 x 10^8 m/s)

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

Solution—

$$E_p = \frac{1}{2}mv^2 = \frac{1}{2} \ \frac{h}{\lambda \ v} \ . \ v^2 = \frac{hv}{2 \ \lambda}$$

$$E_{ph} = hv = \frac{hc}{\lambda}$$

$$\Longrightarrow \frac{E_p}{E_{ph}} = \frac{(hv/2\lambda)}{(hc/\lambda)} = \frac{v}{2c} = \frac{2.25 \ x \ 10^8}{2 \ x \ 3 \ x \ 10^8} = \frac{3}{8}$$

Hence the correct answer will be (2).

39. According to be Broglie, the de Broglie wavelength for electron in an orbit of hydrogen atom is 10^{-9}m. The principal quantum number for this electron is

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

Solution—

$$2\pi r_1 n = \lambda$$

$$or \quad n = \frac{\lambda}{2 \pi r_1}$$

$$= \frac{10^{-9}}{2 \; x \; 3.14 \; x \; 5.13 \; x \; 10^{-11}} = 3$$

Hence the correct answer will be (3).

ELECTRONS AND PHOTONS

40. Sodium and copper have work functions 2.3 eV and 4.5 eV respectively. Then the ratio of the wavelengths is nearest to
(1) 1 : 2 (2) 4 : 1 (3) 2 : 1 (4) 1 : 4

Solution –

Work function = hc/λ

$$\frac{W_{Na}}{W_{Cu}} = \frac{4.5}{2.3} = \frac{2}{1}$$

Hence the correct answer will be (3).

41. 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
(1) $v_1^2 - v_2^2 = \frac{2h}{m}(f_1 - f_2)$

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

(2) $v_1^2 + v_2^2 = \frac{2h}{m}(f_1 + f_2)$

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

Solution –

For photoelectric effect, according to Einstein's equation,
Kinetic energy of emitted electron = *hf* – (work function ϕ)

$$\therefore \frac{1}{2}mv_1^2 = hf_1 - \phi$$

$$\therefore \frac{1}{2}mv_2^2 = hf_2 - \phi$$

$$\therefore \frac{1}{2}m(v_1^2 - v_2^2) = h(f_1 - f_2)$$

$$\therefore v_1^2 - v_2^2 = \frac{2h}{m}(f_1 - f_2)$$

Hence the correct answer will be (1).

42. According to Einstein's photoelectric equation, the plot of the kinetic energy of the emitted photo electrons from a metal vs the frequency, of the incident radiation gives a straight line whose slope
(1) Depends on the nature of the metal used
(2) Depends on the intensity of the radiation
(3) Depends both on the intensity of the radiation and the metal used
(4) Is the same for all metals and independent of the intensity of the radiation.

Solution –

According to Einstein's equation,

Kinetic energy = $hf - \phi$ where kinetic energy and *f* (frequency) are variables, compare it with equation,

$$y = mx + c$$

∴ slope of line = *h*

h is Plank's constant.

Hence the slope is same for all metals and independent of the intensity of radiation. Option (4) represents the answer.

Hence the correct answer will be (4).

43. 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

(1) 540 mm (2) 400 nm (3) 310 nm (4) 220 nm

Solution –

Let $\lambda_m =$ Longest wavelength of light

$$\therefore \ \frac{hc}{\lambda_m} = \phi \text{ (work function)}$$

$$\therefore \ \lambda_m = \frac{hc}{\phi} = \frac{(6.63 \ x \ 10^{-34}) \ \ x \ (3 \ x \ 10^8)}{4.0 \ x \ 1.6 \ x \ 10^{-19}}$$

$$\lambda_m = 310 \ nm$$

Hence the correct answer will be (3).

44. 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 photocathode
would

(1) Decrease by a factor of 2 (2) increase by a factor of 2
(3) decrease by a factor of 4 (4) increase by a factor of 4

Solution – $I = \frac{P \ of \ source}{4\pi \ (distance)^2} = \frac{P}{4\pi d^2}$

Here, we assume light to spread uniformity in all directions.
Number of photo-electrons emitted from a surface depend on intensity of light/ falling on it. Thus the number of electrons emitted n depends directly on *I*. *P* remains constant as the source is the same.

$$\therefore \ \frac{I_2}{I_1} = \frac{n_2}{n_1} \Rightarrow \frac{P_2}{P_1}\left(\frac{d_1}{d_2}\right)^2 = \frac{n_2}{n_1}$$

$$\therefore \ \frac{n_2}{n_1} = \left(\frac{P}{P}\right)\left(\frac{1}{1/2}\right)^2 = \frac{4}{1}$$

Hence the correct answer will be (4).

45. If the kinetic energy of a free electron doubles, its de Broglie wavelength changes by the
Factor

(1) $1\sqrt{2}$ (2) $\sqrt{2}$ (3) $1/2$ (4) 2

Solution –

De Broglie wavelength $\lambda = h/p = h/\sqrt{(2mK)}$

$\therefore \quad \lambda = \frac{h}{\sqrt{2mK}}$ where K = kinetic energy of particle

$$\therefore \quad \frac{\lambda_2}{\lambda_1} = \sqrt{\frac{K_1}{K_2}} = \sqrt{\frac{K_1}{2K_1}} = \frac{1}{\sqrt{2}}$$

Hence the correct answer will be (1).

46. Photon of frequency *v* has a momentum associated with it. If c is the velocity of light, the momentum is

(1) hv/c (2) v/c (3) *hvc* (4) hv/c^2

Solution –

Energy of a photon *E* = *hv* ....(i)

Also *E* = *pc* ....(ii)

Where *p* is the momentum of a photon

From (i) and (ii), we get

$$hv = pc \ \ or \ \ p = \frac{hv}{c}$$

Hence the correct answer will be (1).

47. Flash spectrum confirms a/an

(1) Total solar eclipse (2) lunar eclipse

(3) earthquake (4) magnetic storm

Hence the correct answer will be (1).

48. The photoelectric threshold wavelength for silver is λ_0 . The energy of the electron ejected from the surface of silver by an incident wavelength $\lambda(\lambda < \lambda_0)$ will be

(1) $hc(\lambda_0 - \lambda)$ (2) $\frac{hc}{\lambda_0 - \lambda}$ (3) $\frac{h}{c}\left(\frac{\lambda_0 - \lambda}{\lambda\lambda_0}\right)$ (4) $hc\left(\frac{\lambda_0 - \lambda}{\lambda\lambda_0}\right)$

Solution –

According to Einstein's photoelectric equation

$$k = \frac{hc}{\lambda} - \frac{hc}{\lambda_0}$$

$$= hc\left(\frac{1}{\lambda} - \frac{1}{\lambda_0}\right) = hc\left(\frac{\lambda_0 - \lambda}{\lambda\lambda_0}\right)$$

Hence the correct answer will be (4)

49. An electron of mass m_e and a proton of mass m_p are moving with the same speed. The ratio of their de-Broglie's wavelengths $\frac{\lambda_e}{\lambda_p}$ is

(1) 1 (2) 1836 (3) $\frac{1}{1836}$ (4) 918

Solution –

De Broglie wavelength, $\lambda = \frac{h}{mv}$

Where m is the mass and v is the speed of the particle.

As electron and proton both are moving with same speed, therefore the ratio of their de Broglie wavelengths is

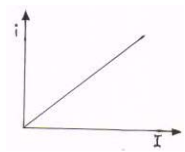
$$\frac{\lambda_e}{\lambda_p} = \frac{m_p}{m_e} = \frac{1.67 \ x \ 10^{-27} \ kg}{9.1 \ x \ 10^{-31} \ kg} = 1836$$

Hence the correct answer will be (2).

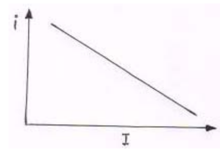
PHOTO ELECTRIC EFFECT

50. The correct curve between the intensity of incident photons and the photoelectric current is

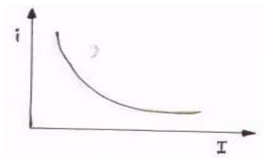
(1)



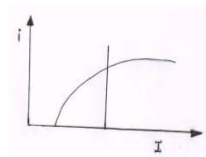
(2)



(3)



(4)



Solution –

Because $i \propto I$

Hence the correct answer will be (1).

51. When a piece of metal is illuminated by monochromatic light of wavelength λ then the stopping potential for photoelectric current is $3V_0$. When the same surface is illuminated by light of wavelength 2λ, then the stopping potential becomes V_0. The value of threshold wavelength for photoelectric emission will be –

(1) 4λ (2) 8λ (3) $\frac{4}{3}\lambda$ (4) 6λ

Solution – $\frac{hc}{\lambda} - \phi_0 = 3V_0$

$\frac{hc}{2\lambda} - \phi_0 = V_0$

or $\frac{hc}{\lambda}\left[1 - \frac{1}{2}\right] = 2V_0$

$\frac{hc}{2\lambda} = 2V_0$

or $\lambda = \frac{hc}{4V_0}$

or $4\lambda = \frac{hc}{V_0}$

Hence the correct answer will be (1).

52. When blue light is made incident on a metallic surface, then electrons are emitted by it. But electrons are not emitted by green light. By which of the following radiations the photo-electric emission will be possible?

(1) Red (2) Infrared (3) Violet (4) Yellow

Solution – Photoelectric emission will be possible by radiations of wavelength less than that of green light. Because

$\lambda_V < \lambda_G$

Hence the correct answer will be (3).

53. When the source of light is kept at a distance of 1m from photoelectric cell then the value of stopping potential is 4 volt. If it is kept at a distance of 4m then stopping potential will be –

(1) 2 Volt (2) 1 Volt (3) 4 Volt (4) 16 Volt

Solution – The stopping potential does not depend on the intensity of Incident radiations.

Hence the correct answer will be (3).

54. On making ultraviolet light of energy 6.2 eV incident on aluminum surface, faster photoelectrons are emitted. If the work function of aluminum surface is 4.2 eV, then the kinetic energy of these fastest electrons will be—

(1) 3.2×10^{-19} Joule (2) 3.2×10^{-17} Joule (3) 3.2×10^{-16} Joule (4) 3.2×10^{-11} Joule

Solution –

$E_k = E - \phi_0 \, 6.2 - 4.2$

$E_k = 2.0\, eV$ or $E_k = 2.0 \; X \; 1.6 \; X \; 10^{-19}$

$= 3.2 \times 10^{-19}$ Joule

Hence the correct answer will be (1).

55. The maximum kinetic energy of electrons emitted by a metallic plate of work function 2eV, when light of wavelength 4000 $\dot{A}$ is made incident on it, will be—

(1) 2 eV (2) 1.1 eV (3) 0.5 eV (4) 1.5 eV

Solution – $E_k = \frac{hc}{\lambda} - \phi_0$

$$= \frac{6.62 \; X \; 10^{-34} \; X \; 3 \; X \; 10^{8}}{4 \; X \; 10^{-7}} - 2 \, X \, 1.6 \; X \; 10^{-19}$$

= 1.1 eV

Hence the correct answer will be (2).

56. The light photons of energy 1eV and 2.5 eV respectively are made incident on a metallic plate of work function 0.5 eV one after the other. The ratio of maximum kinetic energies of photoelectrons emitted by them will be –

(1) 4 : 1 (2) 1 : 4 (3) 1 : 5 (4) 1 : 2

Solution –

$$\frac{[E_{k\,max}]_1}{[E_{k\,max}]_2} = \frac{hv_1 - \phi_0}{hv_2 - \phi_0}$$

$$\frac{[E_{k\,max}]_1}{[E_{k\,max}]_2} = \frac{1 - 0.5}{2.5 - 0.5} = \frac{5}{20} = \frac{1}{4}$$

Hence the correct answer will be (2).

57. The slope of V_0 – v curve is equal to –

(1) e (2) ϕ_0 (3) $\frac{h}{e}$ (4) h

Solution – The equation of curve between V_0 and v is

$$\frac{hv}{e} - \frac{hV_0}{e} = V_0$$

This is the equation of a straight line with slope = $= \frac{h}{e}$

Hence the correct answer will be (3).

58. The energy of incident photons corresponding to maximum wavelength of visible light will be–

(1) 3.2 eV (2) 7 eV (3) 1.55 eV (4) 1 eV

Solution – $E = \frac{hc}{\lambda} = \frac{6.62\ x\ 10^{-34}\ x\ 3\ x\ 10^{8}}{8000\ x\ 10^{-10}\ x\ 1.6\ x\ 10^{-19}}$

= 1.55 eV

Hence the correct answer will be (3).

59. The following figure shows V_0 – v curve for two different metallic surfaces P and Q. The work function of P, as compared to that of Q, is –

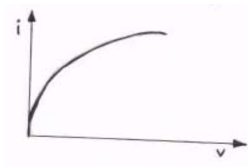
(1) less (2) more (3) equal (4) nothing can be said

Solution – Because the value of $v_0$for P is less that for Q, hence $\phi_P < \phi_Q$

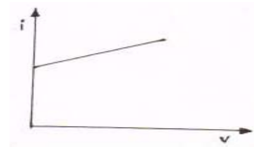
Hence the correct answer will be (1).

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

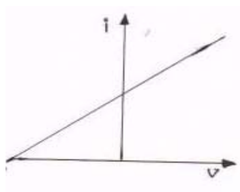
(1)



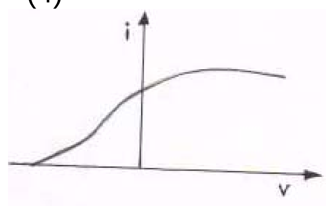
(2)



(3)



(4)



Hence the correct answer will be (4).

61. The work function of a metal is 2.5 eV. When photon of some proper energy is made incident on it, then an electron of 1.5 eV is emitted. The energy of photon will be –

(1) 4 eV (2) 1 eV (3) 1.5 eV (4) 2.5 eV

Solution –

$$E = \phi_0 + eV = 2.5 + 1.5 = 4\ eV$$

Hence the correct answer will be (1).

62. The threshold wavelength of lithium is 8000 $\dot{A}$. When light of wavelength 9000 $\dot{A}$ is made incident on it, then the photoelectrons—

(1) Will not be emitted (2) will be emitted
(3) more electrons will be emitted (4) nothing can be said

Hence the correct answer will be (1).

63. The threshold frequency for a metal is 10^{15} Hz. When light of wavelength 4000 $\dot{A}$ is made incident on it, then—

(1) Photoelectrons will be emitted from it with zero speed.
(2) Photoelectric emission will not be started by it.
(3) Photoelectrons will be emitted with speed 10^5 m/s.
(4) Photoelectrons will be emitted with speed 10^3 m/s

Hence the correct answer will be (2).

64. The photoelectric currents at distances r_1 and r_2 of light source from photoelectric cell are I_1 and I_2 respectively.

The value of $\frac{I_1}{I_2}$ will be –

(1) $\frac{r_1}{r_2}$ (2) $\frac{r_2}{r_1}$ (3) $\left(\frac{r_1}{r_2}\right)^2$ (4) $\left(\frac{r_2}{r_1}\right)^2$

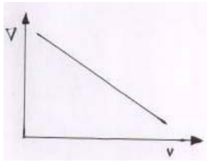
Solution –

$$I \propto \frac{1}{r^2} \qquad \therefore \frac{I_1}{I_2} = \left(\frac{r_2}{r_1}\right)^2$$

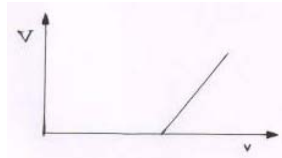
Hence the correct answer will be (4).

65. The curve between the frequency (v) and stopping potential (V) in a photoelectric cell will be—

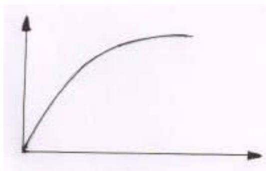
(1)



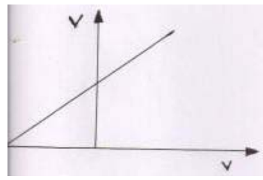
(2)



(3)



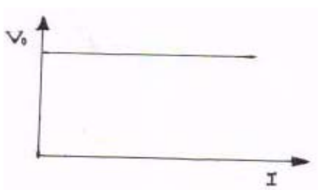
(4)



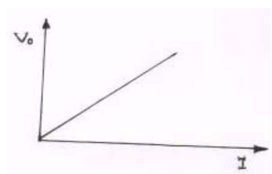
Hence the correct answer will be (2).

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

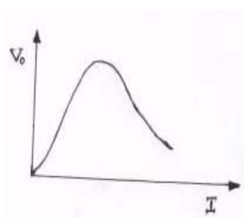
(1)



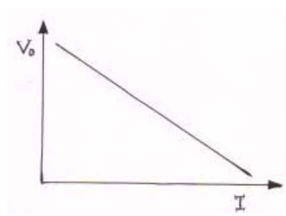
(2)



(3)



(4)



Hence the correct answer will be (2).

67. The photoelectric effect was experimentally studied by—

(1) Einstein (2) Lennard (3) Hertz (4) Rutherford

Hence the correct answer will be (3).

68. Stopping potential depends on—

(1) Frequency of incident light (2) intensity of incident light
(3) number of emitted electrons (4) number of incident photons

Hence the correct answer will be (1).

69. Ultraviolet radiations of wavelength 250 nm and intensity 5.0 W/m^2 are made incident on the surface of a metal (work-function = 3.2 eV). The maximum energy of emitted photoelectrons will be—
(1) 3.2 eV (2) 5.0 eV (3) 1.8 eV (4) 2.5 Ev

Solution –

$$E_{k_{max}} = hv - \phi$$

$$hv = \frac{hc}{\lambda} = \frac{2 \ x \ 10^{-25}}{2.50 \ x \ 10^{-7} \ x \ 1.6 \ x \ 10^{-19}} = 5 \ eV$$

$$\therefore \ E_{k_{max}} = 5 - 3.2 = 1.8 \ eV$$

Hence the correct answer will be (3).

70. In the above problem, if only 1% of the incident photons emit photoelectrons, then the number of photoelectrons emitted per second per unit area will be –
(1) 6.25 x 10^{18} (2) 6.25 x 10^{16} (3) 6.25 x 10^{14} (4) 6.25 x 10^{12}

Solution – No of photons emitted per second per unit area

$$n_p = \frac{1}{hv} = \frac{5}{5 \ x \ 1.6 \ x \ 10^{-19}}$$

$$= 6.25 \ x \ 10^{18}$$

∴ No. of photoelectrons = 0.01 x 6.25 x 10^{18}

= 6.25 x 10^{16}

Hence the correct answer will be (2).

71. The radiations of two photons, whose energies are two times and five times the work function of a metal, are made incident on the metal surface in succession. The ratio of the velocities of emitted photo-electrons in two cases will be—
(1) 2 : 5 (2) 1 : 4 (3) 1 : 3 (4) 1 : 2

Solution –

$$E_k = hv - \phi$$

$$\therefore \ \frac{E_{k_1}}{Ek_2} = \frac{2\phi - \phi}{5\phi - \phi} = \frac{\phi}{4 \ \phi} = \frac{v_1^2}{v_2^2}$$

$$\therefore \ \frac{v_1}{v_2} = 1 : 2$$

Hence the correct answer will be (4).

72. Increase in intensity of incident radiations increases
(1) the number of photoelectrons emitted
(2) the energy of photoelectrons emitted
(3) the threshold frequency
(4) the threshold wavelength

Hence the correct answer will be (1).

73. The incorrect statement about a photon is
(1) its rest mass is zero
(2) its energy is *hv*
(3) its threshold frequency
(4) its exerts no pressure

Hence the correct answer will be (4).

74. The graph shows V v/s v plots for two photoelectric surfaces A and B. The work function of A is—
(1) greater than that of B (2) less than that of B
(3) same as that of B (4) none of these

Hence the correct answer will be (2).

75. Radiations of frequency v are incident on a photosensitive material. The maximum kinetic energy of emitted photons is E. When the frequency of radiations is doubled, the maximum kinetic energy of photoelectrons will be –
(1) 2E (2) $\frac{E}{2}$ (3) E – *hv* (4) E + *hv*

Solution – $E = hv - hv_0$

or $E^` = 2hv - hv_0 = E + hv$

Hence the correct answer will be (4).

76. In a photo electric phenomenon, the number of photoelectrons emitted depends on
(1) the intensity of incident radiation
(2) the frequency of incident radiation
(3) the velocity of incident radiation
(4) the work function of the photo cathode

Hence the correct answer will be (1).

77. The photoelectric work function for a metal surface is 4.125 eV. The cut-off wavelength for this surface is—
(1) 4125 $\dot{A}$ (2) 2065.5$\dot{A}$ (3) 3000 $\dot{A}$ (4) 6000 $\dot{A}$

Solution – Work function $W_0 = \frac{hc}{\lambda}$

$$\therefore \lambda = \frac{hc}{W_0} = \frac{12400}{4.125} = 3000\ \dot{A}$$

Hence the correct answer will be (3).

78. The photoelectric work function of a metal surface is 2eV. When light of frequency 1.5×10^{15} Hz is incident on it, the maximum kinetic energy of the photoelectrons, is nearly

(1) 8 eV (2) 6 eV (3) 2 eV (4) 4 eV

Solution –

$hv = W_o + \frac{1}{2} mV^2$

$$\therefore \quad \frac{1}{2} mV^2 = hv - W_o$$

$$= \left[\frac{(6.6 \quad x \quad 10^{-34})(1.5 \quad x \ 10^{15})}{1.6 \ x \ 10^{-19}}\right] - 2$$

= 4.2 eV nearly

Hence the correct answer will be (4).

79. In a photoelectric experiment, the maximum velocity of photoelectrons emitted

(1) depends on intensity of incident radiation
(2) does not depend on the cathode material
(3) depends on frequency of incident radiation
(4) does not depend on wavelength of the incident radiation

Hence the correct answer will be (3).

80. If in a photoelectric experiment the wavelength of incident radiation is reduced from 6000 $\dot{A}$ to 4000 $\dot{A}$, then

(1) stopping potential will decrease
(2) stopping potential will increase
(3) kinetic energy of emitted electrons will decrease
(4) the value of work function will decrease

Hence the correct answer will be (2).

81. 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

(1) The stopping potential will be 0.2 V
(2) the stopping potential will be 0.6 V
(3) the saturation current will be 6 mA
(4) the saturation current will be 18mA

Solution – Stopping potential depends on the wavelength of incident radiation. It is independent of the distance between the sources and photoelectric cell.

Hence the correct answer will be (2).

82. In a photoelectric experiment, the stopping potential V_s is plotted against the frequency v of incident light. The resulting curve is a straight line which makes an angle θ with the v-axis. Then tan θ will be equal to
$(\phi = work\ \ function\ of\ surface)$.

(1) $\frac{h}{e}$ (2) $\frac{e}{h}$ (3) $\frac{-\phi}{e}$ (4) $\frac{eh}{\phi}$

Solution – $k_{max} = hv - \phi$

$$eV_0 = hv - \phi \Rightarrow V_0 = \frac{hv}{e} - \frac{\phi}{e}$$

Comparing with equation of straight line $y = mx + c$
$\tan\theta = \frac{h}{e}$

Hence the correct answer will be (1).

83. If the intensity and frequency of incident light is doubled then:
(1) photo electric current will become 4 times
(2) kinetic energy of the emitted electron will be increased and current will be 2 times
(3) kinetic energy of electrons will be 4 times
(4) the kinetic energy of electrons will be 2 times

Solution – As the intensity of light increases no. of incident photons increases so the photo current increases. As the frequency increases kinetic energy of electrons increases.

Hence the correct answer will be (2).

84. Quantum nature of lights explained by which of the following phenomena
(1) Huygen’s wave theory
(2) Photo electric effect
(3) Maxwell electromagnetic theory
(4) de-Broglie theory

Hence the correct answer will be (2).

85. As the intensity of incident light increases
(1) Photoelectric current increases
(2) Photoelectric current decreases
(3) Kinetic energy of emitted photoelectrons increases
(4) Kinetic energy of emitted photoelectrons decreases

Solution – We know that ejection of photons is directly proportional to the intensity of light. Therefore if we increase the intensity of incident light, photoelectric current will also increase.

Hence the correct answer will be (1).

86. If the threshold wavelength for a certain metal is 2000 $\dot{A}$, then the work-function of the metal is
(1) 6.2 J (2) 6.2 eV (3) 6.2 MeV (4) 6.2 KeV

Solution – $(W) = \frac{hc}{\lambda} = \frac{(6.6 \ X \ 10^{-34}) \ X \ (3 \ X \ 10^{8})}{2000 \ X \ 10^{-10}}$

$= 9.9 \ x \ 10^{-19}$ J = 6.2 eV

Hence the correct answer will be (2).

87. 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
(1) Possible (2) not possible (3) data is incomplete (4) zero

Solution – Given: Work function of aluminium (W_0) = 4.2 eV and energy of each photon (E) = 3.5 eV. We know that emission of electron from a surface is possible only when the energy of each incident photon is more than the work function of the surface. In this case, since $E < W_0$, therefore emission of electron is not possible.

Hence the correct answer will be (2).

88. Light of certain wavelength and intensity ejects photoelectrons from a metal plate. Then this beam is replaced by another beam of smaller wavelength and smaller intensity. As a result:
(1) No change occurs (2) Emission of photoelectric stops
(3) K.E of the photoelectric decreases but the strength of the photoelectric current increases.
(4) K.E of the photoelectrons increases but the strength of the photoelectric current decreases.

Hence the correct answer will be (4).

89. A photon of energy 8 eV is incident on a metal surface of threshold frequency 1.6 x 10^{15} Hz. The K.E of the photoelectrons emitted (in eV). (Take h = 6 x 10^{-34} J-S).
(1) 6 (2) 1.6 (3) 1.2 (4) 2

Solution – $E_k = E - hv$

$$\Rightarrow E_k = 8 - \frac{6 \ X \ 10^{-34} \ X \ 1.6 \ X \ 10^{15}}{1.6 \ X \ 10^{-19}} = 2eV$$

Hence the correct answer will be (4).

90. Graph of maximum kinetic energy of the photo-electrons against v, the frequency of the radiation incident of the metal, is a straight line of slope equal to:
(1) Work function (2) stopping potential (3) $\frac{h}{e}$
(4) h

Solution –

$\frac{1}{2} mV^2 = eV = hv - hv_0$

Compare with y = mx + c

$\therefore \ m = h$

Hence the correct answer will be (4).

91. Relation between the stopping potential V_0 of a metal and the maximum velocity v of the photoelectrons is

(1) $V_0 \propto \frac{1}{v^2}$ (2) $V_0 \propto v^2$ (3) $V_0 \propto v$ (4) $V_0 \propto \frac{1}{v}$

Solution –

$E_{max} = \frac{1}{2} mV^2 = eV_0 \Rightarrow V_0 \propto v^2$

Hence the correct answer will be (2).

92. Two radiations containing photon of energy twice and five times the work function of a metal are incident successively on the metal surface. The ratio of the maximum velocities of the emitted electrons in the two cases will be

(1) 1 : 1 (2) 1 : 2 (3) 1 : 4 (4) 1 : 3

Solution

$$\frac{1}{2} mV^2 = \phi - \phi_0 \Rightarrow v = \sqrt{\frac{2}{m}} (\phi - \phi_0)$$

$$\therefore \frac{v_1}{v_2} = \sqrt{\frac{2\phi_0 - \phi_0}{5\phi_0 - \phi_0}} = \frac{1}{2}$$

Hence the correct answer will be (2).

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

(1) each emitted electron carries one quarter of the initial energy.
(2) number of electrons emitted is one half initial
(3) number of electrons emitted is one quarter of the initial number.
(4) each emitted electron carries one half the initial energy.

Hence the correct answer will be (3).

94. When the intensity of incident light is doubled then the maximum kinetic energy of electrons will become

(1) double (2) half (3) four times (4) uncharged

Solution – In photoelectric effect on increasing the intensity of light, the number of emitted photoelectrons increases and not their kinetic energy.

Hence the correct answer will be (4).

95. A light of wavelength λ and amplitude A is incident on metallic surface of threshold wavelength λ_0 in a photocell.
The saturation current in photocell is proportional to

(1) A^2 if $\lambda > \lambda_0$ (2) A^2 if $\lambda < \lambda_0$
(3) A if $\lambda < \lambda_0$ (4) A if $\lambda > \lambda_0$

Solution – The saturated photocurrent (i) is directly proportional to the intensity of incident light if its wavelength is less than the threshold wavelength.

Hence the correct answer will be (2).

96. When green light is incident on a certain metal surface electrons are emitted but no electrons are emitted by yellow light. If res light is incident on the same metal surface then :
(1) more energetic electrons will be emitted
(2) less energetic electrons will be emitted
(3) emission of electrons will depend on the intensity of light
(4) no electrons will be emitted

Solution – Threshold frequency $= v_{green}$

$\because \ v_{red} < v_{green}$

$\therefore$ No electrons will be emitted

Hence the correct answer will be (4).

97. Light of frequency v is incident on a substance of threshold frequency $v_0 (v_0 < v)$. The energy of the emitted photo-electric will be :
(1) $h(v - v_0)$ (2) $\frac{h}{v}$ (3) $he(v - v_0)$ (4) $\frac{h}{v_0}$

Solution –

$$\therefore \ hv = hv_0 + \frac{1}{2} mV^2$$

$$\therefore \ \frac{1}{2} mV^2 = h(v - v_0)$$

Hence the correct answer will be (1).

98. The curve drawn between velocity and frequency of photon in vacuum will be a :
(1) straight line parallel to frequency axis
(2) straight line parallel to velocity axis
(3) straight line passing through origin and making an angle of 45^0 with frequency axis
(4) Hyperbola

Solution – In vacuum velocity of photon does not depend on frequency.

Hence the correct answer will be (1).

99. Threshold wavelength for a metal is 5200 $\dot{A}$ Photoelectrons will be ejected if it is irradiated by a light from:
(1) 50 watt infrared lamp (2) 1 watt infrared lamp
(3) 50 watt ultraviolet lamp (4) 0.5 watt infrared lamp

Solution – $\lambda_{UV} < 5200 \ \dot{A}$

Hence the correct answer will be (3).

100. The slope of frequency of incident light and stopping potential for a given surface will be :

(1) h (2) $\frac{h}{e}$ (3) eh (4) e

Solution – $eV = hv - nv_0$ or $V = \left(\frac{h}{e}\right) v - \frac{hv_0}{e}$

$$y = mx + c$$

$\therefore \quad m = \frac{h}{e}$

Hence the correct answer will be (2).

101. A photo-cell is illuminated by a source of light, which is placed at a distance d from the cell, if the distance becomes $\frac{d}{2}$ then the number of electrons emitted per second will be

(1) Remain same (2) four times (3) two times (4) one-fourth

Solution – No of photoelectrons $\propto I \propto \frac{1}{r^2}$

$$\frac{N_1}{N_2} = \left(\frac{r_2}{r_1}\right)^2$$

or $\frac{N}{N_2} = \frac{1}{4} \Rightarrow N^2 = 4N$

Hence the correct answer will be (2).

102. The work function of aluminium is 4.125 eV. The cut off wavelength for photoelectric effect for aluminium is-

(1) 150 nm (2) 420 nm (3) 200 nm (4) 300 nm

Solution –

$$\phi = \frac{hc}{\lambda} \quad \therefore \quad \lambda = \frac{hc}{\phi} = \frac{2 \ X \ 10^{-25} \ X \ 10^{9}}{4.125 \ X \ 1.6 \ X \ 10^{-19}}$$

= 300 nm

Hence the correct answer will be (4).