Dual Nature of Matter and Radiation

Question1

An electron and an alpha particle are accelerated by the same potential difference. Let λ_θ and λ^α denote the de-Broglie wavelengths of the electron and the alpha particle, respectively, then:

[NEET 2024 Re]

Options:

A.

$\lambda_e > \lambda_e$

B.

$\lambda_e = 4\lambda_\alpha$

C.

$\lambda_e = \lambda_a$

D.

$\lambda_e < \lambda_\Delta$

Answer: A

Solution:

de-Broglie wavelength is given by

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

For same potential difference

$$\lambda \propto \frac{1}{\sqrt{mq}}$$

$$\frac{\lambda_\alpha}{\lambda_e} = \sqrt{\frac{m_e q_e}{m_\alpha q_\alpha}}$$

$$\because m_\alpha >>> m_e$$

$$\lambda_e > \lambda_e$$

Question2

If ϕ is the work function of photosensitive material in eV and light of

wavelength of numerical value λ = hc/e metre, is incident on it with energy above its threshold value at an instant then the maximum kinetic energy of the photo-electron ejected by it at that instant (Take h-Plank's constant, c-velocity of light in free space) is (in SI units):

[NEET 2024 Re]

Options:

A.

e + 2ϕ

B.

2e − ϕ

C.

e − ϕ

D.

e + ϕ

Answer: C

Solution:

$$(K.E))_{max} = \frac{hc}{\lambda} - \phi_0$$

$$\text{and } \lambda = \frac{hc}{e}$$

$$\Rightarrow (K.E)_{max} = \frac{hc}{\frac{hc}{e}} - \phi_0$$

$$\Rightarrow (K.E)_{max} = e - \phi_0 \Rightarrow (K.E.)_{max} = e - \phi$$

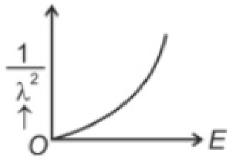
Question3

The graph which shows the variation of $(1/\lambda^2)$ and its kinetic energy, E is (where λ is de Broglie wavelength of a free particle):

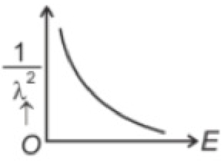
[NEET 2024]

Options:

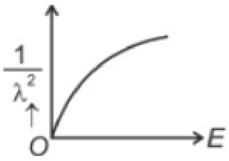
A.



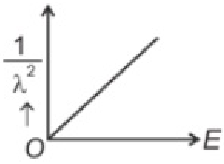
B.



C.



D.



Answer: D

Solution:

de-Broglie wavelength $\lambda = \frac{h}{P} = \frac{h}{mv} = \frac{h}{\sqrt{2mE}}$ where $E = \frac{1}{2}mv^2$

Squaring both sides,

$\lambda^2 = \frac{h^2}{4m^2E}$

$\Rightarrow \frac{1}{\lambda^2} = \text{(constant) } E$

Graph passes through origin with constant slope.

Question4

If c is the velocity of light in free space, the correct statements about photon among the following are:

A. The energy of a photon is E = hv.
B. The velocity of a photon is c.
C. The momentum of a photon, p = hv/c.
D. In a photon-electron collision, both total energy and total momentum are conserved.
E. Photon possesses positive charge.

Choose the correct answer from the options given below:

[NEET 2024]

Options:

A.

A and B only

B.

A, B, C and D only

C.

A, C and D only

D.

A, B, D and E only

Answer: B

Solution:

(A) If c is the velocity of light

so, E = hv (Energy of photon)

(B) Velocity of photon is equal to velocity of light i.e. c.

(C) $\lambda = \frac{h}{p}$

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

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

(D) In photon-electron collision both total energy and total momentum are conserved.

Question5

The work functions of Caesium (Cs), Potassium (K) and Sodium (Na) are 2.14eV,2.30eV and 2.75eV respectively. If incident electromagnetic radiation has an incident energy of 2.20eV, which of these photosensitive surfaces may emit photoelectrons?

[NEET 2023]

Options:

A.

Both Na and K

B.

K only

C.

Na only

D.

Cs only

Answer: D

Solution:

Energy of incident radiation $= 2.80\ \mathrm{eV}$

Work function of $\mathrm{Cs} \longrightarrow 2.14\ \mathrm{eV}$

Work function of $\mathrm{K} \longrightarrow 2.30\ \mathrm{eV}$

Work function of $\mathrm{Na} \longrightarrow 2.75\ \mathrm{eV}$

Since the work function of potassium and sodium are more than energy of incident radiation hence photons may be emitted from caesium.

Question6

The de Broglie wavelength associated with an electron, accelerated by a potential difference of 81V is given by:

[NEET 2023 mpr]

Options:

A.

13.6nm

B.

136nm

C.

1.36nm

D.

0.136nm

Answer: D

Solution:

$$\lambda_e = \frac{12.27}{\sqrt{V}}\mathring{A} = \frac{12.27}{\sqrt{81}}\mathring{A} = \frac{12.27}{9}\mathring{A}$$

$$= 1.36\mathring{A}\left(\because 1\mathring{A} = \frac{1}{10}\mathrm{nm}\right)$$

$$= 0.136\ \mathrm{nm}$$

Question7

The maximum kinetic energy of the emitted photoelectrons in photoelectric effect is independent of :

[NEET 2023 mpr]

Options:

A.

work function of material

B.

intensity of incident radiation

C.

frequency of incident radiation

D.

wavelength of incident radiation

Answer: B

Solution:

Solution:

Maximum kinetic energy of emitted electron is independent of intensity of radiation.

Question8

The light rays having photons of energy 4.2 eV are falling on a metal surface having a work function of 2.2 eV. The stopping potential of the surface is :
[NEET Re-2022]

Options:

A. 6.4V

B. 2 eV

C. 2V

D. 1.1V

Answer: C

Solution:

Given

$hv = 4.2\text{ eV}$

$w = 2.2\text{ eV}$

$V_s = ?$

By Einstein's equation

$hV = w + eV_s$

$4.2eV = 2.2\text{ eV} + e \times V_s$

$2eV = eV_s$

$2 \times 1.6 \times 10^{-19} = 1.6 \times 10^{-19} \times V_s$

$V_s = 2v$

Question9

The threshold frequency of a photoelectric metal is v_0. If light of frequency $4v_0$ is incident on this metal, then the maximum kinetic energy of emitted electrons will be
[NEET Re-2022]

Options:

A. $4hh_0$

B. hv_0

C. $2hhv_0$

D. $3hh_0$

Answer: D

Solution:

Given $v = 4v_0$

By photo electric equation

$hv = hv_0 + K \cdot E_{max}$

$h \times 4v_0 = hv_0 + K \cdot E_{max}$

$K \cdot E_{max} = 3hv_0$

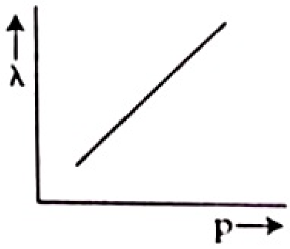
Question10

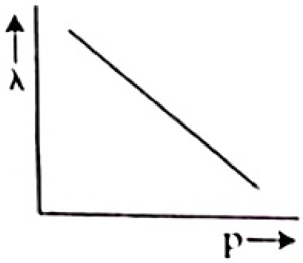
The graph which shows the variation of the de Broglie wavelength (λ) of

a particle and its associated momentum (p) is [NEET-2022]

Options:

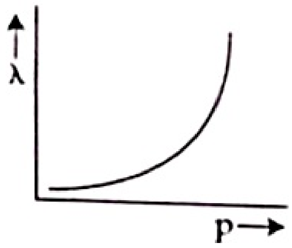
A.



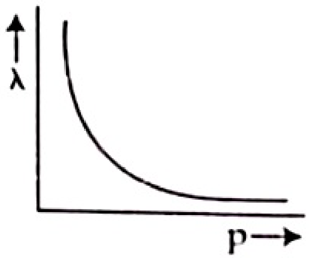


B.

C.



D.



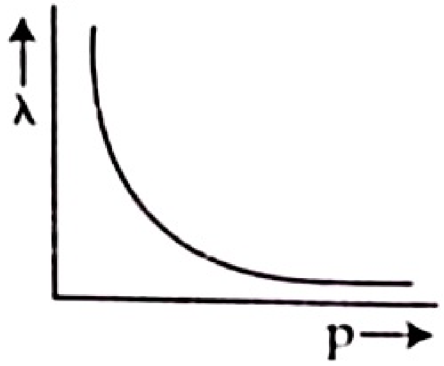
Answer: D

Solution:

- de-Broglie wavelength associated with a particle is given by

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

$\lambda \propto \frac{1}{p}$



Question11

When two monochromatic lights of frequency, v and $\frac{v}{2}$ are incident on a photoelectric metal, their stopping potential becomes $\frac{V_s}{2}$ and V_s respectively. The threshold frequency for this metal is [NEET-2022]

Options:

A. 2v

B. 3v

C. $\frac{2}{3}$v

D. $\frac{3}{2}$v

Answer: D

Solution:

Since $k_{max} = eV_s = h\nu - \varphi$

$$\frac{ev_S}{2} = h\nu - h\nu_0 \ldots \text{(i)}$$

$$ev_S = \frac{h\nu}{2} - h\nu_0 \ldots \text{(ii)}$$

$$\frac{1}{2}\left[\frac{h\nu}{2} - h\nu_0\right] = h\nu - h\nu_0$$

$$\Rightarrow h\nu_0 - \frac{h\nu_0}{2} = h\nu - \frac{h\nu}{4}$$

$$\Rightarrow \frac{h\nu_0}{2} = \frac{3h\nu}{4}$$

$$\nu_0 = \frac{3\nu}{2}$$

Language of question is wrongly framed. The values of stopping potentials should be interchanged.

Question12

The number of photons per second on an average emitted by the source of monochromatic light of wavelength 600 nm, when it delivers the power of 3.3×10^{-3} watt will be ($h = 6.6 \times 10^{-34}$ J s)
[NEET 2021]

Options:

A. 10^{18}

B. 10^{17}

C. 10^{16}

D. 10^{15}

Answer: C

Solution:

The power of a source is given as

$$P = \frac{E}{t} = \frac{n}{t}\left(\frac{hc}{\lambda}\right)$$

$$\Rightarrow \frac{n}{t} = \frac{P}{\left(\frac{hc}{\lambda}\right)}$$

(Here $\frac{n}{t}$ is number of photons emitted per second)

$$\Rightarrow \frac{n}{t} = \frac{3.3 \times 10^{-3} \times 6 \times 10^{-7}}{6.6 \times 10^{-34} \times 3 \times 10^{8}}$$

$= 10^{16}$ photons per second

Question13

An electron is accelerated from rest through a potential difference of V volt. If the de Broglie wavelength of the electron is 1.227×10^{-2}nm the potential difference is:
[2020]

Options:

A. 10^2V

B. 10^3V

C. 10^4V

D. 10V

Answer: C

Solution:

(c) Using, $\lambda = \frac{12.27}{\sqrt{V}}$Å

$\Rightarrow \sqrt{V} = \frac{12.27 \times 10^{-10}}{1.227 \times 10^{-11}} = 10^2$

[Given, $\lambda = 1.227 \times 10^{-11}$m]

$\therefore V = 10^4$ volt

Question14

Light of frequency 1.5 times the threshold frequency is incident on a photosensitive material. What will be the photoelectric current if the frequency is halved and intensity is doubled?
[2020]

Options:

A. four times

B. one-fourth

C. zero

D. doubled

Answer: C

Solution:

(c) For photoelectric emission, photoelectric current, incident light frequency should be greater than threshold frequency.Light of frequency 1.5 times the threshold frequency

v_0 incident. $v = \frac{3}{2}v_0$

If frequency is halved,

$\therefore v' = \frac{v}{2} = \frac{3}{4}v_0$

$ ∵ v^{'} ∴ No photoelectric emission will take place.

Question15

An electron is accelerated through a potential difference of 10,000 V. Its de Broglie wavelength is, (nearly) ($m_e = 9 \times 10^{-31}$kg)
(NEET 2019)

Options:

A. 12.2nm

B. 12.2×10^{-13}m

C. 12.2×10^{-12}m

D. 12.2×10^{-14}m

Answer: C

Solution:

de Broglie wavelength of electron,

$\lambda_e = \frac{12.27A°}{\sqrt{V\,(\text{in}\,V)}}$

Here, $V = 10000V$

$\therefore \lambda_e = \frac{12.27}{\sqrt{10000}} \times 10^{-10}m = 12.27 \times 10^{-12}m$

Question16

The work function of a photosensitive material is 4.0eV. The longest wavelength of light that can cause photon emission from the substance is (approximately)
(OD NEET 2019)

Options:

A. 3100nm

B. 966nm

C. 31nm

D. 310nm

Answer: D

Solution:

Required wavelength of light,
$\lambda_0 = \frac{hc}{\phi} = \frac{1240eV - nm}{4eV} \approx 310nm$

Question17

An electron of mass m with an initial velocity $\vec{v} = v_0\hat{i} (v_0 > 0)$ enters an electric field $\vec{E} = -\vec{E}_0\hat{i}$ (E_0 = right. constant left. > 0) at t = 0. If λ_0 is its de-Broglie wavelength initially, then its de- Broglie wavelength at time t is
(NEET 2018)

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Options:

A. $\frac{\lambda_0}{\left(1 + \frac{eE_0}{mv_0}t\right)}$

B. $\lambda_0\left(1 + \frac{eE_0}{mv_0}t\right)$

C. $\lambda_0 t$

D. λ_0.

Answer: A

Solution:

Here, $\vec{E} = -E_0\hat{i}$; initial velocity $\vec{v} = v_0\hat{i}$
Force acting on electron due to electric field
$\vec{F} = (-e)\left(-E_0\hat{i}\right) = eE_0\hat{i}$
Acceleration produced in the electron,
$\vec{a} = \frac{\vec{F}}{m} = \frac{eE_0}{m}\hat{i}$
Now, velocity of electron after time t,
$\vec{v}_t = \vec{v} + \vec{a}t = \left(v_0 + \frac{eE_0t}{m}\right)\hat{i}$ or $\left|\vec{v}_t\right| = v_0 + \frac{eE_0t}{m}$

Now, $\lambda_t = \frac{h}{mv_t} = \frac{h}{m\left(v_0 + \frac{eE_0t}{m}\right)} = \frac{h}{mv_0\left(1 + \frac{eE_0t}{mv_0}\right)}$

$= \frac{\lambda_0}{\left(1 + \frac{eE_0t}{mv_0}\right)} \left(\because \lambda_0 = \frac{h}{mv_0}\right)$

Question18

When the light of frequency $2v_0$ (where v_0 is threshold frequency), is incident on a metal plate, the maximum velocity of electrons emitted is v_1. When the frequency of the incident radiation is increased to $5v_0$, the maximum velocity of electrons emitted from the same plate is v_2. The ratio of v_1 to v_2 is
(NEET 2018)

Options:

A. 1: 2

B. 1: 4

C. 4: 1

D. 2 : 1

Answer: A

Solution:

According to the Einstein's photoelectric equation, $E = W_0 + \frac{1}{2}mv^2$

When frequency of incident light is $2\upsilon_0$.

$h(2\upsilon_0) = h\upsilon_0 + \frac{1}{2}mv_1^2 \Rightarrow h\upsilon_0 = 12mv_1^2$ ....(i)

When frequency of incident light is $5\upsilon_0$

$h(5\upsilon_0) = h\upsilon_0 + \frac{1}{2}mv_2^2 \Rightarrow 4h\upsilon_0 = \frac{1}{2}mv_2^2$ ....(ii)

Dividing (i) by (ii) ,$\frac{1}{4} = \frac{v_1^2}{v_2^2}$ or $\frac{v_1}{v_2} = \frac{1}{2}$

Question19

The de-Broglie wavelength of a neutron in thermal equilibrium with heavy water at a temperature T (kelvin) and mass m, is
(2017 NEET)

Options:

A. $\frac{h}{\sqrt{3mkT}}$

B. $\frac{2h}{\sqrt{3mkT}}$

C. $\frac{2h}{\sqrt{mkT}}$

D. $\frac{h}{\sqrt{mkT}}$

Answer: A

Solution:

Kinetic energy of a neutron in thermal equilibrium with heavy water at a temperature T is given as

$K = \frac{3}{2}kT$ .....(i)

Also momentum (p) is, $p = \sqrt{2mK}$

From eqn. (i)

$p = \sqrt{2m.\frac{3}{2}kT} = \sqrt{3mkT}$

Required de-Broglie wavelength is given as

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

Question20

The photoelectric threshold wavelength of silver is 3250×10^{-10}m. The velocity of the electron ejected from a silver surface by ultraviolet light of wavelength 2536×10^{-10}m is [Given : $h = 4.14 \times 10^{-15}$ eVs and $c = 3 \times 10^{8} ms^{-1}$] (2017 NEET)

Options:

A. $\approx 0.6 \times 10^{6} ms^{-1}$

B. $\approx 61 \times 10^{3} ms^{-1}$

C. $\approx 0.3 \times 10^{6} ms^{-1}$

D. $\approx 6 \times 10^{5} ms^{-1}$

Answer: D

Solution:

The maximum kinetic energy is given as

$K_{max} = h\upsilon - \phi_0 = h\upsilon - h\upsilon_0 = \frac{hc}{\lambda} - \frac{hc}{\lambda_0}$

where $\lambda_0 =$ threshold wavelength or $\frac{1}{2}mv^2 = \frac{hc}{\lambda} - \frac{hc}{\lambda_0}$

Here,

$h = 4.14 \times 10^{-15} eV\,s,\ c = 3 \times 10^8 ms^{-1}$

$\lambda_0 = 3250 \times 10^{-10} m = 3250Å$

$\lambda = 2536 \times 10^{-10} m = 2536Å,\ m = 9.1 \times 10^{-31} kg$

$h_c = 4.14 \times 10^{-15} eV\,s \times 3 \times 10^8 ms^{-1} = 12420 eV\,Å$

$\therefore \frac{1}{2}mv^2 = 1240\left[\frac{1}{2536} - \frac{1}{3250}\right] eV = 1.076 eV$

$v^2 = \frac{2.152 eV}{m} = \frac{2.152 \times 1.6 \times 10^{-19}}{9.1 \times 10^{-31}}$

$\therefore v \approx 6 \times 10^5 s^{-1} = 0.6 \times 10^6 ms^{-1}$

Note: Options (a) and (d) are same. So both are correct

Question21

An electron of mass m and a photon have same energy E. The ratio of de-Broglie wavelengths associated with them is
(c being velocity of light)
(2016 NEET Phase-I)

Options:

A. $c(2mE)^{\frac{1}{2}}$

B. $\frac{1}{c}\left(\frac{2m}{E}\right)^{\frac{1}{2}}$

C. $\frac{1}{c}\left(\frac{E}{2m}\right)^{\frac{1}{2}}$

D. $\left(\frac{E}{2m}\right)^{\frac{1}{2}}$

Answer: C

Solution:

For electron of energy E

de-Broglie wavelength, $\lambda_e = \frac{h}{p} = \frac{h}{\sqrt{2mE}}$

For photon of energy, $E = h\upsilon = \frac{hc}{\lambda_p}$

$\Rightarrow \lambda_p = \frac{hc}{E}$.............(ii)

$\therefore \frac{\lambda_e}{\lambda_p} = \frac{h}{\sqrt{2mE}} \times \frac{E}{hc} = \frac{1}{c}\left(\frac{E}{2m}\right)^{\frac{1}{2}}$

Question22

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 NEET Phase-I)

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Options:

A. $\frac{5}{2}\lambda$

B. 3λ

C. 4λ

D. 5λ

Answer: B

Solution:

According to Einstein's photoelectric equation,
$eV_s = \frac{hc}{\lambda} - \frac{hc}{\lambda_0}$
∴ as per question,$eV = \frac{hc}{\lambda} - \frac{hc}{\lambda_0}$.......(i)
$\frac{eV}{4} = \frac{hc}{2\lambda} - \frac{hc}{\lambda_0}$........(ii)
From equations (i) and (ii), we get
$\frac{hc}{2\lambda} - \frac{hc}{4\lambda} = \frac{hc}{\lambda_0} - \frac{hc}{4\lambda_0}$
$\Rightarrow \frac{hc}{4\lambda} = \frac{3hc}{4\lambda_0}$ or $\lambda_0 = 3\lambda$

Question23

Electrons of mass m with de-Broglie wavelength λ fall on the target in an X-ray tube.The cutoff wavelength (λ_0) of the emitted X-ray is
(2016 NEET Phase-II)

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Options:

A. $\lambda_0 = \frac{2mc\lambda^2}{h}$

B. $\lambda_0 = \frac{2h}{mc}$

C. $\lambda_0 = \frac{2m^2c^2\lambda^3}{h^2}$

D. $\lambda_0 = \lambda$

Answer: A

Solution:

Kinetic energy of electrons

$K = \frac{p^2}{2m} = \frac{\left(\frac{h}{\lambda}\right)^2}{2m} = \frac{h^2}{2m\lambda^2}$

So, maximum energy of photon = K

$\frac{hc}{\lambda_0} = \frac{h^2}{2m\lambda^2} \therefore \lambda_0 = \frac{2mc\lambda^2}{h}$

Question24

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 NEET Phase-II)

Options:

A. +3 V

B. +4 V

C. -1 V

D. -3 V

Answer: D

Solution:

According Einstein's photoelectric equation maximum kinetic energy of photoelectrons,

$KE_{max} = Ev - \phi$

or $2 = 5 - \phi \therefore \phi = 3eV$

When $E_v = 6eV$ then

$KE_{max} = 6 - 3 = 3eV$

or $e(V_{cathode} - V_{anode}) = 3eV$

or $V_{cathode} - V_{anode} = 3V = -V_{stopping}$

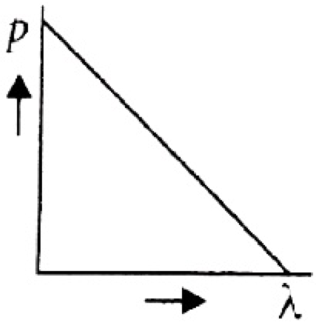
$\therefore V_{stopping} = -3V$

Question25

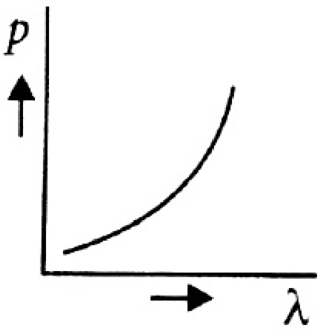
Which of the following figures represent the variation of particle momentum and the associated de-Broglie wavelength? (2015)

Options:

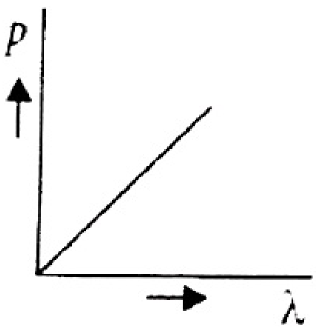
A.



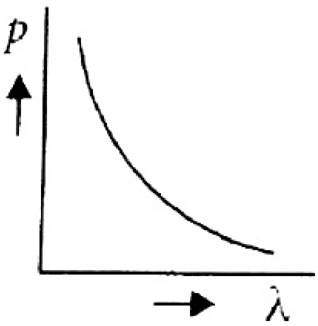
B.



C.



D.



Answer: D

Solution:

de-Broglie wavelength, $\lambda = \frac{h}{p}$

or $\lambda \propto \frac{1}{p}$, λp = constant

This represents a rectangular hyperbola.

Question26

A certain metallic surface is illuminated with monochromatic light of wavelength,λ.The stopping potential for photo-electric 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 photo-electric effect is
(2015 Cancelled)

Options:

A. $\frac{\pi}{4}$

B. $\frac{\lambda}{6}$

C. 6λ

D. 4λ

Answer: D

Solution:

Solution:
According to Einstein's photoelectric equation
$eV_s = \frac{hc}{\lambda} - \frac{hc}{\lambda_0}$
where $V_s =$ Stopping potential
λ = Incident wavelength
λ_0 = Threshold wave length
or $V_s = \frac{hc}{e}\left(\frac{1}{\lambda} - \frac{1}{\lambda_0}\right)$
For the first case
$3V_0 = \frac{hc}{e}\left(\frac{1}{\lambda} - \frac{1}{\lambda_0}\right)$ ....(i)
For the second case
$V_0 = \frac{hc}{e}\left(\frac{1}{2\lambda} - \frac{1}{\lambda_0}\right)$ ....(ii)
Divide eqn. (i) by (ii), we get
$$3 = \frac{\left(\frac{1}{\lambda} - \frac{1}{\lambda_0}\right)}{\left(\frac{1}{2\lambda} - \frac{1}{\lambda_0}\right)}$$
$3\left(\frac{1}{2\lambda} - \frac{1}{\lambda_0}\right) = \left(\frac{1}{\lambda} - \frac{1}{\lambda_0}\right)$
$\frac{3}{2\lambda} - \frac{3}{\lambda_0} = \frac{1}{\lambda} - \frac{1}{\lambda_0}$
$\frac{1}{2\lambda} = \frac{2}{\lambda_0}$ or $\lambda_0 = 4\lambda$

Question27

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)

Options:

A. $\frac{2hc}{\lambda}$

B. $\frac{hc}{3\lambda}$

C. $\frac{hc}{2\lambda}$

D. $\frac{hc}{\lambda}$

Answer: C

Solution:

Solution:
Let ϕ_0 be the work function of the surface of the material. Then,According to Einstein's photoelectric equation, the maximum kinetic energy of the emitted photoelectrons in the first case is

$$K_{max_1} = \frac{hc}{\lambda} - \phi_0$$

and that in the second case is

$$K_{max_2} = \frac{hc}{\frac{\lambda}{2}} - \phi_0 = \frac{2hc}{\lambda} - \phi_0$$

But $K_{max_2} = 3K_{max_1}$(given)

$$\therefore \frac{2hc}{\lambda} - \phi_0 = 3\left(\frac{hc}{\lambda} - \phi_0\right)$$

$$\frac{2hc}{\lambda} - \phi_0 = \frac{3hc}{\lambda} - 3\phi_0$$

$$3\phi_0 - \phi_0 = \frac{3hc}{\lambda} - \frac{2hc}{\lambda}$$

$$2\phi_0 = \frac{hc}{\lambda} \text{ or } \phi_0 = \frac{hc}{2\lambda}$$

Question28

Light of wavelength 500 nm is incident on a metal with work function 2.28 eV. The de Broglie wavelength of the emitted electron is (2015)

Options:

A. $\geq 2.8 \times 10^{-9}$m

B. $\leq 2.8 \times 10^{-12}$m

C. $<2.8 \times 10^{-10}$m

D. $<2.8 \times 10^{-9}$m

Answer: A

Solution:

According to Einstein's photoelectric equation, the maximum kinetic energy of the emitted electron is
$K_{max} = \frac{hc}{\lambda} - \phi_0$
where λ is the wavelength of incident light and ϕ_0 is the work function
Here $\lambda = 500nm$, $hc = 1240 eV\,nm$ and $\phi_0 = 2.28eV$
$\therefore K_{max} = \frac{1240eV\,nm}{500nm} - 2.28eV$
$= 2.48eV - 2.28eV = 0.2eV$
The de Broglie wavelength of the emitted electron is
$\lambda_{min} = \frac{h}{\sqrt{2mK_{max}}}$
where h is the Planck's constant and m is the mass of the electron.
As $h = 6.6 \times 10^{-34} J\,s$, $m = 9 \times 10^{-31} kg$
and $K_{max} = 0.2eV = 0.2 \times 1.6 \times 10^{-19} J$
$\therefore \lambda = \frac{6.6 \times 10^{-34} J\,s}{\sqrt{2(9 \times 10^{-31} kg)(0.2 \times 1.6 \times 10^{-19} J)}}$

$= \frac{6.6}{2.4} \times 10^{-9} m = 2.8 \times 10^{-9} m$
So $\lambda \geq 2.8 \times 10^{-9}$m

Question29

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)

Options:

A. 0.65 eV

B. 1.0 eV

C. 1.3 eV

D. 1.5 eV

Answer: B

Solution:

According to Einstein's photoelectric equation,
The kinetic energy of emitted photoelectrons is
$K = h\upsilon - \phi_0$

where $h\upsilon$ is the energy of incident radiation and ϕ_0 is work function of the metal.
As per question,
$0.5\text{eV} = h\upsilon - \phi_0$............(i)
$0.8\text{eV} = 1.2h\upsilon - \phi_0$.......(ii)
On solving eqns. (i) and (ii), we get
$\phi_0 = 1.0\text{eV}$

Question30

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)

Options:

A. 25

B. 75

C. 60

D. 50

Answer: B

Solution:

Solution:
de Broglie wavelength,
$\lambda = \frac{h}{\sqrt{2mK}}$...........(i)
where m is the mass and K is the kinetic energy of the particle.When kinetic energy of the particle is increased to 16 times, then its de Broglie wavelength becomes,
$\lambda' = \frac{h}{\sqrt{2m(16K)}} = \frac{1}{4}\frac{\lambda}{\sqrt{2mk}} = \frac{\lambda}{4}$ (Using (i))
% change in the de Broglie wavelength
$= \frac{\lambda - \lambda'}{\lambda} \times 100 = \left(1 - \frac{\lambda'}{\lambda}\right) \times 100 = \left(1 - \frac{1}{4}\right) \times 100 = 75\%$

Question31

The wavelength λ_e of an electron and λ_p of a photon of same energy E are related by
(2013 NEET)

Options:

A. $\lambda_p \propto \sqrt{\lambda_e}$

B. $\lambda_p \propto \frac{1}{\sqrt{\lambda_e}}$

C. $\lambda_p \propto \lambda_e{}^2$

D. $\lambda_p \propto \lambda_e$

Answer: C

Solution:

Wavelength of an electron of energy E is

$\lambda_e = \frac{h}{\sqrt{2m_eE}}$............(i)

Wavelength of a photon of same energy E is

$\lambda_p = \frac{hc}{E}$ or $E = \frac{hc}{\lambda_p}$............(ii)

Squarin both sides of Eq. (i), we get

$\lambda_e{}^2 = \frac{h^2}{2m_eE}$ or $E = \frac{h^2}{2m_e\lambda_e{}^2}$............(ii)

Equating (ii) and (iii), we get

$\frac{hc}{\lambda_p} = \frac{h^2}{2m_e\lambda_e{}^2}$

$\lambda_p = \frac{2m_ec}{h}\lambda_e{}^2$

$\lambda_p \propto \lambda_e{}^2$

Question32

For photoelectric emission from certain metal the cutoff frequency is υ.If radiation of frequency 2υ impinges on the metal plate, the maximum possible velocity of the emitted will be(m is the electron mass)
(2013 NEET)

Options:

A. $\sqrt{\frac{2h\upsilon}{m}}$

B. $\sqrt{2}\frac{h\upsilon}{m}$

C. $\sqrt{\frac{h\upsilon}{(2m)}}$

D. $\sqrt{\frac{h\upsilon}{m}}$

Answer: A

Solution:

Work function, $\phi = h\upsilon$
According to Einstein's photoelectric equation
$\frac{1}{2}mv_{max}^2 = h(2\upsilon) - h\upsilon$
$\frac{1}{2}mv_{max}^2 = h\upsilon$
$v_{max}^2 = \frac{2hv\upsilon}{m}$
$v_{max} = \sqrt{\frac{2h\upsilon}{m}}$

Question33

A source of light is placed at a distance of 50cm 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 25cm, the new stopping potential will be :
(KN NEET 2013)

Options:

A. $V_0 / 2$

B. V_0

C. $4V_0$

D. $2V_0$

Answer: B

Solution:

Solution:
By changing the position of source of light from photocell, there will be a change in the intensity of light falling on photocell.
As stopping potential is independent of the intensity of the incident light, hence stopping potential remains same i.e., V_0.

Question34

The de-Broglie wavelength of neutrons in thermal equilibrium at temperature T is
(KN NEET 2013)

Options:

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.

Answer: D

Solution:

de Broglie wavelength of neutrons in thermal equilibrium at temperature T is
$\lambda = \frac{h}{\sqrt{2mk_BT}}$
where m is the mass of the neutron
Here, $m = 1.67 \times 10^{-27}$ kg
$k_B = 1.38 \times 10^{-23} J K^{-1}$
$h = 6.63 \times 10^{-34} J s$
$\therefore \lambda = \frac{6.63 \times 10^{-34}}{\sqrt{2 \times 1.67 \times 10^{-27} \times 1.38 \times 10^{-23} \times T}}$
$= \frac{3.08 \times 10^{-34} \times 10^{25}}{\sqrt{T}} = \frac{30.8 \times 10^{-10}}{\sqrt{T}} m = \frac{30.8}{\sqrt{T}}$Å

Question35

Monochromatic radiation emitted when electron on hydrogen atom jumps from first excited state to the ground state irradiates a photosensitive material. The stopping potential is measured to be 3.57 V. The threshold frequency of the material is
(2012)

Options:

A. 4×10^{15} Hz

B. 5×10^{15} Hz

C. 1.6×10^{15} Hz

D. 2.5×10^{15} Hz

Answer: C

Solution:

For hydrogen atom,$E - n = -\frac{13.6}{n^2} eV$
For ground state,$n = 1$
$\therefore E_1 = -\frac{13.6}{1^2} = -13.6 eV$
For first excited state, $n = 2$

$\therefore E_2 = -\frac{13.6}{2^2} = -3.4eV$

The energy of the emitted photon when an electron jumps from first excited state to ground state is
$h\upsilon = E_2 - E_1 = -3.4eV - (-13.6eV) = 10.2eV$

Maximum kinetic energy,
$K_{max} = eV_s = e \times 3.57V = 3.57eV$
According to Einstein's photoelectric equation
$K_{max} = h\upsilon - \phi_0$
where ϕ_0 is the work function and hv is the incident energy
$\phi_0 = h\upsilon - K_{max} = 10.2eV - 3.57eV = 6.63eV$

Threshold frequency,
$\upsilon_0 = \frac{\phi_0}{h} = \frac{6.63 \times 1.6 \times 10^{-19} J}{6.63 \times 10^{-34} J\ s}$

$= 1.6 \times 10^{15}$ Hz

Question36

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)

Options:

A. 1 Å

B. 0.1 Å

C. 10 Å

D. 0.01 Å

Answer: D

Solution:

Solution:
Radius of the circular path of a charged particle in a magnetic field is given by
$R = \frac{mv}{Bq}$ or $mv = RBq$
Here, $R = 0.83cm = 0.83 \times 10^{-2}$
$B = 0.25 Wbm^{-2}$
$q = 2e = 2 \times 1.6 \times 10^{-19} C$
$\therefore mv = (0.83 \times 10^{-2})(0.25)(2 \times 1.6 \times 10^{-19})$

de Broglie wavelength,
$\lambda = \frac{h}{mv} = \frac{6.6 \times 10^{-34}}{0.83 \times 10^{-2} \times 0.25 \times 2 \times 1.6 \times 10^{-19}} = 0.01Å$

Question37

If the momentum of an electron is changed by P, then the de Broglie wavelength associated with it changes by 0.5%. The initial momentum of electron will be
(2012 Mains)

Options:

A. 200P

B. 400P

C. P/200

D. 100P

Answer: A

Solution:

de Broglie wavelength associated with an electron is
$\lambda = \frac{h}{P}$ or $P = \frac{h}{\lambda}$
$\therefore \frac{\Delta P}{P} = -\frac{\Delta \lambda}{\lambda}$
$\frac{P}{P_{initial}} = \frac{0.5}{100}$
$P_{initial} = 200P$

Question38

Two radiations of photon energies 1 eV and 2.5 eV, successively illuminate a photosensitive metallic surface of work function 0.5 eV. The ratio of the maximum speeds of the emitted electrons is
(2012 Mains)

Options:

A. 1 : 4

B. 1 : 2

C. 1 : 1

D. 1 : 5

Answer: B

Solution:

According to Einstein's photoelectric equation $\frac{1}{2}mv_{max}{}^2 = h\upsilon - \phi_0$

where $\frac{1}{2}mv_{max}{}^2$ x is the maximum kinetic energy of the emitted electrons,$h\upsilon$ is the incident energy and ϕ_0 is the work function of the metal.

$\therefore \frac{1}{2}mv_{max_1}{}^2 = 1eV - 0.5eV = 0.5eV$ ....(i)

and

$\frac{1}{2}mv_{max_2}{}^2 = 2.5eV - 0.5eV = 2eV$ ....(ii)

Divide (i) and (ii), we get

$$\frac{v_{max_1}{}^2}{v_{max_2}{}^2} = \frac{0.5}{2}$$

$$\frac{v_{max_1}}{v_{max_2}} = \sqrt{\frac{0.5}{2}} = \frac{1}{2}$$

Question39

Photoelectric emission occurs only when the incident light has more than a certain minimum
(2011)

Options:

A. power

B. wavelength

C. intensity

D. frequency

Answer: D

Solution:

Solution:
According to Einstein's photoelectric equation
$K_{max} = h\upsilon - h\upsilon_0$
Since K_{max} is +ve, the photoelectric emission occurs only if
$h\upsilon > h\upsilon_0$ or $\upsilon > \upsilon_0$
The photoelectric emission occurs only when the incident light has more than a certain minimum frequency. This minimum frequency is called threshold frequency.

Question40

In the Davisson and Germer experiment, the velocity of electrons emitted from the electron gun can be increased by
(2011)

Options:

A. increasing the potential difference between the anode and filament

B. increasing the filament current

C. decreasing the filament current

D. decreasing the potential difference between the anode and filament

Answer: A

Question41

Light of two different frequencies whose photons have energies 1 eV and 2.5 eV respectively illuminate a metallic surface whose work function is 0.5 eV successively. Ratio of maximum speeds of emitted electrons will be
(2011)

Options:

A. 1 : 4

B. 1 : 2

C. 1 : 1

D. 1 : 5

Answer: B

Solution:

Here work function, $\phi_0 = 0.5\text{eV}$

According to Einstein's photoelectric equation

Maximum kinetic energy of the emitted electrons	=	Incident photon energy	- Work function

$\therefore K_{max_1} = 1\text{eV} - 0.5\text{eV} = 0.5\text{eV}$ ......(i)

and $K_{max_2} = 2.5\text{eV} - 0.5\text{eV} = 2\text{eV}$ .....(ii)

Divide (i) by (ii), we get

$$\frac{K_{max_1}}{K_{max_2}} = \frac{0.5\text{eV}}{2\text{eV}} = \frac{1}{4}$$

$$\frac{\frac{1}{2}mv_{max_1}^{\ 2}}{\frac{1}{2}mv_{max_2}^{\ 2}} = \frac{1}{4} \text{ or } \frac{v_{max_1}}{v_{max_2}} = \sqrt{\frac{1}{4}} = \frac{1}{2}$$

Question42

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 he electrons would
(2011)

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Options:

A. increase by 2 times

B. decrease by 2 times

C. decrease by 4 times

D. increase by 4 times

Answer: B

Solution:

The de Broglie wavelength λ associated with the electrons is
$\lambda = \frac{1.227}{\sqrt{V}} nm$
where V is the accelerating potential in volts
or $\lambda \propto \frac{1}{\sqrt{V}}$
$\therefore \frac{\lambda_1}{\lambda_2} = \sqrt{\frac{V_2}{V_1}} = \frac{\sqrt{100 \times 10^3}}{\sqrt{25 \times 10^3}} = 2$ or $\lambda_2 = \frac{\lambda_1}{2}$

Question43

In photoelectric emission process from a metal of work function 1.8 eV, the kinetic energy of most energetic electrons is0.5 eV. The corresponding stopping potential is
(2011)

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Options:

A. 1.8 V

B. 1.3 V

C. 0.5 V

D. 2.3 V

Answer: C

Solution:

The stopping potential V_s is related to the maximum kinetic energy of the emitted electrons K_{max} through the relation
$K_{max} = eV_s$
$0.5eV = eV_s$ or $V_s = 0.5V$

Question44

The threshold frequency for a photosensitive metal is 3.3×10^{14} Hz.If light of frequency 8.2×10^{14}Hz is incident on this metal, the cut-off voltage for the photoelectron emission is nearly (2011)

Options:

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A. 1 V

B. 2 V

C. 3 V

D. 5 V

Answer: B

Solution:

According to Einstein's photoelectric equation
$eV_s = h\upsilon - h\upsilon_0$
Where $\upsilon =$ Incident frequency
$\upsilon_0 =$ Threshold frequency
$V_s =$ Cut-off or stooping potential
or $V_s = \frac{h}{e}(\upsilon - \upsilon_0)$
Substituting the given values, we get
$V_s = \frac{6.63 \times 10^{-34}(8.2 \times 10^{14} - 3.3 \times 10^{14})}{1.6 \times 10^{-19}} \approx 2V$

Question45

A 200 W sodium street lamp emits yellow light of wavelength 0.6 pm. Assuming it to be 25% efficient in converting electrical energy to light, the number of photons of yellow light it emits per second is (2011)

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Options:

A. 1.5×10^{20}

B. 6×10^{18}

C. 62×10^{20}

D. 3×10^{19}

Answer: A

Solution:

Energy of a photon, $E = \frac{hc}{\lambda}$

$= \frac{(6.6 \times 10^{-34} J\ s)(3 \times 10^{8} ms^{-1})}{0.6 \times 10^{6} J} = 33 \times 10^{-20} J$

Number of photons emitted per second is

$N = \frac{\frac{25}{100} P}{E} = \frac{\frac{25}{100} \times 200W}{33 \times 10^{-20} J} = 1.5 \times 10^{20}$

Question46

A beam of cathode rays is subjected to crossed electric field (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 (Where V is the potential difference between cathode and anode)
(2010)

Options:

A. $\frac{B^2}{2VE^2}$

B. $\frac{2VB^2}{E^2}$

C. $\frac{2VE^2}{B^2}$

D. $\frac{E^2}{2B^2}$

Answer: D

Solution:

Solution:
When a beam of cathode rays (or electrons) are subjected to crossed electric (E) and magnetic (B) fields, the beam is not deflected, if
Force on electron due to magnetic field = Force on electron due to electric field
$Bev = eE$ or $v = \frac{E}{B}$..........(i)

If V is the potential difference between cathode and anode, then

$\therefore \frac{1}{2}mv^2 = eV$

$\frac{e}{m} = \frac{v^2}{2V}$..........(ii)

Substituting the value of v from equation (i) in equation (ii), we get

$\frac{e}{m} = \frac{E^2}{2VB^2}$

Specific charge of the cathode rays, $\frac{e}{m} = \frac{E^2}{2VB^2}$

Question47

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 wave length 5100Å. Then, (power of S_2)/(power of S_1) is equal to (2010)

Options:

A. 1.00

B. 1.02

C. 1.04

D. 0.98

Answer: A

Solution:

Solution:

For a source S_1,

Wave length, $\lambda_1 = 5000Å$

Number of photons emitted per second, $N_1 = 10^{15}$

Energy of each photon, $E_1 = \frac{hc}{\lambda_1}$

Power of source S_1, $P_1 = E_1 N_1 = \frac{N_1 hc}{\lambda_1}$

For a Source S_2,

Wave length, $\lambda_2 = 5100Å$

Number of photons emitted per second, $N_2 = 1.02 \times 10^{15}$

Energy of each photon, $E_2 = \frac{hc}{\lambda_2}$

Power of source S_2, $P_2 = N_2 E_2 = \frac{N_2 hc}{\lambda_2}$

$$\therefore \frac{\text{Power of} S_2}{\text{Power of } S_1} = \frac{P_2}{P_1} = \frac{\frac{N_2 hc}{\lambda_2}}{\frac{N_1 hc}{\lambda_1}} = \frac{N_2 \lambda_1}{N_1 \lambda_2}$$

$$= \frac{(1.02 \times 10^{15} \text{photons/s}) \times (5000Å)}{(10^{15} \text{photons/s}) \times (5100Å)} = \frac{51}{51} = 1$$

Question48

The potential difference that must be applied to stop the fastest photoelectrons emitted by a nickel surface, having work function 5.01 eV, when ultraviolet light of 200 nm falls on it, must be
(2010)

Options:

A. 2.4 V

B. -1.2 V

C. -2.4 V

D. 1.2 V

Answer: B

Solution:

Here,
Incident wave length, $\lambda = 200\text{nm}$
Work function $\phi_0 = 5.01\text{eV}$
According to Einstein's photoelectric equation
$eV_s = h\upsilon - \phi_0$
$eV_s = \frac{hc}{\lambda} - \phi_0$
where V_s is the stopping potential
$eV_s = \frac{(1240\text{eV nm})}{(200\text{m})} - 5.01\text{eV}$
$= 6.2\text{ev} - 5.01\text{eV} = 1.2\text{eV}$
Stopping potential, $V_s = 1.2\text{V}$
The potential difference that must be applied to stop photoelectrons $= -V_s = -1.2\text{V}$

Question49

When monochromatic radiation of intensity / falls on a metal surface, the number of photoelectrons and their maximum kinetic energy are N and T respectively. If the intensity of radiation is 21, the number of emitted electrons and their maximum kinetic energy are respectively
(2010 Mains)

Options:

A. N and 2T

B. 2N and T

C. 2N and 2T

D. N and T

Answer: B

Solution:

The number of photoelectrons ejected is directly proportional to the intensity of incident light. Maximum kinetic energy is independent of intensity of incident light but depends upon the frequency of light. Hence, option (b) is correct.

Question50

The electron in the hydrogen atom jumps from excited state (n = 3) to its ground state (n = 1) and the photons thus emitted irradiate a photosensitive material. If the work function of the material is 5.1eV, the stopping potential is estimated to be (the energy of the electron in nth state $E_n = -\frac{13.6}{n^2} eV$)

(2010 Mains)

Options:

A. 5.1 V

B. 12.1 V

C. 17.2 V

D. 7 V

Answer: D

Solution:

Solution:
Energy released when electron in the atom jumps from excited state (n = 3) to ground state (n = 1) is

$E = h\upsilon = E_3 - E_1 = -\frac{13.6}{3^2} - \left(\frac{-13.6}{1^2}\right)$

$= \frac{-13.6}{9} + 13.6 = 12.1 eV$

Therefore, stopping potential
$eV_s = h\upsilon - \phi_0 = 12.1 - 5.1$ [∵ Work function $\phi_0 = 5.1$]
$V_s = 7V$

Question51

The number of photoelectrons emitted for light of a frequency υ (higher than the threshold frequency υ_0) is proportional

(2009)

Options:

A. threshold frequency (υ_0)

B. intensity of light

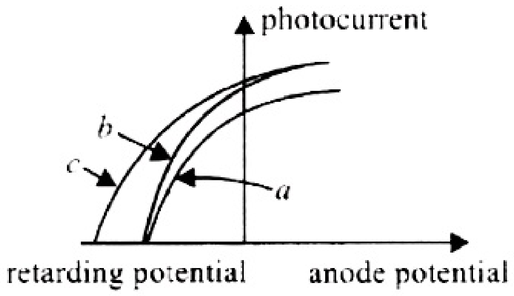
C. frequency of light (υ)

D. $\upsilon - \upsilon_0$

Answer: B

Question52

The figure shows a plot of photo current versus anode potential for a photosensitive surface for three different radiations. Which one of the following is a correct statement?



(2009)

Options:

A. Curves (a) and (b) represent incident radiations of same frequency but of different intensities.

B. Curves (b) and (c) represent incident radiations of different frequencies and different intensities.

C. Curves (b) and (c) represent incident radiations of same frequency having same intensity.

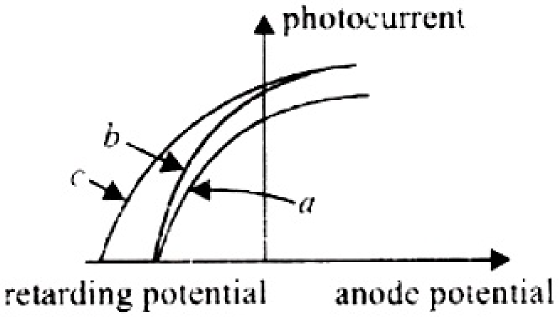
D. Curves (a) and (b) represent incident radiations of different frequencies and different intensities.

Answer: A

Solution:

Solution:
(a) and (b) represent radiations of the same frequency because their kinetic energies are the same. But saturation

photocurrents are different. Therefore, intensities are different.



Question53

Monochromatic light of wavelength 667 nm is produced by a helium neon laser. The power emitted is 9 mW. The number of photons arriving per sec. on the average at a target irradiated by this beam is
(2009)

Options:

A. 3×10^{16}

B. 9×10^{15}

C. 3×10^{19}

D. 9×10^{17}

Answer: A

Solution:

$\lambda = 6670 Å$
Energy of a photon,
$E = \frac{12400 eV Å}{6670 Å} = \frac{12400}{6670} \times 1.6 \times 10^{-19}$

Energy emitted per second,power $P = 9 \times 10^{-3} J$
∴Number of photons incident per second $= \frac{\text{Power}}{\text{Energy}} = \frac{P}{E}$
$= \frac{9 \times 10^{-3} \times 6670}{12400 \times 1.6 \times 10^{-19}} = 3 \times 10^{16}$

Question54

The work function of a surface of a photosensitive material is 6.2 eV. The wavelength of the incident radiation for which the stopping potential is 5 V lies in the
(2008)

Options:

A. Infrared region

B. X-ray region

C. Ultraviolet region

D. Visible region

Answer: C

Solution:

$\phi_0 = 6.2\text{eV}$
$K_{max} = 5\text{eV}$;
$\therefore h\upsilon = 11.2\text{eV}$
$\therefore \lambda = \frac{hc}{E} = \frac{12400\text{eV Å}}{11.2\text{eV}} = 1107\text{Å}$
This wavelength is in the ultraviolet region.

Question55

A particle of mass 1 mg has the same wavelength as an electron moving with a velocity of $3 \times 10^6 \text{ms}^{-1}$.The velocity of the particle is (mass of electron $= 9.1 \times 10^{-31}$kg)
(2008)

Options:

A. $3 \times 10^{-31} \text{ms}^{-1}$

B. $2.7 \times 10^{-21} \text{ms}^{-1}$

C. $2.7 \times 10^{-18} \text{ms}^{-1}$

D. $9 \times 10^{-2} \text{ms}^{-1}$

Answer: C

Solution:

As, $\lambda = \frac{h}{mv}$; if for the two particles λ is same, then their momentum must be same.
$\therefore m_p v_p = m_e v_e$
or $10^{-6} \times v_p = (9.1 \times 10^{-31}) \times (3 \times 10^6)$
or
$v = \frac{(9.1 \times 10^{-31}) \times (3 \times 10^6)}{10^{-6}} = 2.73 \times 10^{-18} \text{ms}^{-1}$

Question56

In the phenomenon of electric discharge through gases at low pressure, the coloured glow in the tube appears as a result of
(2008)

Options:

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

Answer: A

Solution:

Solution:
Collisions of the charged particles with the atoms in the gas.

Question57

A beam of electron passes undeflected through mutually perpendicular electric and magnetic fields. If the electric field is switched off, and the same magnetic field is maintained, the electrons move
(2007)

Options:

A. in a circular orbit

B. along a parabolic path

C. along a straight line

D. in an elliptical orbit.

Answer: A

Solution:

Solution:
Electron travelling in a magnetic field perpendicular to its velocity - circular path.

Question58

Monochromatic light of frequency 6.0×10^{14} Hz is produced by a laser. The power emitted is 2×10^{-3} W. The number of photons emitted, on the average, by the source per second is
(2007)

Options:

A. 5×10^{16}

B. 5×10^{17}

C. 5×10^{14}

D. 5×10^{15}

Answer: D

Solution:

Solution:
Power of monochromatic light beam is $P = N h\upsilon$ where N is the number of photons emitted per second.
Power $P = 2 \times 10^{-3}$ W
Energy of one photon $E = h\upsilon$
$= 6.63 \times 10^{-34} \times 6 \times 10^{14}$ J
Number of photons emitted per second, $N = \frac{P}{E}$
$= \frac{2 \times 10^{-3}}{6.63 \times 10^{-34} \times 6 \times 10^{14}} = 0.05 \times 10^{17} = 5 \times 10^{15}$

Question59

A 5 watt source emits monochromatic light of wavelength 5000 Å. When placed 0.5 m away, it liberates photoelectrons from a photosensitive metallic surface. When the source is moved to a distance of 1.0 m, the number of photoelectrons liberated will be reduced by a factor of
(2007)

Options:

A. 8

B. 16

C. 2

D. 4 .

Answer: D

Solution:

For a light source of power P watt, the intensity at a distance d is given by $I = \frac{P}{4\pi d^2}$

where we assume light to spread out uniformly in all directions i.e., it is a spherical source.

$\therefore I \propto \frac{1}{d^2}$ or $\frac{I_1}{I_2} = \frac{d_2^2}{d_1^2}$

or, $\frac{I_1}{I_2} = \left(\frac{1}{0.5}\right)^2$ or, $\frac{I_1}{I_2} = 4$ or, $I_2 = \frac{I_1}{4}$.

In a photoelectric emission, the number of photoelectrons liberated per second from a photosensitive metallic surface is proportional to the intensity of the light. When a intensity of source is reduced by a factor of four, the number of photoelectrons is also reduced by a factor of 4

Question60

A photocell employs photoelectric effect to convert (2006)

Options:

A. change in the frequency of light into a change in the electric current

B. change in the frequency of light into a change in electric voltage

C. change in the intensity of illumination into a change in photoelectric current

D. change in the intensity of illumination into a change in the work function of the photocathode.

Answer: C

Solution:

Solution:
The photoelectric current is directly proportional to the intensity of illumination. Therefore a change in the intensity of the incident radiation will change the photocurrent also.

Question61

When photons of energy hυ fall on an aluminium plate (of work function E_0), photoelectrons of maximum kinetic energy K are ejected. If the frequency of radiation is doubled, the maximum kinetic energy of the ejected photoelectrons will be (2006)

Options:

A. $K + h\upsilon$

B. $K + E_0$

C. 2 K

D. K

Answer: A

Solution:

Solution:
Let K and K' be the maximum kinetic energy of photoelectrons for incident light of frequency υ and 2υ respectively.
According to Einstein's photoelectric equation,
$K = h\upsilon - E_0$ ....(i)
and $K' = h(2\upsilon) - E_0$ .....(ii)
$= 2h\upsilon - E_0 = h\upsilon + h\upsilon - E_0$
$K' = h\upsilon + K$ [using (i)]

Question62

In a discharge tube ionization of enclosed gas is produced due to collisions between
(2006)

Options:

A. neutral gas atoms/molecules

B. positive ions and neutral atoms/ molecules

C. negative electrons and neutral atoms/ molecules

D. photons and neutral atoms/molecules.

Answer: C

Question63

The momentum of a photon of energy $1\ MeV$ in $kg\ m/s$ will be
(2006)

Options:

A. 5×10^{-22}

B. 0.33×10^{6}

C. 7×10^{-24}

D. 10^{-22}

Answer: A

Solution:

Energy of photon $E = 1 \text{M eV}$
Momentum of photon $p = \frac{E}{c}$
$\therefore p = \frac{E}{c} = \frac{1 \times 10^{6} \times 1.6 \times 10^{-19} J}{3 \times 10^{8} ms^{-1}} = 0.53 \times 10^{-21}$
$\approx 5 \times 10^{-22} kg\ m / s$.

Question64

The work functions 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 photoelectrons for a radiation of wavelength 4100Å is/are
(2005)

Options:

A. A only

B. A and B only

C. all the three metals

D. none.

Answer: B

Question65

A photosensitive metallic surface has work function, $h\upsilon_0$. If photons of energy $2h\upsilon_0$ fall on this surface, the electrons come out with a maximum velocity of $4 \times 10^{6}\ m / s$. When the photon energy is increased to $5h\upsilon_0$, then maximum velocity of photoelectrons will be
(2005)

Options:

A. 2×10^7 m / s

B. 2×10^6 m / s

C. 8×10^6 m / s

D. 8×10^5 m / s

Answer: C

Solution:

K . E . = hυ − W

i.e., $\frac{1}{2}mv_{max}{}^2 = h\upsilon - W$

$\Rightarrow 12m \times (4 \times 10^6)^2 = 2h\upsilon_0 - h\upsilon_0$

or, $\frac{1}{2}m \times 0(4 \times 10^6)^2 = h\upsilon_0$

Another case, $2h\upsilon_0 \rightarrow 5h\upsilon_0$

$\frac{1}{2}mv_{max}{}^2 = 4h\upsilon_0$

$\Rightarrow \frac{1}{2}mv_{max}{}^2 = 4 \times \frac{1}{2} \times m \times (4 \times 10^6)^2$

$\Rightarrow v_{max}{}^2 = 64 \times 10^{12}$

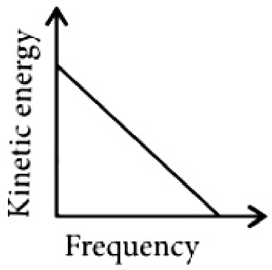
$\Rightarrow v_{max} = 8 \times 10^6 m / s$

Question66

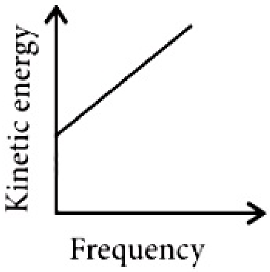
According to Einstein's photoelectric equation, the graph between the kinetic energy of photoelectrons ejected and the frequency of incident radiation is
(2004, 1996)

Options:

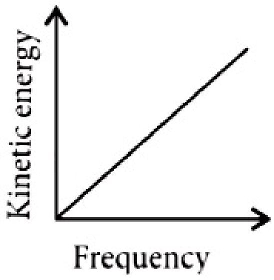
A.



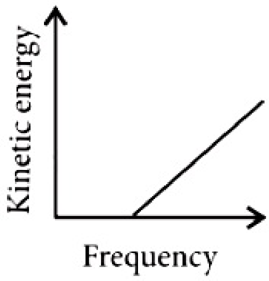
B.



C.



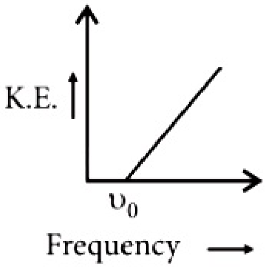
D.



Answer: D

Solution:

Solution:



The maximum kinetic energy of photoelectron ejected is given by
K.E. $= h\upsilon - W = h\upsilon - h\upsilon_0$
where work function depends on the type of material.
If the frequency of incident radiation is greater than υ_0 only then the ejection of photoelectrons start. After that as frequency increases kinetic energy also increases.

Question67

A photoelectric cell is illuminated by a point source of light 1m away. When the source is shifted to 2m then (2003)

Options:

A. each emitted electron carries one quarter of the initial energy

B. number of electrons emitted is half the initial number

C. each emitted electron carries half the initial energy

D. number of electrons emitted is a quarter of the initial number.

Answer: D

Solution:

Solution:

Photoelectric current $I \propto$ intensity of light and intensity $\propto \frac{1}{(\text{ distance })^2}$

$\therefore I \propto \frac{1}{(\text{distance })^2}$

Question68

J.J. Thomson's cathode-ray tube experiment demonstrated that (2003)

Options:

A. cathode rays are streams of negatively charged ions

B. all the mass of an atom is essentially in the nucleus

C. the e / m of electrons is much greater than the e / m of protons

D. the e / m ratio of the cathode-ray particles changes when a different gas is placed in the discharge tube

Answer: C

Question69

The value of Planck's constant is (2002)

Options:

A. 6.63×10^{-34} J / sec

B. 6.63×10^{-34} kg − m^2 / sec

C. 6.63×10^{-34} kg − m^2

D. 6.63×10^{-34} J − sec

Answer: D

Solution:

Solution:
The value of Planck's constant is 6.63×10^{-34} J s.

Question70

If particles are moving with same velocity, then which has maximum de Broglie wavelength?
(2002)

Options:

A. proton

B. α -particle

C. neutron

D. β -particle.

Answer: D

Solution:

Solution:
de Broglie wavelength for a particle is given by $\lambda = \frac{h}{p} = \frac{h}{mv}$, where m, v and p are the mass, velocity and momentum respectively. h is Planck's constant. Now, since all the particles are moving with same velocity, the particle with least mass will have maximum de-Broglie wavelength. Out of the given four particles (proton, neutron, α -particles, i.e., He nucleus and β -particles, i.e., electrons) β -particle has the lowest mass and therefore it has maximum wavelength.

Question71

When ultraviolet rays incident on metal plate then photoelectric effect does not occur, it occurs by incidence of
(2002)

Options:

A. infrared rays

B. X-rays

C. radio wave

D. micro wave.

Answer: B

Solution:

Solution:
If photo electric effect does not occur by ultraviolet rays then it simply means that wavelength of ultraviolet rays is more than the threshold wavelength for the metal.
In given examples only the X-rays have lower wavelength than that of ultraviolet so it may produce the effect.
So the correct answer is X-rays.

Question72

Which of the following is not the property of cathode rays? (2002)

Options:

A. It produces heating effect

B. It does not deflect in electric field

C. It casts shadow

D. It produces fluorescence.

Answer: B

Solution:

Solution:
Cathode rays are basically negatively charged particles (electrons). If the cathode rays are allowed to pass between two plates kept at a difference of potential, the rays are found to be deflected from the rectilinear path. The direction of deflection shows that the rays carry negative charges.

Question73

Which one among the following shows particle nature of light? (2001)

Options:

A. photo electric effect

B. interference

C. refraction

D. polarization.

Answer: A

Question74

In Thomson mass spectrograph $\vec{E} \perp \vec{B}$ then the velocity of electron beam will be
(2001)

Options:

A. $\frac{|\vec{E}|}{|\vec{B}|}$

B. $\vec{E} \times \vec{B}$

C. $\frac{|\vec{B}|}{|\vec{E}|}$

D. $\frac{\vec{E}^2}{\vec{B}^2}$

Answer: A

Solution:

$eE = evB \quad \therefore v = \frac{|E|}{|B|}$

Question75

A photo-cell is illuminated by a source of light, which is placed at a distance d from the cell. If the distance become $\frac{d}{2}$, thennumber of electrons emitted per second will be
(2001)

Options:

A. remain same

B. four times

C. two times

D. one-fourth

Answer: B

Solution:

Intensity becomes 4 times. So number increases.

Question76

By photoelectric effect, Einstein proved (2000)

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Options:

A. $E = h\upsilon$

B. $K.E. = \frac{1}{2}mv^2$

C. $E = mc^2$

D. $E = \frac{-Rhc^2}{n^2}$

Answer: A

Question77

Who evaluated the mass of electronindirectly with help of charge (2000)

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Options:

A. Thomson

B. Millikan

C. Rutherford

D. Newton.

Answer: A

Question78

When a proton is accelerated through 1 V then its kinetic energy will be (1999)

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Options:

A. 1 eV

B. 13.6 eV

C. 1840 eV

D. 0.54 eV

Answer: A

Solution:

Solution:
$K.E. = 1.6 \times 10^{-19} \times 1 = 1 \text{ eV}$

Question79

The photoelectric work function for a metal surface is 4.125 eV . The cut-off wavelength for this surface is (1999)

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Options:

A. 3000Å

B. 2062.5Å

C. 4125Å

D. 6000Å

Answer: A

Solution:

$$\phi = h\upsilon = \frac{hc}{\lambda}$$
$$\Rightarrow \lambda = \frac{hc}{\phi} = \frac{1242eV\ .nm}{4.125} \approx 3000Å$$

Question80

As the intensity of incident light increases (1999)

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Options:

A. kinetic energy of emitted photoelectrons increases

B. photoelectric current decreases

C. photoelectric current increases

D. kinetic energy of emitted photoelectrons decreases.

Answer: C

Solution:

Solution:
If the intensity of light of a given frequency is increased, then the number of photons striking the surface per second will increase in the same ratio. This increased number of photons strikes more electrons of metals and hence number of photoelectrons emitted through the surface increase and hence photoelectric current increases.

Question81

In a photo-emissive cell, with exciting wavelength λ, the fastest electron has speedv. If the exciting wavelength is changed to $\frac{3\lambda}{4}$, the speed of the fastest emitted electron will be (1998)

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Options:

A. less than $v\left(\frac{4}{3}\right)^{1/2}$

B. $v\left(\frac{4}{3}\right)^{1/2}$

C. $v\left(\frac{3}{4}\right)^{1/2}$

D. greater than $v\left(\frac{4}{3}\right)^{1/2}$.

Answer: D

Solution:

According to Einstein's photoelectric equation,

$\frac{1}{2}mv^2 = \frac{hc}{\lambda} - W_0$ or , $\frac{hc}{\lambda} = \frac{1}{2}mv^2 + W_0$

and $\frac{1}{2}mv_1{}^2 = \frac{hc}{3\lambda/4} - W_0 = \frac{4}{3}\left(\frac{1}{2}mv^2 + W_0\right) - W_0$

So, v_1 is greater than $v\left(\frac{4}{3}\right)^{1/2}$

Question82

Which of the following statement is correct? (1997)

Options:

A. The photocurrent increases with intensity of light

B. The stopping potential increases with increase of incident light

C. The current in photocell increases with increasing frequency

D. The photocurrent is proportional to the applied voltage.

Answer: A

Solution:

Solution:
since the emission of photoelectrons is directly proportional to the intensity of the incident light, therefore photocurrent increases with the intensity of light.

Question83

The kinetic energy of an electron, which is accelerated in the potential difference of 100 volts, is (1997)

Options:

A. 416.6 cal

B. 6.636 cal

C. 1.602×10^{-17} J

D. 1.6×10^{4} J .

Answer: C

Solution:

Solution:
Potential difference (V) = 100 volts.
Kinetic energy of an electron (K.E.) $= eV = (1.6 \times 10^{-19}) \times 100 = 1.6 \times 10^{-17}$ joule

----

Question84

An electron beam has a kinetic energy equal to 100 eV. Find its wavelength associated with a beam, if mass of electron $= 9.1 \times 10^{-31}$ kg and 1 eV $= 1.6 \times 10^{-19}$J / eV.
(Planck's constant $= 6.6 \times 10^{-34}$ J s)
(1996)

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Options:

A. 24.6Å

B. 0.12Å

C. 1.2Å

D. 6.3Å

Answer: C

Solution:

Kinetic energy (E) = 100 eV;
Mass of electron (m) $= 9.1 \times 10^{-31}$ kg;
1 eV $= 1.6 \times 10^{-19}$ J and
Planck's constant (h) $= 6.6 \times 10^{-34}$ J s.
Energy of an electron (E) $= 100 \times (1.6 \times 10^{-19})$ J

or $\lambda = \frac{h}{\sqrt{2mE}} = \frac{6.6 \times 10^{-34}}{\sqrt{2 \times 9.1 \times 10^{-31} \times 100 \times 1.6 \times 10^{-19}}}$

$= 1.2 \times 10^{-10}$ m = 1.2Å

Question85

In a discharge tube at 0.02 mm, there is formation of
(1996)

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Options:

A. Crooke's dark space

B. Faraday's dark space

C. both space partly

D. none of these.

Answer: A

Question86

An electron of mass m and charge e is accelerated from rest through a potential difference V in vacuum. Its final velocity will be (1996)

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Options:

A. $\sqrt{\frac{2eV}{m}}$

B. $\sqrt{\frac{eV}{m}}$

C. $\frac{eV}{2m}$

D. $\frac{eV}{m}$.

Answer: A

Solution:

The kinetic energy of an electron $\frac{1}{2} \times mv^2 = eV$

or final velocity of electron (v) = $\sqrt{\frac{2eV}{m}}$

Question87

If a photon has velocity c and frequency υ, then which of the following represents its wavelength? (1996)

Options:

A. $\frac{h\upsilon}{c^2}$

B. $h\upsilon$

C. $\frac{h\upsilon}{E}$

D. $\frac{h\upsilon}{c}$

Answer: C

Solution:

Energy of the photon $E = \frac{hc}{\lambda}$

or $\lambda = \frac{hc}{E}$, where λ is the wavelength.

Question88

The velocity of photons is proportional to (where $\upsilon =$ frequency) (1996)

Options:

A. $\frac{1}{\sqrt{\upsilon}}$

B. υ^2

C. υ

D. None

Answer: D

Solution:

Solution:
The velocity of a photon in vacuum is a constant. $c = \upsilon\lambda$. But $c =$ constant and onecannot say that it is proportional to υ or λ but only $c = \upsilon\lambda$.
In media, for a particular medium, υ remain the same, velocity changes. Therefore λ changes. The question is wrong.

Question89

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)

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Options:

A. $\lambda \frac{M}{m}$

B. $\lambda \frac{m}{M}$

C. $\lambda \sqrt{\frac{M}{m}}$

D. $\lambda \sqrt{\frac{m}{M}}$

Answer: D

Solution:

Solution:
Momentum of electrons,
$(p_e) = \sqrt{2meV}$ and momentum for proton $(p_p) = \sqrt{2M\,eV}$
Therefore, $\frac{\lambda_p}{\lambda_e} = \frac{h / p_p}{h / p_e} = \frac{p_e}{p_p} = \frac{\sqrt{2meV}}{\sqrt{2M\,eV}} = \sqrt{\left(\frac{m}{M}\right)}$
Therefore, $\lambda_p = \lambda \sqrt{\left(\frac{m}{M}\right)}$

Question90

If we consider electrons and photons of same wavelength, then they will have same
(1995)

©

Options:

A. momentum

B. angular momentum

C. energy

D. velocity.

Answer: A

Solution:

Wavelength $(\lambda) = \frac{h}{mv} = \frac{h}{p}$. Therefore for same wavelength of electrons and photons, the momentum should be same.

Question91

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)

Options:

A. 1: 2

B. 2: 1

C. 4: 1

D. 1: 4

Answer: B

Solution:

$$W_0 = \frac{hc}{\lambda_0} \text{ or } W_0 \propto \frac{1}{\lambda_0}$$

$$\Rightarrow \frac{W_1}{W_2} = \frac{\lambda_2}{\lambda_1} = \frac{600}{300} = 2$$

Question92

Number of ejected photoelectrons increases with increase (1993)

Options:

A. in intensity of light

B. in wavelength of light

C. in frequency of light

D. never.

Answer: A

Solution:

Photoelectric current is directly proportional to the intensity of incident light.

Question93

Momentum of photon wavelength λ is (1993)

Options:

A. $\frac{h\upsilon}{c}$

B. zero

C. $\frac{h\lambda}{c^2}$

D. $\frac{h\lambda}{c}$.

Answer: A

Solution:

Momentum of the photon $= \frac{h\upsilon}{c}$

Question94

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 changes are I_1 and I_2, all other conditions remaining unchanged, then (assuming $h\upsilon > W_2$) (1992)

Options:

A. $I_1 = I_2$

B. $I_1 < I_2$

C. $I_1 > I_2$

D. $I_1 < I_2 < 2I_1$.

Answer: A

Solution:

The work function has no effect on photoelectric current so long as $h\upsilon > W_0$. The photoelectric current is proportional to the intensity of incident light. since there is no change in the intensity of light, hence $I_1 = I_2$.

Question95

Photoelectric work function of a metal is 1 eV . Light of wavelength λ = 3000Å falls on it. The photo electrons come out with a maximum velocity
(1991)

Options:

A. 10 metres/sec

B. 10^2 metres/ sec

C. 10^4 metres/sec

D. 10^6 metres/sec.

Answer: D

Solution:

$h\upsilon = W + \frac{1}{2}mv^2$ or $\frac{hc}{\lambda} = W + \frac{1}{2}mv^2$
Here $\lambda = 3000Å = 3000 \times 10^{-10}$ m
and $W = 1$ eV $= 1.6 \times 10^{-19}$ joule
$\therefore \frac{(6.6 \times 10^{-34})(3 \times 10^8)}{3000 \times 10^{-10}}$
$= (1.6 \times 10^{-19}) + \frac{1}{2} \times (9.1 \times 10^{-31})v^2$
Solving we get $v \cong 10^6$m / s

Question96

The wavelength of a 1 keV photon 1.24×10^{-9} m. What is the frequency1 MeV photon?
(1991)

Options:

A. 1.24×10^{15}

B. 2.4×10^{20}

C. 1.24×10^{18}

D. 2.4×10^{23}

Answer: B

Solution:

Here, $\frac{hc}{\lambda} = 10^3 eV$ and $h\upsilon = 10^6$ eV

Hence, $\upsilon = \frac{10^3 c}{\lambda} = \frac{10^3 \times 3 \times 10^8}{1.24 \times 10^{-9}} = 2.4 \times 10^{20} Hz$

Question97

An electron with (rest mass m_0) moves with a speed of 0.8 c. Its mass when it moves with this speed is
(1991)

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Options:

A. m_0

B. $\frac{m_0}{6}$

C. $\frac{5m_0}{3}$

D. $\frac{3m_0}{5}$.

Answer: C

Solution:

$$m = \frac{m_0}{\sqrt{1 - \frac{v^2}{c^2}}} = \frac{m_0}{\sqrt{c^2 - (0.8c)^2 c^2}} = \frac{5m_0}{3}$$

Question98

A radio transmitter operates at a frequency 880 kHz and a power of 10 kW . The number of photons emitted per second is
(1990)

Options:

A. 1.72×10^{31}

B. 1.327×10^{25}

C. 1.327×10^{37}

D. 1.327×10^{45}.

Answer: A

Solution:

No. of photons emitted per sec,

$$n = \frac{\text{Power}}{\text{Energy of photon}}$$

$$= \frac{P}{h\upsilon} = \frac{10000}{6.6 \times 10^{-34} \times 880 \times 10^{3}} = 1.72 \times 10^{31}$$

Question99

The momentum of a photon of an electromagnetic radiation is 3.3×10^{-29} kg ms^{-1}. What is the frequencyof the associated waves? [$h = 6.6 \times 10^{-34}$ J s; . $c = 3 \times 10^{8}$ ms^{-1}] (1990)

Options:

A. 1.5×10^{13} Hz

B. 7.5×10^{12} Hz

C. 6×10^{3} Hz

D. 3×10^{3} Hz

Answer: A

Solution:

Momentum of the photon $= \frac{h\upsilon}{c} \Rightarrow \frac{c}{\upsilon} = \frac{h}{p} = \lambda$

$$\upsilon = \frac{c}{\lambda} = \frac{cp}{h} = 3 \times 10^{8} \times \frac{3.3 \times 10^{-29}}{6.6 \times 10^{-34}} = 1.5 \times 10^{13} \text{ Hz}$$

where, $\upsilon =$ frequency of radiation

Question100

**Ultraviolet radiations of 6.2 eV falls on an aluminium surface. Kinetic energy of fastest electron emitted is (work function $= 4.2$ eV)
(1989)**

Options:

A. 3.2×10^{-21} J

B. 3.2×10^{-19} J

C. 7×10^{-25} J

D. 9×10^{-32} J

Answer: B

Solution:

Solution:
Kinetic energy of fastest electron $= E - W_0 = 6.2 - 4.2 = 2.0$ eV
$= 2 \times 1.6 \times 10^{-19} = 3.2 \times 10^{-19}$ J

Question101

**The de Broglie wave corresponding to a particle of mass m and velocity v has a wavelength associated with it
(1989)**

Options:

A. $\frac{h}{mv}$

B. hmv

C. $\frac{mh}{v}$

D. $\frac{m}{hv}$

Answer: A

Solution:

Solution:
de Broglie wavelength, $\lambda = \frac{h}{p} = \frac{h}{mv}$

Question102

The energy of a photon of wavelength λ is
(1988)

Options:

A. $hc\lambda$

B. $\frac{hc}{\lambda}$

C. $\frac{\lambda}{hc}$

D. $\frac{\lambda h}{c}$

Answer: B

Solution:

Solution:
Energy of a photon $E = h\upsilon = \frac{hc}{\lambda}$

Question103

Thermions are
(1988)

Options:

A. protons

B. electrons

C. photons

D. positrons.

Answer: B

Solution:

When a metal is heated, electrons are ejected out of it, which are called thermions.

Question104

The threshold frequency for photoelectric effect on sodium corresponds to a wavelength of 5000Å . Its work function is (1988)

Options:

A. 4×10^{-19}J

B. 1 J

C. 2×10^{-19} J

D. 3×10^{-19} J .

Answer: A

Solution:

$$W_0 = \frac{hc}{\lambda_0}$$

$$= \frac{6.63 \times 10^{-34} \times 3 \times 10^{8}}{5000 \times 10^{-10}} = 4 \times 10^{-19} \text{J}$$
