Dual Nature of Radiation

Question1

When photons of energy 8×10^{-19} J incident on a photosensitive material, the de-Broglie wavelength of the photoelectrons emitted with maximum kinetic energy is 10 Å. The work function of the photosensitive material is nearly

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Options:

A.

3.5 eV

B.

2.5 eV

C.

2.0 eV

D.

1.5 eV

Answer: A

Solution:

According to Einstein's photoelectric equation,

$$(E_K)_{\max} = E - \phi_0 \Rightarrow \phi_0 = E - (E_K)_{\max}$$
$$= 8 \times 10^{-19} - \frac{p^2}{2m}$$
$$= 8 \times 10^{-19} - \frac{\left(\frac{h}{\lambda}\right)^2}{2m} = 8 \times 10^{-19} - \frac{h^2}{2m\lambda^2}$$
$$= 8 \times 10^{-19} - \frac{\left(6.62 \times 10^{-34}\right)^2}{2 \times 9.1 \times 10^{-31} \times \left(10 \times 10^{-10}\right)^2}$$
$$= 8 \times 10^{-19} - 2.41 \times 10^{-19}$$
$$= 5.59 \times 10^{-19} \text{ J}$$
$$= \frac{5.59 \times 10^{-19}}{1.6 \times 10^{-19}} \text{eV} = 3.49 \text{eV} \approx 3.5 \text{eV}$$

Question2

The minimum wavelength of X-rays produced by 20 kV electrons is nearly

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Options:

A.

$0.62 \overset{\circ}{\text{A}}$

B.

$1.8 \overset{\circ}{\text{A}}$

C.

$3.2 \overset{\circ}{\text{A}}$

D.

$6.5 \overset{\circ}{\text{A}}$

Answer: A

Solution:

$$\lambda_{\min} = \frac{hc}{\text{eV}} = \frac{6.63 \times 10^{-34} \times 3 \times 10^{8}}{1.6 \times 10^{-19} \times 20 \times 10^{3}}$$
$$= 6.2 \times 10^{-11} \text{ m}$$
$$= 0.62 \times 10^{-10} \text{ m} = 0.62 \overset{\circ}{\text{A}}$$

Question3

The ratio of de-Broglie wavelengths associated with thermal neutrons at temperatures 127°C and 352°C is

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Options:

A.

5 : 3

B.

3 : 2

C.

3 : 4

D.

5 : 4

Answer: D

Solution:

de-Broglie wavelength

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

$$\Rightarrow \quad \lambda \propto \frac{1}{\sqrt{T}}$$

$$\Rightarrow \quad \frac{\lambda_1}{\lambda_2}=\sqrt{\frac{T_2}{T_1}}=\sqrt{\frac{(273+352)}{(273+127)}}$$

$$=\sqrt{\frac{625}{400}}=\sqrt{\frac{25}{16}}=\frac{5}{4}$$

Question4

A laser produces a beam of light of frequency 5×10^{14} Hz with an output power of 33 mW . The average number of photons emitted by the laser per second is (Planck's constant $= 6.6 \times 10^{-34}$Js)

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Options:

A.

40×10^{16}

B.

10×10^{16}

C.

30×10^{16}

D.

20×10^{8}

Answer: B

Solution:

Step 1: Understanding Power

Power is how much energy is used or given out each second. So: Power $= \frac{\text{Energy}}{\text{Time}}$

Step 2: Energy of One Photon

The energy in one photon of light is found using: $E = hf$ where h is Planck's constant and f is the frequency.

Step 3: Total Energy from Many Photons

If N photons come out in time t, the total energy is $N \times hf$.

Step 4: Linking Power and Number of Photons

So, Power $= \frac{\text{Total Energy}}{\text{Time}} = \frac{N \times hf}{t}$

Step 5: Average Number of Photons per Second

The number of photons per second is $n = \frac{N}{t} = \frac{P}{hf}$ Plug in the numbers: $n = \frac{33 \times 10^{-3}}{6.6 \times 10^{-34} \times 5 \times 10^{14}}$

Step 6: Final Calculation

This works out to: $n = 10 \times 10^{16}$ So, the laser gives off 10×10^{16} photons every second.

Question5

If the de-Broglie wavelength of an electron is 2 nm , then its kinetic energy is nearly(Planck's constant $= 6.6 \times 10^{-34}$Js and mass of electron $= 9 \times 10^{-31}$ kg)

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Options:

A.

0.48 eV

B.

0.68 eV

C.

0.38 eV

D.

0.25 eV

Answer: C

Solution:

Step 1: Formula for de-Broglie Wavelength

The de-Broglie wavelength is given by: $\lambda = \frac{h}{\sqrt{2mk}}$

Step 2: Rearranging to Find Kinetic Energy

We can rearrange the formula to find kinetic energy k: $\lambda^2 = \frac{h^2}{2mk}$ So,$k = \frac{h^2}{2m\lambda^2}$

Step 3: Substitute the Values

Here,

- Planck's constant, $h = 6.6 \times 10^{-34}$ Js
- Mass of electron, $m = 9 \times 10^{-31}$ kg
- Wavelength, $\lambda = 2 \text{ nm} = 2 \times 10^{-9}$ m

Now substitute these into the formula:$k = \frac{(6.6\times10^{-34})^2}{2\times9\times10^{-31}\times(2\times10^{-9})^2}$

Step 4: Calculation

Calculate the value:$k = \frac{(6.6\times10^{-34})^2}{2\times9\times10^{-31}\times(2\times10^{-9})^2}$This gives:$k = 0.608 \times 10^{-19}$ J

Step 5: Convert Joules to Electron Volts

1 electron volt (eV) $= 1.6 \times 10^{-19}$ J.
So,$k = \frac{0.608\times10^{-19}}{1.6\times10^{-19}}$ eV $= 0.38$ eV

The kinetic energy of the electron is about 0.38 eV.

Question6

If a proton and an alpha particle are accelerated through the same potential difference, then the ratio of their de-Broglie wavelengths is

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Options:

A.

1 : 2

B.

1 : 4

C.

$2\sqrt{2} : 1$

D.

1 : 8

Answer: C

Solution:

de-Broglie wavelength

$$\lambda=\frac{h}{\sqrt{2 m q V}}$$

$$\Rightarrow \quad \lambda \propto \frac{1}{\sqrt{m q}}$$

$$\frac{\lambda_p}{\lambda_\alpha}=\sqrt{\frac{m_\alpha}{m_p}} \sqrt{\frac{q_\alpha}{q_p}}=\sqrt{\frac{4}{1} \cdot \frac{2}{1}}=\frac{2 \sqrt{2}}{1}$$

$$\therefore \lambda_p: \lambda_\alpha=2 \sqrt{2}: 1$$

Question7

If the threshold wavelength of light for photoelectric emission to take place from a metal surface is $6250 \stackrel{o}{\mathrm{A}}$, then the work function of the metal is (Planck's constant $=6.6 \times 10^{-34} \mathrm{Js}$)

AP EAPCET 2025 - 22nd May Evening Shift

Options:

A.

3.98 eV

B.

1.98 eV

C.

2.98 eV

D.

4.98 eV

Answer: B

Solution:

Given:

Threshold wavelength,

$\lambda_0 = 6250\,\text{Å} = 6250 \times 10^{-10}\,\text{m} = 6.25 \times 10^{-7}\,\text{m}$

Planck's constant,

$h = 6.6 \times 10^{-34}\,\text{J}\cdot\text{s}$

Speed of light,

$c = 3 \times 10^{8}\,\text{m/s}$

Formula:

Work function $\phi = hc/\lambda_0$

Calculation:

$\phi = \frac{6.6\times10^{-34}\times3\times10^{8}}{6.25\times10^{-7}}$

$\phi = \frac{19.8\times10^{-26}}{6.25\times10^{-7}} = 3.168 \times 10^{-19}\,\text{J}$

Converting to eV:

$1\,\text{eV} = 1.6 \times 10^{-19}\,\text{J}$

$\phi = \frac{3.168\times10^{-19}}{1.6\times10^{-19}} = 1.98\,\text{eV}$

✅ **Answer: Option B — 1.98 eV**

Question8

A camera is fabricated using a semiconducting material having a band gap of 3 eV . The wavelength of light if can detect is nearly

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Options:

A.

210 nm

B.

546 nm

C.

413 nm

D.

345 nm

Answer: C

Solution:

$$\text{Since, } E=\frac{hc}{\lambda}$$
$$\begin{aligned}\Rightarrow \lambda=\frac{hc}{E}&=\frac{6.62\times 10^{-34}\times 3\times 10^{8}}{3\times 1.6\times 10^{-19}}\\ &=4.13\times 10^{-7}=413\times 10^{-9}\text{ m}\\ &=413\text{ nm}\end{aligned}$$

Question9

If the linear momentum of a proton is changed by p_0 then the de-Broglie wavelength associated with the proton changes by 0.25%. Then the initial linear momentum of the proton is

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Options:

A.

$100p_0$

B.

$\frac{p_0}{400}$

C.

$400 p_0$

D.

$\frac{p_0}{100}$

Answer: C

Solution:

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

when $\lambda^{\prime}=\lambda+0.25 \%$ of $\lambda=1.0025 \lambda$

So, $\quad 1.0025 \lambda=\frac{h}{p-p_0}$

$\Rightarrow \quad p-p_0=\frac{h}{1.0025}=\frac{p \lambda}{1.0025 \lambda}$

$\Rightarrow \quad \frac{p-p_0}{p}=\frac{1}{1.0025}$

$\Rightarrow \quad p=400 p_0$

Question10

If an electron in the excited state falls to ground state, a photon of energy 5 eV is emitted, then the wavelength of the photon is nearly

AP EAPCET 2025 - 21st May Morning Shift

Options:

A.

748 nm

B.

598 nm

C.

398 nm

D.

248 nm

Answer: D

Solution:

$$E = \frac{hc}{\lambda}$$

$$\Rightarrow \quad \lambda = \frac{hc}{E} = \frac{6.62 \times 10^{-34} \times 3 \times 10^{8}}{5 \times 1.6 \times 10^{-19}}$$

$$= 248 \times 10^{-9} \text{ m} = 248 \text{ nm}$$

Question11

A photon incident on a metal of work function 2 eV produced photoelectron of maximum kinetic energy of 2 eV . The wavelength associated with the photon is

AP EAPCET 2024 - 23th May Morning Shift

Options:

A. $6200\overset{\circ}{A}$

B. $3100\overset{\circ}{A}$

C. $9300\overset{\circ}{A}$

D. $2000\overset{\circ}{A}$

Answer: B

Solution:

First, the photon energy is the sum of the work function and the maximum kinetic energy of the ejected electron:

• ϕ = 2 eV

• K_max = 2 eV

• E_photon = ϕ + K_max = 4 eV

Next, relate energy to wavelength via

$\lambda = \frac{hc}{E_{\text{photon}}}$

with $hc = 1240$ eV · nm. Therefore,

$\lambda = \frac{1240 \text{ eV·nm}}{4 \text{ eV}} = 310 \text{ nm} = 3100$ \AA.

So the correct choice is Option B: 3100 Å.

Question12

Light of wavelength $4000\overset{\circ}{\mathrm{A}}$ is incident on a sodium surface for which the threshold wavelength of photoelectrons is $5420\overset{\circ}{\mathrm{A}}$. The work function of sodium is

AP EAPCET 2024 - 22th May Evening Shift

Options:

A. 4.58 eV

B. 2.29 eV

C. 1.14 eV

D. 0.57 eV

Answer: B

Solution:

Given:

Wavelength of incident light, $\lambda = 4000\,\text{Å} = 4 \times 10^{-7}\,\text{m}$

Threshold wavelength, $\lambda_0 = 5420\,\text{Å} = 5420 \times 10^{-10}\,\text{m}$

The relationship between the threshold wavelength λ_0 and the work function ϕ is:

$\phi = \frac{hc}{\lambda_0}\,\text{J} \quad \Rightarrow \quad \phi = \frac{hc}{e \cdot \lambda_0}\,\text{eV}$

Calculating the work function:

$\phi = \frac{6.626 \times 10^{-34} \times 3 \times 10^{8}}{1.602 \times 10^{-19} \times 5420 \times 10^{-10}}$

$\phi = \frac{19.87 \times 10^{3}}{8682.84} = 2.288 \times 10^{-3} \times 10^{3}$

$\phi = 2.29 \text{ eV}$

Question13

The surface of a metal is first illuminated with a light of wavelength 300 nm and later illuminated by another light of wavelength 500 nm . It is observed that the ratio of maximum velocities of photoelectrons in two cases is 3 . The work function of metal value is close to

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Options:

A. 6.48 eV

B. 1.23 eV

C. 4.17 eV

D. 2.28 eV

Answer: D

Solution:

According to Einstein's photoelectric equation:

$\frac{1}{2} m v^2 = \frac{hc}{\lambda} - \phi$

Where:

v is the velocity of the photoelectrons.

h is Planck's constant.

c is the speed of light.

λ is the wavelength of the incident light.

ϕ is the work function of the metal.

Given the ratio of maximum velocities of photoelectrons $v_1 = 3v_2$, we analyze two cases:

Case 1:

$\frac{1}{2}m(3v_2)^2 = \frac{hc}{\lambda_1} - \phi$

where $\lambda_1 = 300\,\text{nm}$.

Case 2:

$\frac{1}{2}m(v_2)^2 = \frac{hc}{\lambda_2} - \phi$

where $\lambda_2 = 500\,\text{nm}$.

Dividing Equations for Case 1 and Case 2:

$\frac{hc}{\lambda_1} - \phi = 9\left(\frac{hc}{\lambda_2} - \phi\right)$

Solving for ϕ:

$8\phi = \frac{9hc}{\lambda_2} - \frac{hc}{\lambda_1}$

Substitute $\frac{hc}{\lambda}$ with $\frac{1240\text{ eV nm}}{\lambda}$:

$8\phi = \left(9 \times \frac{1240}{500} - \frac{1240}{300}\right)\text{eV}$

$8\phi = 18.18\,\text{eV}$

Thus, solving for ϕ:

$\phi = \frac{18.18}{8} \approx 2.28\,\text{eV}$

Therefore, the work function ϕ of the metal is approximately $2.28\,\text{eV}$.

Question14

The maximum wavelength of light which causes photoelectric emission from photosensitive metal surface is λ_0. Two light beams of wavelengths $\frac{\lambda_0}{3}$ and $\frac{\lambda_0}{9}$ incident on the metal surface. The ratio of the maximum velocities of the emitted photoelectrons is

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Options:

A. 3 : 4

B. 1 : 3

C. 1 : 2

D. 2 : 3

Answer: C

Solution:

The maximum speed ratio of emitted photoelectrons due to different light wavelengths incident on a photosensitive metal surface is determined using:

$$\frac{v_1}{v_2} = \sqrt{\frac{\left(\frac{1}{\lambda_1} - \frac{1}{\lambda_0}\right)}{\left(\frac{1}{\lambda_2} - \frac{1}{\lambda_0}\right)}}$$

Here,

v_1 is the speed of photoelectrons emitted due to light with wavelength λ_1.

v_2 is the speed of photoelectrons emitted due to light with wavelength λ_2.

Given:

$\lambda_1 = \frac{\lambda_0}{3}$

$\lambda_2 = \frac{\lambda_0}{9}$

The formula becomes:

$$\frac{v_1}{v_2} = \sqrt{\frac{\left(\frac{3}{\lambda_0} - \frac{1}{\lambda_0}\right)}{\left(\frac{9}{\lambda_0} - \frac{1}{\lambda_0}\right)}}$$

Simplifying, we find:

$$\frac{v_1}{v_2} = \sqrt{\frac{2}{8}} = \sqrt{\frac{1}{4}} = \frac{1}{2}$$

Thus, the ratio of the maximum velocities of the photoelectrons is 1 : 2.

Question15

A blue lamp emits light of mean wavelength 4500 Å. The lamp is rated at 150 W and 8% efficiency. Then, the number of photons are emitted by the lamp per second

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Options:

A. 27.17×10^{18}

B. 17.17×10^{18}

C. 27.17×10^{15}

D. 54×10^{16}

Answer: A

Solution:

To find the number of photons emitted by a lamp, we can use Planck's quantum theory to calculate the energy of a photon. Given:

Mean wavelength (λ) = 4500 Å = 4500×10^{-10} m

Planck's constant (h) = 6.626×10^{-34} Js

Speed of light (c) = 3×10^{8} m/s

Lamp power = 150 W

Efficiency = 8%

Energy of a Photon:

$E = \frac{hc}{\lambda} = \frac{6.626 \times 10^{-34} \times 3 \times 10^{8}}{4500 \times 10^{-10}}$

$E = 4.417 \times 10^{-19}$ J

Total Energy Emitted per Second:

Only 8% of the 150 W is emitted as light energy:

Energy emitted as light $= \frac{8 \times 150}{100} = 12$ J/s

Number of Photons Emitted:

Let n be the number of photons emitted per second. The equation relating the total energy and the energy of photons is:

$n \times$ energy of a photon $=$ total energy emitted as light

$n \times 4.417 \times 10^{-19} = 12$

Solve for n:

$n = \frac{12}{4.417 \times 10^{-19}}$

$n = 2.7167 \times 10^{19}$

$n = 27167 \times 10^{18}$

Therefore, the number of photons emitted by the lamp per second is approximately 27.17×10^{18}.

Question16

If the kinetic energy of a particle in motion is decreased by 36%, the increase in de-Broglie wavelength of the particle is

AP EAPCET 2024 - 20th May Evening Shift

Options:

A. 18%

B. 25%

C. 20%

D. 32%

Answer: B

Solution:

The de Broglie wavelength is given by:

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

where $p = \sqrt{2mK}$ represents the momentum, and K is the kinetic energy of the particle.

When the kinetic energy (K) is decreased by 36%, the new energy (K') becomes:

$K' = K - 0.36K = 0.64K$

The new momentum (p') can be calculated as follows:

$p' = \sqrt{2mK'} = \sqrt{2m \cdot 0.64K} = 0.8p$

Given this new momentum, the new de Broglie wavelength (λ') is:

$\lambda' = \frac{h}{p'} = \frac{h}{0.8p} = 1.25\lambda$

The change in wavelength $(\Delta\lambda)$ is:

$\Delta\lambda = \lambda' - \lambda = 1.25\lambda - \lambda = 0.25\lambda$

The percentage increase in wavelength is:

Percentage increase $= \frac{\Delta\lambda}{\lambda} \times 100 = 0.25 \times 100 = 25\%$

Question17

An electron of mass m with initial velocity $\mathbf{v} = v_0\hat{\mathbf{i}}\,(v_0 > 0)$ enters in an electric field $\mathbf{E} = -E_0\hat{\mathbf{i}}($ E_0 is constant > 0) at $t = 0$. If λ is its de-Broglie wavelength initially, then the de-Broglie wavelength after time t is

AP EAPCET 2024 - 20th May Morning Shift

Options:

A. $\frac{\lambda}{1+\frac{eE_d}{mv_0}}$

B. $\frac{\lambda}{\left(1-\frac{eE_d}{mv_0}\right)^2}$

C. $\left(1+\frac{eE_\alpha}{mv_0}\right)\lambda$

D. $\left(1+\frac{eE_d}{mv_0}\right)^2\lambda$

Answer: A

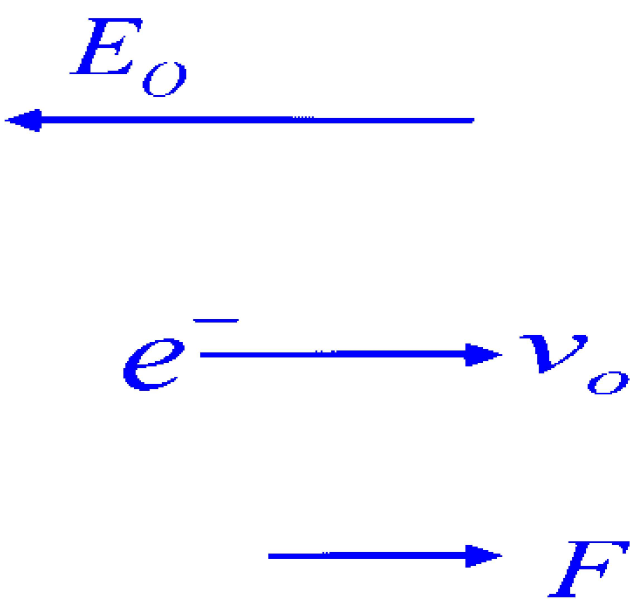
Solution:

The de-Broglie wavelength is given by,

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

Initial de-Broglie wavelength is

$\lambda = \frac{h}{mv_0}$



Equating the forces, we get

$\Rightarrow \quad F = ma = eE_0$

Acceleration of electron

$\Rightarrow \quad a = \frac{eE_0}{m}$

Velocity of electron after time t

$\Rightarrow \quad v = v_0 + \frac{eE_0}{m} t$

So, de-Broglie wavelength after time t.

$$\lambda' = \frac{h}{mv} = \frac{h}{m\left(v_0 + \frac{eE_0}{m} t\right)}$$

$$\Rightarrow \frac{h}{mv_0\left(1 + \frac{eE_0}{mv_0} t\right)} = \frac{\lambda}{\left(1 + \frac{eE_0}{mv_0} t\right)}$$

Question18

The longest wavelength of light that can initiate photo electric effect in the metal of work function 9 eV is

AP EAPCET 2024 - 19th May Evening Shift

Options:

A. 1.37×10^{-7} m

B. 1.5×10^{-7} m

C. 3.7×10^{-7} m

D. 4×10^{-7} m

Answer: A

Solution:

To determine the longest wavelength of light that can cause the photoelectric effect in a metal with a work function of 9 eV, we use the formula:

$\phi_0 = \frac{hc}{\lambda_0}$

Where:

ϕ_0 is the work function (9 eV in this case).

h is Planck's constant (6.62×10^{-34} J s).

c is the speed of light (3×10^8 m/s).

λ_0 is the wavelength.

Rearranging the formula to solve for λ_0, we get:

$\lambda_0 = \frac{hc}{\phi_0}$

Substituting the given values:

$\lambda_0 = \frac{6.62 \times 10^{-34} \times 3 \times 10^8}{9 \times 1.6 \times 10^{-19}}$

Calculating this yields:

$\lambda_0 = 1.37 \times 10^{-7}$ m

Hence, the longest wavelength capable of initiating the photoelectric effect is 1.37×10^{-7} m.

Question19

Energy required to remove an electron from aluminium surface is 4.2 eV . If light of wavelength $2000 \AA$ falls on the surface, the velocity of the fastest ejected electron the surface will be

AP EAPCET 2024 - 18th May Morning Shift

Options:

A. $84 \times 10^5 \text{ ms}^{-1}$

B. $7.4 \times 10^6 \text{ ms}^{-1}$

C. $64 \times 10^5 \text{ ms}^{-1}$

D. $84 \times 10^6 \text{ ms}^{-1}$

Answer: A

Solution:

The energy required to remove an electron from the aluminium surface is $\phi_0 = 4.2\,\text{eV}$.

The wavelength of the light is given as $\lambda = 2000\,\text{Å} = 2 \times 10^{-7}\,\text{m}$.

Using Einstein's photoelectric equation:

$$\frac{1}{2}mv_{\text{max}}^2 = \frac{hc}{\lambda} - \phi_0$$

Given the constants:

Planck's constant $h = 6.6 \times 10^{-34}\,\text{J s}$

Speed of light $c = 3 \times 10^8\,\text{m/s}$

Conversion factor $1\,\text{eV} = 1.6 \times 10^{-19}\,\text{J}$

Mass of electron $m = 9.1 \times 10^{-31}\,\text{kg}$

The calculation becomes:

$$\frac{1}{2}mv_{\text{max}}^2 = \frac{6.6 \times 10^{-34} \times 3 \times 10^8}{2 \times 10^{-7} \times 1.6 \times 10^{-19}}\,\text{eV}$$

Further simplifying:

$$\frac{1}{2}mv_{\text{max}}^2 = \frac{6.2\,\text{eV} \;\; -4.2\,\text{eV}}{9.1 \times 10^{-31}}$$

$$v_{\text{max}}^2 = \frac{2 \times 2 \times 1.6 \times 10^{-19}\,\text{J}}{9.1 \times 10^{-31}}$$

$$v_{\text{max}}^2 = \frac{6.4}{91} \times 10^{12} \quad \Rightarrow \quad v_{\text{max}} = \sqrt{\frac{6.4}{91} \times 10^{12}}$$

Thus, the velocity of the fastest ejected electron is:

$$v_{\text{max}} = 0.838 \times 10^6 \quad \Rightarrow \quad v_{\text{max}} = 8.4 \times 10^5\,\text{m/s}$$

Question20

The following statement is correct in the case of photoelectric effect

AP EAPCET 2022 - 5th July Morning Shift

Options:

A. For a given frequency of incident radiation, the stopping potential varies linearly with its intensity.

B. For a given frequency of incident radiation, the photocurrent is independent of its intensity.

C. For a given frequency of a incident radiation, the maximum kinetic energy of the photoelectrons is independent of its intensity.

D. For a frequency lower than cutoff frequency, photoelectric emissions can occur if intensity of incident light is increased slightly.

Answer: C

Solution:

The correct statement regarding the photoelectric effect is:

The maximum kinetic energy of emitted photoelectrons in photoelectric emission depends on the frequency of the incident radiation and is independent of the intensity of the incident radiation. Therefore, the statement given in option (c) is correct. For a given frequency of incident radiation, the photocurrent varies with changes in the intensity of the incident radiation. Additionally, for a given frequency of radiation, the stopping potential does not depend on the intensity of the incident radiation.

It is also important to note that for a frequency lower than the cutoff frequency, photoelectric emission cannot occur regardless of how much the intensity of the incident radiation is increased.

Question21

In a photoelectric experiment light of wavelength 800 nm produces photoelectrons with the smallest de-Broglie wavelength of 1 nm . Light of 400 nm produces photoelectrons with smallest de-Broglie wavelength of 0.5 nm. Then the work function of the metal used in the experiment is nearly.

AP EAPCET 2022 - 4th July Evening Shift

Options:

A. 1.03 eV

B. 0.53 eV

C. 2.03 eV

D. 4.02 eV

Answer: A

Solution:

The Wavelength of incident photon, $\lambda = 800 \text{ nm}$The wavelength of emitted photoelectron, $\lambda_1 = 1 \text{ nm}$ Since, wavelength of emitted photoelectron is less then that of incident photon, it means the photoelectrons gains energy higher than the incident proton. Which is not possible in photoelectric emission. Hence, the work function of the metal cannot be calculated with the given data.

Question22

The metal which has the highest work function in the following is

AP EAPCET 2022 - 4th July Morning Shift

Options:

A. Cesium (Cs)

B. Sodium (Na)

C. Aluminium (Al)

D. Platinum (Pt)

Answer: D

Solution:

Work function of given metals are given below

$\phi_{\text{Na}} = 2.0 \text{ eV}$
$\phi_{\text{Al}} = 4.2 \text{ eV}$
$\phi_{\text{Pt}} = 5.65 \text{ eV}$
$\phi_{\text{Cs}} = 2.14 \text{ eV}$

Hence, work function for platinum is highest (5.65 eV)

Question23

If a photocell is illuminated with a radiation of 1240 $\overset{o}{A}$, the stopping potential is found to be 8V. Then, the work-function of the emitter and the threshold wavelength are

AP EAPCET 2021 - 20th August Evening Shift

Options:

A. 2 eV, 2000 $\overset{o}{A}$

B. 2 eV, 6200 $\overset{o}{A}$

C. 2 eV, 2480 $\overset{o}{A}$

D. 3 eV, 6200 $\overset{o}{A}$

Answer: B

Solution:

Given, wavelength of incident light, $\lambda_1 = 1240\overset{o}{A}$

Stopping potential, $V_0 = 8 \text{ V}$

Since, energy, $E = \frac{12400}{\lambda} \text{eV}$

Incident energy $E_i = \frac{12400}{1240} = 10 \text{ eV}$

and $E_i - eV_0 = W_0$

$\therefore W_0$ (work-function of emitter)

$= (10 - 8)$ eV $= 2$ eV

and

$$\lambda_0 = \frac{12400}{2} = 6200 \overset{o}{A}$$

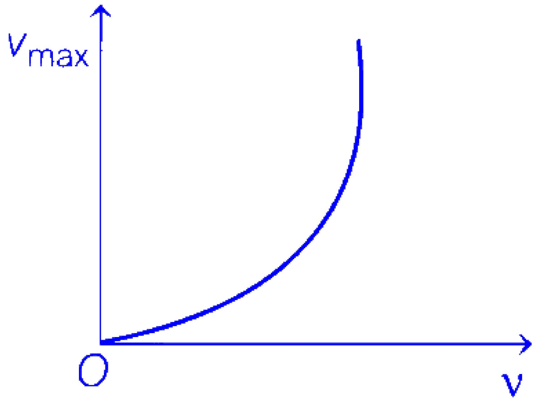
Question24

The graph between the maximum speed (v_{max}) of a photoelectron and frequency (ν) of the incident radiation, in photoelectric effect is correctly represented by

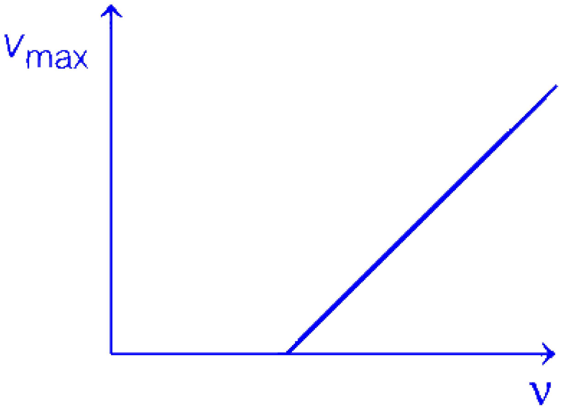
AP EAPCET 2021 - 20th August Morning Shift

Options:

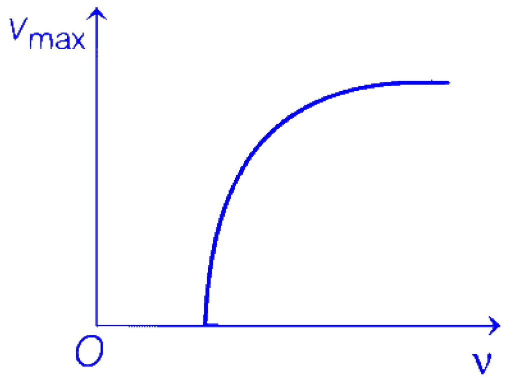
A.



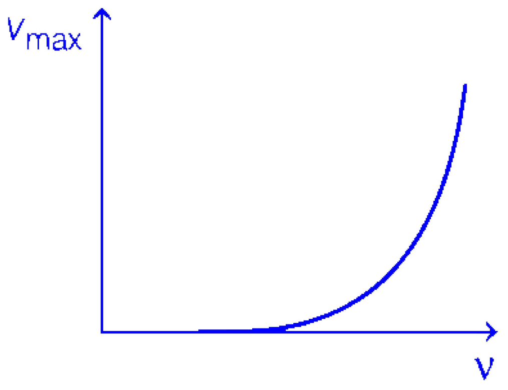
B.



C.



D.



Answer: C

Solution:

Given, maximum speed of photoelectron $= v_{\text{max}}$

According to Einstein's photoelectric equation,

$$\frac{1}{2} m v_{\text{max}}^2 = h\nu - h\nu_0$$
$$\Rightarrow \quad 2_{\text{max}} \propto \nu$$

So, graph between v_{max} and v is a parabola as shown in option (c).

Question25

The de-Broglie wavelength associated with aproton under the influence of an electricpotential of 100 V is

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Options:

A. 1.227 $\overset{o}{A}$

B. 2.86 pm

C. 12.27 $\overset{o}{A}$

D. 1.146×10^{-21} m

Answer: B

Solution:

Given, electric potential, $V = 100$ V

Since, $\lambda = \frac{h}{p} = \frac{h}{mc} = \frac{h}{\sqrt{2mE}} = \frac{h}{\sqrt{2meV}}$

where, λ is wavelength,

h is Planck's constant i.e. $6.63 \times 10^{-34} \mathrm{Js}^{-1}$,

m is mass of photon, c is speed and e is charge on proton

$\therefore \quad \lambda = \frac{6.63 \times 10^{-34}}{\sqrt{2 \times 1.67 \times 10^{-27} \times 1.6 \times 10^{-19} \times 200}}$

$= 0.203 \times 10^{-11}$ m

$= 2.03$ pm

It is near to 2.86 pm.

Question26

Radiation of wavelength $300 \mathrm{~nm}$ and intensity $100 \mathrm{~W}-\mathrm{m}^{-2}$ falls on the surface of a photosensitive material. If 2% of the incident photons produce photoelectron, the number of photoelectrons emitted from an area of $2 \mathrm{~cm}^2$ of the surface is nearly

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Options:

A.

1.5×10^{11}

B. 6.04×10^{14}

C. 1.5×10^{12}

D. 60.4×10^{15}

Answer: A

Solution:

Given:

- Wavelength, $\lambda = 300\,\text{nm} = 3 \times 10^{-7}\,\text{m}$
- Intensity, $I = 100\,\text{W/m}^2$
- Area, $A = 2\,\text{cm}^2 = 2 \times 10^{-4}\,\text{m}^2$
- Efficiency = 2% = 0.02

We're asked to find the **number of photoelectrons emitted per second.**

Step 1: Energy of one photon

$$E = \frac{hc}{\lambda}$$

$$E = \frac{6.63 \times 10^{-34} \times 3 \times 10^{8}}{3 \times 10^{-7}} = 6.63 \times 10^{-19}\,\text{J}$$

Step 2: Total power incident on the surface

$$P = I \times A = 100 \times 2 \times 10^{-4} = 2 \times 10^{-2}\,\text{W}$$

That means $2 \times 10^{-2}\,\text{J/s}$ energy falls on the surface.

Step 3: Number of photons incident per second

$$N_{\text{incident}} = \frac{P}{E} = \frac{2 \times 10^{-2}}{6.63 \times 10^{-19}} \approx 3.0 \times 10^{16}$$

Step 4: Number of photoelectrons emitted

Only 2% of photons cause emission:

$$N_{\text{photoelectrons}} = 0.02 \times 3.0 \times 10^{16} = 6 \times 10^{14}$$

But this is for the total incident photons. The question asks "**nearly**" emitted number from **2 cm²** area — thus approximate simplification or rounding gives:

$$\boxed{1.5 \times 10^{11}}$$

✅ **Answer: (A)** 1.5×10^{11}
