PHYSICS

Q.1 When yellow light is incident on a surface no electrons are emitted while green light can emit. Infrared light is incident on the surface then -

(A) no electrons are emitted

(B) Photons are emitted

(C) electrons of higher energy are emitted

(D) electrons of lower energy are emitted

[A]

Q.2 Light of frequency ν is incident on a certain photo electric substance with threshold frequency ν_0. The work function for the substance is -

(A) hν (B) $h\nu_0$

(C) $h\nu - h\nu_0$ (D) $hc(\nu + \nu_0)$ **[B]**

Q.3 Three photons of energy 5eV, 6eV, 7eV are incident on metal having work function 3eV. The maximum kinetic energy of emitted photoelectrons is-

(A) 2eV (B) 3 eV

(C) 4 eV (D) 15 eV **[C]**

Q.4 Electromagnetic radiations having electric field variation is as

$$E = E_0\cos^2\frac{\omega t}{2}\cos\omega_0 t$$

is incident on metal plate having work function $\frac{h(\omega+\omega_0)}{4\pi}$, h is planck's constant. The maximum kinetic energy of emitted photoelectrons is –

(A) $\frac{h\omega_0}{4\pi}$ (B) $\frac{h\omega}{4\pi}$

(C) $\frac{h(\omega+\omega_0)}{4\pi}$ (D) $\frac{h(\omega-\omega_0)}{4\pi}$ **[C]**

Q.5 We wish to observe an object which is 2.5 Å in size. The minimum energy photon that can be used -

(A) 5 KeV (B) 8 KeV

(C) 10 KeV (D) 12 KeV **[A]**

Q.6 When 24.8 KeV X-rays strike a material, the photoelectrons emitted from K shell are observed to move in a circle of radius 23 mm in a magnetic field of 2×10^{-2}T. The binding energy of K-shell electrons is –

(A) 6.2 KeV (B) 5.4 KeV

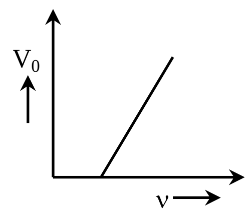
(C) 7.4 KeV (D) 8.6 KeV **[A]**

Q.7 The number of visible photons of wavelength 5000Å that a 100 W bulb with 3% efficiency emit per second is –

(A) 10^{19} (B) 10^{9}

(C) 10^{33} (D) 10^{25} **[A]**

Q. 8 In photoelectric effect, the slope of straight line graph between stopping potential (V_0) and frequency of incident light (ν) gives :



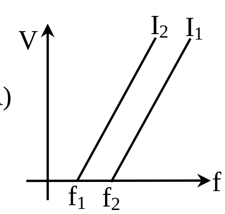
(A) charge on electrons

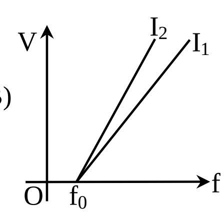
(B) work function of emitter

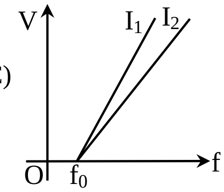
(C) Plank's constant

(D) ratio of Planck's constant to charge on electron **[D]**

Q.9 A photoelectric experiment is performed at two different light intensities I_1 and I_2 (> I_1). Choose the correct graph showing the variation of stopping potential versus frequency of light.

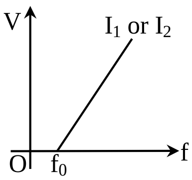
(A)


(B)


(C) 

(D) None of these **[D]**

Sol. The value of stopping potential depends on the maximum kinetic energy of the photo-electron and thus it is independent of the intensity of light. Therefore, none of the graph shown is correct. The correct graph is shown in the figure.



Q.10 The radiation emitted, when an electron jumps from n = 3 to n = 2 orbit is a hydrogen atom, falls on a metal to produce photoelectron. The electrons from the metal surface with maximum kinetic energy are made to move perpendicular to a magnetic field of $\frac{1}{320}$ T in a radius of 10^{-3}m. Find the work function of metal-

(A) 1.03 eV (B) 1.89 eV
(C) 0.86 eV (D) 2.03 eV **[A]**

Sol. $E_3 - E_2 = 13.6\left[\frac{1}{2^2} - \frac{1}{3^2}\right]$

$= \frac{13.6 \times 5}{36} = 1.89$ eV

Photoelectrons with kE_{max} are moving on circular path.

$r = \frac{mv}{qB}$

$mv = qBr$

$P = qBr = 1.6 \times 10^{-19} \times \frac{1}{3200} \times 10^{-3}$

$\frac{1}{2} \times 10^{-24} = 5 \times 10^{-25}$ kg m/s

Energy of photoelectron = $KE_{max} = \frac{P^2}{2m}$

$= \frac{25 \times 10^{-50}}{2 \times 9.1 \times 10^{-31} \times 1.6 \times 10^{-19}}$ eV

$= 0.86$ eV

Now use Einstein equation

$h\nu = \phi + kE_{max}$

$1.89 = 0.56 + \phi$; $\phi = 1.03$ ev

Q.11 Choose the correct statement (s) related to the photocurrent and the potential difference between the plate and the collector-

(A) Photocurrent always increase with the increase in potential difference
(B) when the potential difference is zero, the photocurrent is also zero
(C) Photocurrent attain a saturation value of some positive value of the potential difference
(D) None of these **[C]**

Q.12 Two photons having -

(A) equal wavelengths have equal linear monenta
(B) equal energies have equal linear momenta
(C) equal frequencies have equal linear momenta
(D) equal linear momenta have equal wavelengths

[D]

Q.13 If K_1 and K_2 are the maximum kinetic energies of photo electrons emitted when lights of wavelength λ_1 and λ_2 respectively incident on a metallic surface and $\lambda_1 = 3\lambda_2$. Then -

(A) $K_1 > \frac{K_2}{3}$ (B) $K_1 < \frac{K_2}{3}$
(C) $K_1 = 3K_2$ (D) $K_2 = 3K_1$ **[B]**

Sol. $K_1 = \frac{hc}{\lambda_1} - \phi$

$K_2 = \frac{hc}{\lambda_2} - \phi$

$$\frac{K_2}{K_1} = \frac{\left(\frac{3hc}{\lambda_1} - \phi\right)}{\left(\frac{hc}{\lambda_1} - \phi\right)} = \frac{3\left(\frac{hc}{\lambda_1} - \frac{\phi}{3}\right)}{\left(\frac{hc}{\lambda_1} - \phi\right)}$$

$\Rightarrow \frac{K_2}{K_1} > 3$

Q.14 Let n_r and n_b be respectively the number of photons emitted by a red bulb and a blue bulb of equal power in a given time -

(A) $n_r = n_b$

(B) $n_r < n_b$

(C) $n_r > n_b$

(D) The information is insufficient to get a relation between n_r and n_b **[C]**

Q.15 The equation E = pc is valid -

(A) for an electron as well as for a photon

(B) for an electron but not for a photon

(C) for a photon but not for an electron

(D) neither for an electron nor for a photon **[C]**

Q.16 The work function of a metal is $h\nu_0$. Light of frequency ν falls on this metal. The photoelectric effect will take place only if -

(A) $\nu \geq \nu_0$ (B) $\nu > 2\nu_0$

(C) $\nu < \nu_0$ (D) $\nu < \nu_0/2$ **[A]**

Q.17 Light of wavelength λ falls on a metal having work function hc/λ_0. Photoelectric effect will take place only if -

(A) $\lambda \geq \lambda_0$ (B) $\lambda \geq 2\lambda_0$

(C) $\lambda \leq \lambda_0$ (D) $\lambda < \lambda_0/2$ **[C]**

Q.18 When stopping potential is applied in an experiment on photoelectric effect, no photocurrent is observed. This means that -

(A) the emission of photoelectrons is stopped

(B) the photoelectrons are emitted but are reabsorbed by the emitter metal

(C) the photoelectrons are accumulated near the collector plate

(D) the photoelectrons are dispersed from the sides of the apparatus **[B]**

Q.19 The kinetic energy of most energetic electrons emitted from a metallic surface is doubled when the wavelength λ of the incident radiation is changed from 400 nm to 310 nm. The work function of the metal is -

(A) 0.9 eV (B) 1.7 eV

(C) 2.2 eV (D) 3.1 eV **[C]**

Sol. $K = \frac{12400}{4000} - \phi = 3.1 - \phi$

$2K = \frac{12400}{3100} - \phi = 4 - \phi$

$\Rightarrow 6.2 - 2\phi = 4 - \phi$

or $2.2 \text{ eV} = \phi$

$\therefore \phi = 2.2 \text{ eV}$

Q.20 The mass of an electron in motion depends upon

(A) direction of motion

(B) its velocity

(C) initial mass of e^-

(D) its shell number **[B]**

Q.21 A photon of energy $h\nu$ is absorbed by a free electron of a metal having work function $\varphi < h\nu$,

(A) The electron is sure to come out

(B) The electron is sure to come out with a kinetic energy $h\nu - \varphi$

(C) Either the electron does not come out or it comes out with a kinetic energy $h\nu - \varphi$ **[B]**

(D) It may come out with a kinetic energy less than $h\nu - \varphi$ **[D]**

Q.22 A modern 200 watt sodium street lamp emits yellow light of wavelength 0.6 µm. Assuming it to be 25% efficient in converting electrical energy to light, number of photons of yellow light it emits per second is -

(A) 6.2×10^{20} (B) 3×10^{19}

(C) 1.5×10^{20} (D) 6×10^{18} **[C]**

Sol. $\frac{n}{t} = \frac{IA}{h\nu} = \frac{IA\lambda}{hc} = \frac{W\lambda}{hc}$

$= \frac{50 \times 6 \times 10^{-7}}{6.6 \times 10^{-34} \times 3 \times 10^{8}}$

$= \frac{300}{20} \times 10^{19}$

$= 1.5 \times 10^{20}$

Q.23 The collector plate in an experiment on photoelectric effect is kept vertically above the emitter plate. Light source is put on and a saturation photocurrent is recorded. An electric field is switched on which has a vertically downward direction.

(A) The photocurrent will increase
(B) The kinetic energy of the electrons will increase
(C) The stopping potential will decrease
(D) The threshold wavelength will increase **[B]**

Q.24 Two identical metal plates show photoelectric effect. Light of wavelength λ_A falls on plate A and λ_B falls on plate B. $\lambda_A = 2\lambda_B$. The maximum K.E. of the photoelectrons are K_A and K_B respectively. Which one of the following is true ?

(A) $2K_A = K_B$ (B) $K_A = 2K_B$
(C) $K_A < K_B/2$ (D) $K_A > 2K_B$ **[C]**

Sol. $K_A = \frac{hc}{\lambda_A} - \phi = \frac{hc}{2\lambda_B} - \phi$ .... (i)

$K_B = \frac{hc}{\lambda_B} - \phi \Rightarrow \frac{hc}{\lambda_B} = K_B + \phi$ .... (ii)

From eq^n (i) & (ii)

$K_A = \frac{1}{2}(K_B + \phi) = \frac{1}{2}K_B - \frac{\phi}{2}$

$K_A < \frac{1}{2}K_B$

Q.25 The threshold frequency for photo electric effect on sodium corresponds to a wavelength 5000 Å. Its work function is -

(A) 15 Joule (B) 10×10^{-19} Joule
(C) 4×10^{-19} Joule (D) None of these

[C]

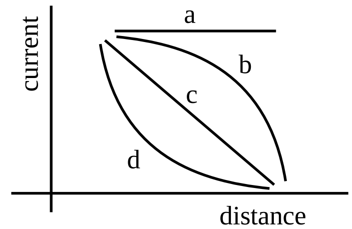
Sol. $\phi = \frac{hc}{\lambda_0}$

$\phi = \frac{20 \times 10^{-26}}{5000 \times 10^{-10}} = 4 \times 10^{-19}$ Joule

Q.26 A point source of light is used in a photoelectric effect. If the source is removed farther from the emitting metal, the stopping potential -

(A) will increase
(B) will decrease
(C) will remain constant
(D) will either increase or decrease **[C]**

Q.27 A point source causes photoelectric effect from a small metal plate. Which of the following curves may represent the saturation photocurrent as a function of the distance between the source and the metal ?



(A) a (B) b
(C) c (D) d **[D]**

Q.28 Light of frequency $4\nu_0$ is incident on the metal of threshold frequency ν_0. The maximum kinetic energy of the emitted photo electrons is

(A) $3\,h\nu_0$ (B) $2\,h\nu_0$
(C) $\frac{3}{2}\,h\nu_0$ (D) $\frac{h\nu_0}{4}$ **[A]**

Sol. $K.E._{max} = 4h\nu_0 - h\nu_0$

$K.E._{max} = 3\,h\nu_0$

Q.29 A proton and an electron are accelerated by the same potential difference. Let λ_e and λ_p denote the de Broglie wavelengths of the electron and the proton respectively -

(A) $\lambda_e = \lambda_p$
(B) $\lambda_e < \lambda_p$
(C) $\lambda_e > \lambda_p$
(D) The relation between λ_e and λ_p depends on the accelerating potential difference

[C]

Q.30 A surface does not ejects electron when illuminated with blue light. Then photoelectrons will be ejected when the surface is illuminated by -

(A) masers (B) infra-red
(C) laser (D) X-rays **[D]**

Q.31 The phenomenon of photoelectric emission depends on -

(A) only wavelength of incident light
(B) only work function of surface
(C) only nature of surface
(D) all of the above **[D]**

Q.32 The work function of a substance is 4 eV. What is the approximate longest wavelength of light that can cause photo-emission ?

(A) 309 nm (B) 209 nm

(C) 109 nm (D) 9 nm **[A]**

Sol. $\lambda_{th} = \frac{hc}{\phi} = \frac{12400}{4}$ Å = 3100 Å = 310 nm

$\lambda \le \lambda_{th} \quad \Rightarrow \lambda \le 310$ nm

Q.33 A photon behaves as if it had a mass equal to -

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

(C) $\frac{c^2}{h\nu}$ (D) $h\nu c$ **[B]**

Sol. $E = mc^2$

$m = \frac{E}{c^2} = \frac{h\nu}{c^2}$

Q.34 A photosensitive plate is illuminated by green light and photoelectrons are emitted with maximum kinetic energy 4 eV. If the intensity of the incident radiation is reduced to one-fourth of the original value, then the maximum K.E. of the photoelectrons will be -

(A) 0.1 eV (B) 1 eV

(C) 4 eV (D) 16 eV **[C]**

Q.35 Photoelectron are emitted with maximum kinetic energy E from a metal surface when light of frequency υ falls on it when light of frequency υ' falls on the same metal, the max. KE. Of emitted Photoelectrons is found to be 2E then υ' is -

(A) $\upsilon^1 = \upsilon$ (B) $\upsilon^1 = 2\upsilon$

(C) $\upsilon^1 > 2\upsilon$ (D) $\upsilon^1 < 2\upsilon$ **[C]**

Sol. $KE = h\upsilon + \phi$ .....(i)

$2KE = h\upsilon' + \phi$ ......(ii)

or $2(h\upsilon + \phi) = h\upsilon' + \phi$

or $\upsilon' = 2\upsilon + \frac{\phi}{h} \Rightarrow \upsilon' > 2\upsilon$

Q.36 The stopping potentials are V_1 and V_2 with incident lights of wavelength λ_1 and λ_2 respectively. Then $V_1 - V_2$ -

(A) $\frac{hc}{e}\left(\frac{\lambda_1\lambda_2}{\lambda_1-\lambda_2}\right)$ (B) $\frac{hc}{e}\left(\frac{1}{\lambda_1}-\frac{1}{\lambda_2}\right)$

(C) $\frac{he}{c}\left(\frac{1}{\lambda_1}-\frac{1}{\lambda_2}\right)$ (D) $\frac{he}{c\lambda_1\lambda_2}(\lambda_1-\lambda_2)$

[B]

Sol. $eV_1 = \frac{hc}{\lambda_1} - \phi$

$eV_2 = \frac{hc}{\lambda_2} - \phi$

$V_1 - V_2 = \frac{hc}{e}\left(\frac{1}{\lambda_1}-\frac{1}{\lambda_2}\right)$

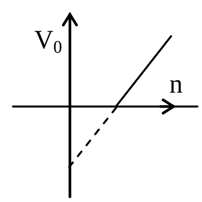
Q.37 The graph between the stopping potential V_0 and frequency (n) of incident photons for photocell is a straight line with a slope -

(A) h (B) eh

(C) e/h (D) h/e **[D]**

Sol. $eV_0 = hn - \phi$

$V_0 = \left(\frac{h}{e}\right) n - \frac{\phi}{e}$



Q.38 All electrons ejected from a surface by incident light of wavelength 200 nm can be stopped before travelling 1 m in the direction of uniform electric field of 4N/C. The work function of the surface is –

(A) 4eV (B) 6.2 eV

(C) 2 eV (D) 2.2 eV **[D]**

Sol. $V_s = E.d$

$V_s = 4$Volt

$eV_s = \frac{12400}{\lambda} - W$

$4\text{ eV} = \frac{12400\text{eV}}{2000} - W$

4eV = 6.2eV – W

[W = 2.2 eV]

Q.39 The maximum kinetic energy of photoelectrons emitted from a surface when photons of energy 5 eV fall on it is 3 eV. The stopping potential in volts is –

(A) 3 eV (B) 2 eV

(C) 8 eV (B) 5 eV **[A]**

Sol. $eV_S = h\nu - \phi = K_{max}$

$V_S = 3$ eV

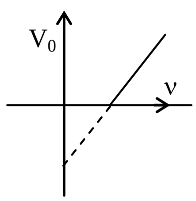
Q.40 The graph between the frequency of incident light and the stopping potential is a -

(A) Parabola (B) Straight line

(C) Hyperbola (D) Circle **[B]**

Sol. Use $eV_0 = h\nu - \phi$

or $V_0 = \frac{h}{e}\nu - \frac{\phi}{e}$



Q.41 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)– **[AIEEE-2009]**

(A) 3.09 eV (B) 1.41 eV

(C) 1.51 eV (D) 1.68 Ev **[B]**

Sol. $\because \frac{hc}{\lambda} = \frac{1}{2}mv^2 + \phi$

$\Rightarrow \phi = \frac{hc}{\lambda} - \frac{1}{2}mv^2$

$= \frac{1240}{400} - 1.68 = 1.41$ eV

Q.42 Light of frequency 1.5 times the threshold frequency is incident on a photosensitive material, photoelectric current is emitted. If the frequency of light is halved and intensity is doubled, the photoelectric current becomes -

(A) 4 times the orginal current

(B) 2 times the original current

(C) half the original current

(D) zero times the original current **[D]**

Sol. $\nu_1 = 1.5\ \nu_0$

$\nu_2 = \frac{\nu_1}{2} = 0.75\ \nu_0 < \nu_0$

$\Rightarrow$ photoelectric effect (P.E.E.) not possible.

Q.43 We wish to observe an object which is 2.5 Å in size. The minimum energy photon that can be used-

(A) 5 KeV (B) 8 KeV

(C) 10 KeV (D) 12 KeV **[A]**

Sol. In order for scattering to occur, the wavelength of the waves must be of the same order of magnitude or smaller than the size of the object being observed. Hence the largest possible wavelength we can use in the present problem is λmax = 2.5 Å. Hence minimum energy is

$E_{min} = h\nu_{min} = \frac{hc}{\lambda_{max}}$

$= \frac{12.40\times10^3 eV.A°}{2.5A°} = 5$ KeV

Q.44 In an experiment tungsten cathode which has a threshold wavelength 2300 Å is irradiated by ultraviolet light of wavelength 1800 Å. The maximum energy of emitted photo-electron will be –

(A) 1.2 eV (B) 1.5 eV

(C) 1.6 eV (D) 1.8 eV **[B]**

Sol. $K_{max} = hc\left(\frac{1}{\lambda} - \frac{1}{\lambda_0}\right)$

$= \frac{6.62\times10^{-34}\times3\times10^8}{1.6\times10^{-19}}\left(\frac{10^{10}}{1800} - \frac{10^{10}}{2300}\right)$

= 1.5 eV

Q.45 The frequency of incident light falling on a photo sensitive plate is doubled, then maximum kinetic energy of the emitted photoelectrons will become –

(A) 2 times of the earlier value

(B) More than 2 times of the earlier value

(C) Less than 2 times of the earlier value

(D) Unchanged **[B]**

Sol. $KE_{max} = h(\nu - \nu_0)$

$$\frac{KE'_{max}}{KE_{max}} = \frac{h(2\nu - \nu_0)}{h(\nu - \nu_0)} > 2$$

Q.46 1.5 mW of 400 nm light is directed at a photo electric cell. If 0.1% of the incident photons produce photo electrons, the current in the cell is-

(A) 0.48μA (B) 0.42mA
(C) 0.48 mA (D) 0.42μA **[A]**

Sol. $n = \frac{P\lambda}{hc}$

$n_e = n \times \beta \% = \frac{P\lambda}{hc} \times \frac{\beta}{100}$

$n_e = \frac{1.5\times10^{-3}\times400\times10^{-9}}{6.6\times10^{-34}\times3\times10^{8}} \times \frac{0.1}{100}$

$I = n_e e$

$= 0.48\ \mu A$

Q.47 Stopping potentials of 24, 100, 110, 115 kV are measured for photoelectrons emitted from a certain element when it is irradiated with monochromatic X-rays. The element is used as a target in an X-ray tube. The energy of K_α line is –

(A) 54 KeV (B) 76 KeV
(C) 88 KeV (D) 32 KeV **[B]**

Sol. Let E_K, E_L, E_M, E_N be the binding energies of K, L, M and N shell. Let E_P be energy of incident photon. Then

$E_P - E_K = 24$ KeV ... (1)

$E_P - E_L = 100$ KeV ... (2)

$E_P - E_M = 110$ KeV .... (3)

$E(K_\alpha) = E_K - E_L = 100 - 24 = 76$ KeV

Q.48 When photons of energy hν are incident on the surface of photosensitive material of work function $h\nu_0$, then -

(A) the kinetic energy of all emitted electrons is $h\nu_0$

(B) the kinetic energy of all emitted electrons is $h(\nu - \nu_0)$

(C) the kinetic energy of all fastest electrons is $h(\nu - \nu_0)$

(D) the kinetic energy of all emitted electrons is hν **[C]**

Sol. $\frac{1}{2} mv_{max}^2 = h\nu - h\nu_o$

$= h(\nu - \nu_o)$

This is Einstein's equation of photoelectric effect.

Q.49 We wish to observe an object which is 2.5 Å in size. The minimum energy photon that can be used -

(A) 5 KeV (B) 8 KeV
(C) 10 KeV (D) 12 KeV **[A]**

Sol. In order for scattering to occur, the wavelength of the waves must be of the same order of magnitude or smaller than the size of the object being observed. Hence the largest possible wavelength we can use in the present problem is $\lambda_{max} = 2.5$ Å. Hence minimum energy is

$E_{min} = h\nu_{min} = \frac{hc}{\lambda_{max}}$

$= \frac{12.40\times10^3}{2.5\text{Å}}$ eV.Å

$= 4.96 \times 10^3$ eV

$= 5$ KeV

Q.50 If the rate of emission of energy from a star is 2.7×10^{36} J/sec, the rate of loss of mass in the star will be -

(A) 3×10^{18} kg/sec (B) 3×10^{19} kg/sec
(C) 3×10^{20} kg/sec (D) 3×10^{21} kg/sec

[B]

Sol. $E = mc^2$

$\therefore m = \frac{E}{c^2} = \frac{2.7\times10^{36}}{9\times10^{16}}$

$= \frac{27\times10^{35}}{9\times10^{16}} = 3 \times 10^{19}$ kg/sec