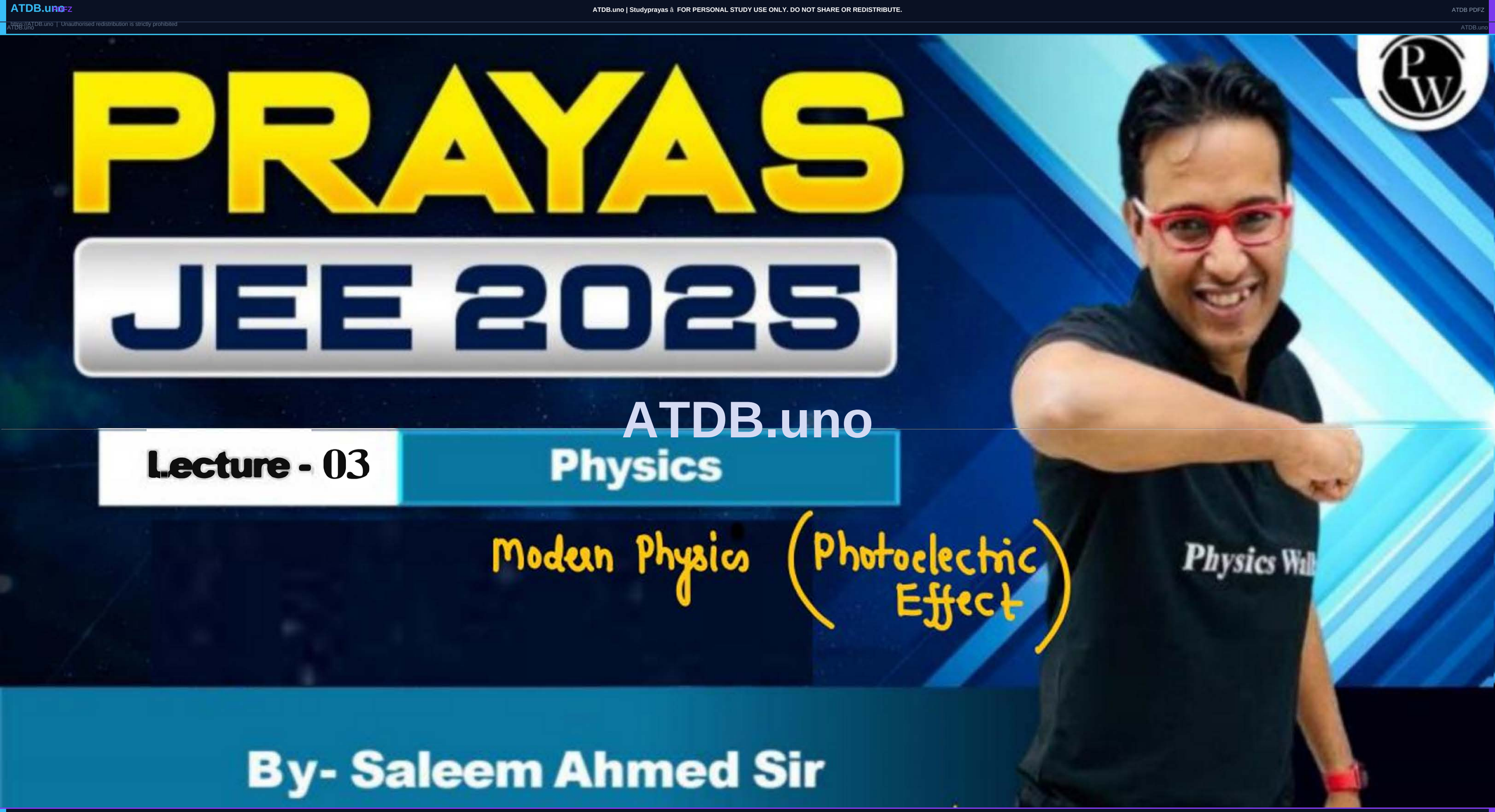
PRAYAS

JEE 2025

Lecture - 03

Physics

Modern Physics (Photoelectric Effect)



By- Saleem Ahmed Sir

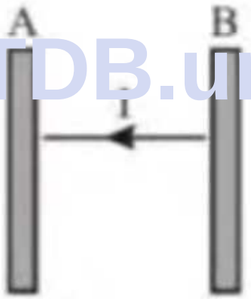
Todays Goal

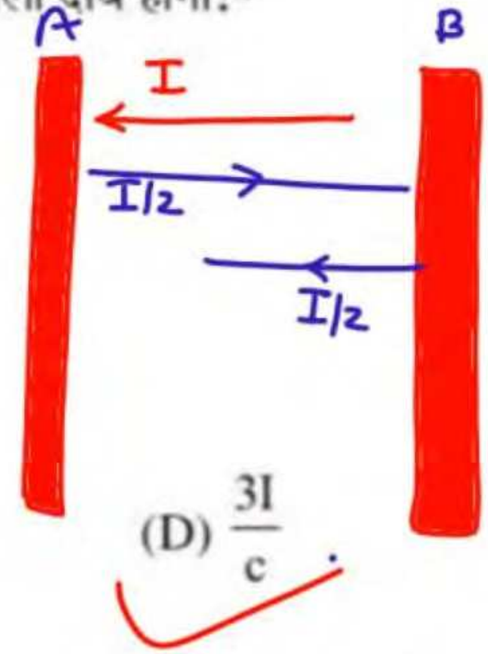
- photoelechoic Effect (Introoduction)

the incident light. The reflected light falls on B which is perfect reflector, the light reflected by B is again partly reflected and partly absorbed and this process continues. For all absorption by A, asborption coefficient is 0.5. The pressure experienced by A due to light is :-

$r = .5$

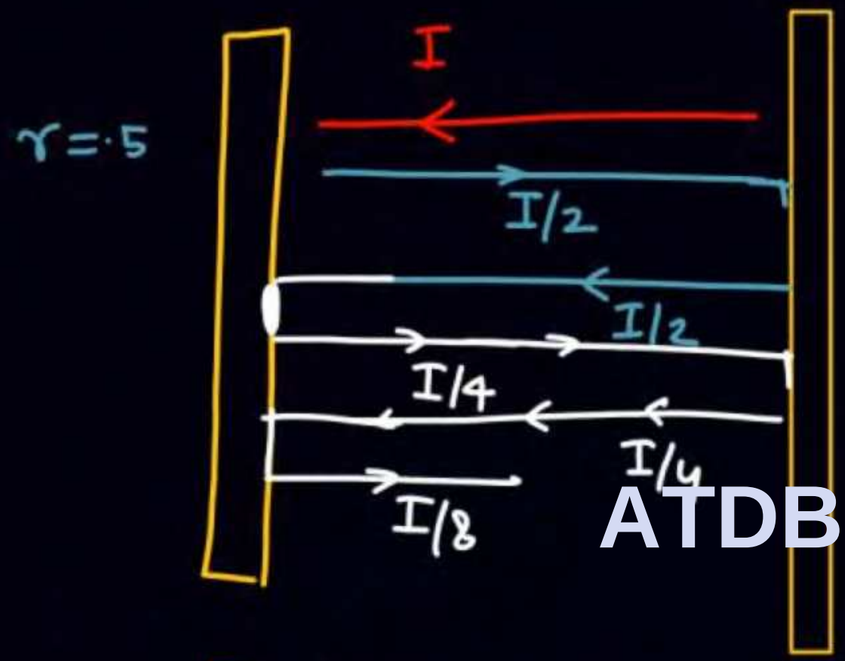
तीव्रता I वाला एक समान्तर प्रकाश पुंज एक ऐसी समतल सतह A पर लम्बवत् आपतित होता है जो आपतित प्रकाश का 50% अवशोषित कर लेती है। परावर्तित प्रकाश एक पूर्णतया परावर्तक B पर आपतित होता है। B द्वारा परावर्तित प्रकाश पुन: आंशिक परावर्तित तथा आंशिक अवशोषित होता है तथा यह प्रक्रम लगातार चलता रहता है। A द्वारा किये गये सम्पूर्ण अवशोषण के लिये अवशोषण गुणांक 0.5 है। प्रकाश के कारण A पर लगने वाला दाब होगा:-





(A) $\frac{1.5\,I}{c}$ (B) $\frac{I}{c}$ (C) $\frac{3I}{2c}$ (D) $\frac{3I}{c}$

Ans. (D)



$\frac{I}{C}\frac{3}{2}$ से

$= \frac{3I}{C}$

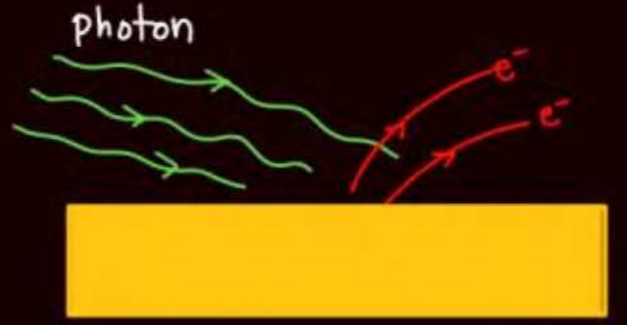
$$P = \frac{I}{C}(1+r) + \frac{(I/2)}{C}(1+r) + \frac{(I/4)}{C}(1+r) + \text{- - - - - } \infty$$

$$= \frac{I}{C}(1+r)\left(1 + \frac{1}{2} + \frac{1}{4} + \text{- - -}\right) = \frac{I}{C}\left(1+\frac{1}{2}\right)\left(\frac{1}{1-1/2}\right)$$

∴

Photoelectric Effect

- when light of sufficient energy, or sufficient small wavelength is incident on a metal surface, e^- are ejected from metal surface. This phenomenon is called photoelectric Effect.



Work function (ϕ) ⟶ It is the min amount of energy required by material for photoelectric effect. It is property of material & commonly its have value between .5eV to 5eV.

Threshold Energy ⟶ It is the min Energy that photon must have to cause photoelectric effect.

ϕ = Work function = Threshold Energy

* ϕ = work function $= h\nu_0 = \frac{hc}{\lambda_0}$

$\nu_0 \longrightarrow$ Threshold frequency

$\lambda_0 \longrightarrow$ Threshold wavelength.

* $E = \phi + (K\varepsilon)_{max}$

E: Energy of one photon

ϕ: work function

$(K\varepsilon)_{max}$: maximum possible K.E. of e^-

* $0 \leq (K\varepsilon) \leq (K\varepsilon)_{max}$

$K\varepsilon$: Kinetic Energy of photo electron

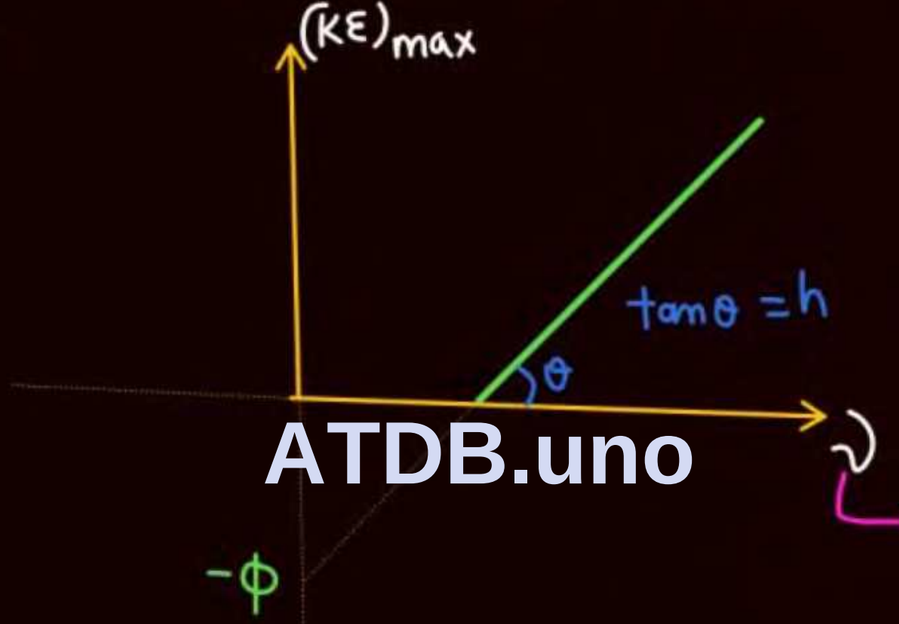
- Electron Emitted from photoelectric Effect is called photoelectron.

- $E = \phi + (K\varepsilon)_{max}$

- $E = h\nu = \frac{hc}{\lambda}$

- $\phi = h\nu_0 = \frac{hc}{\lambda_0}$

Draw Graph between $(K\varepsilon)_{max}$ Vs ν



$E = \phi + (K\varepsilon)_{max}$

$h\nu = \phi + (K\varepsilon)_{max}$

$(K\varepsilon)_{max} = h\nu - \phi$

$y = mx - c$

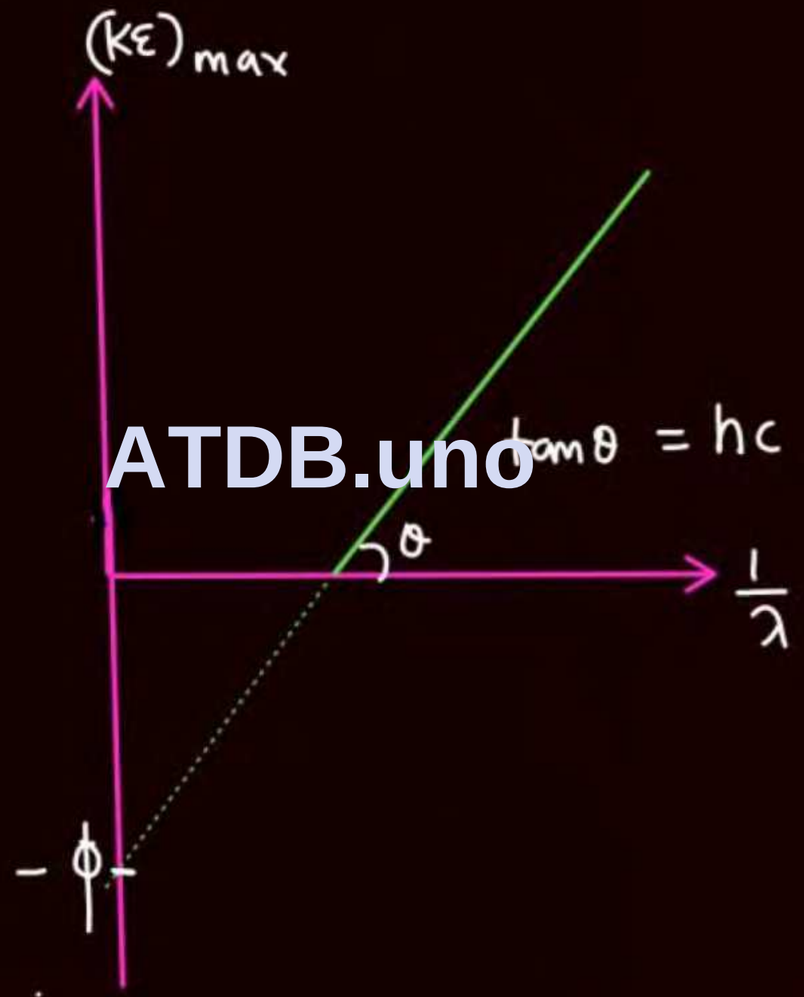
* Draw the graph b/w $(K\varepsilon)_{max}$ Vs $\frac{1}{\lambda}$

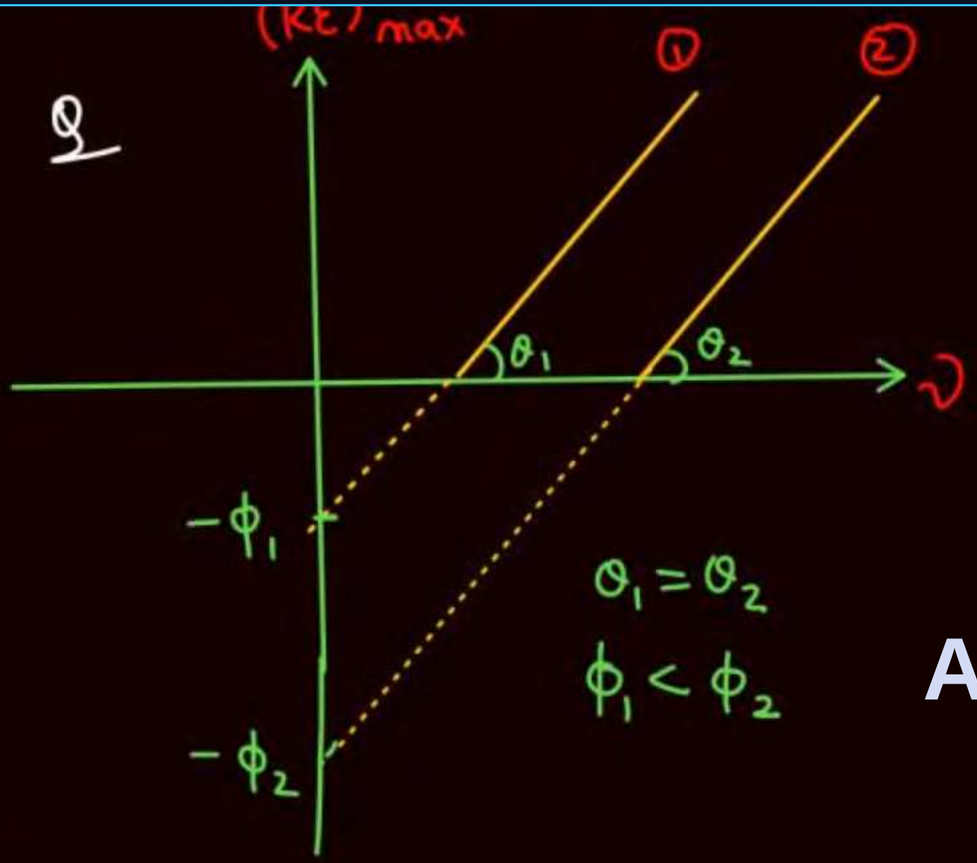
$$E = \phi + K\varepsilon_{max}$$

$$\frac{hc}{\lambda} = \phi + (K\varepsilon)_{max}$$

$$(K\varepsilon)_{max} = \frac{hc}{\lambda} - \phi$$

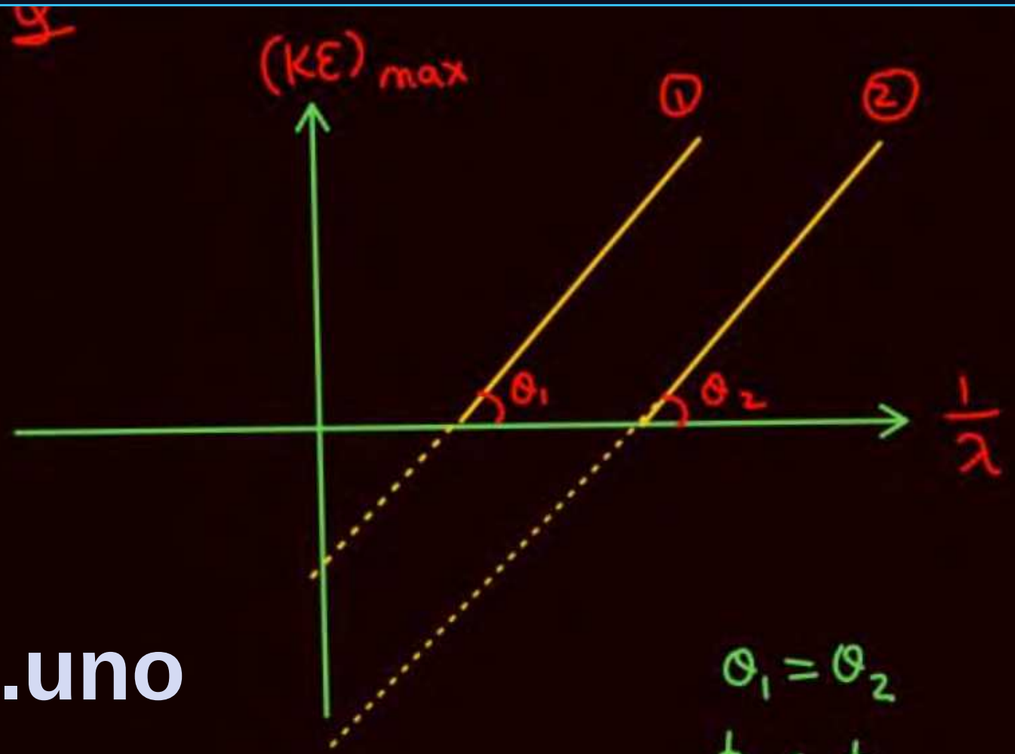
$$y = mx - c$$





$\theta_1 = \theta_2$

$\phi_1 < \phi_2$



$\theta_1 = \theta_2$

$\phi_1 < \phi_2$

$$\text{photoelectron efficiency} = \frac{\text{No. of photoelectron emitted per Unit time}}{\text{No. of photon incident per Unit time}}$$

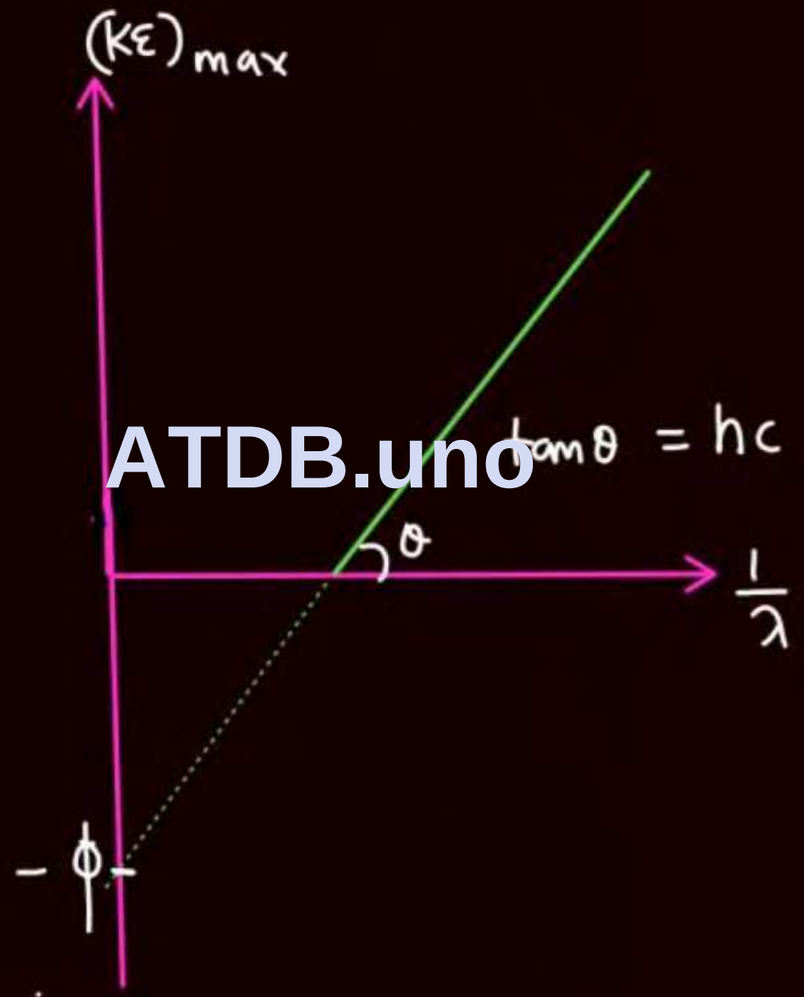
* Draw the graph b/w $(K\varepsilon)_{max}$ Vs $\frac{1}{\lambda}$

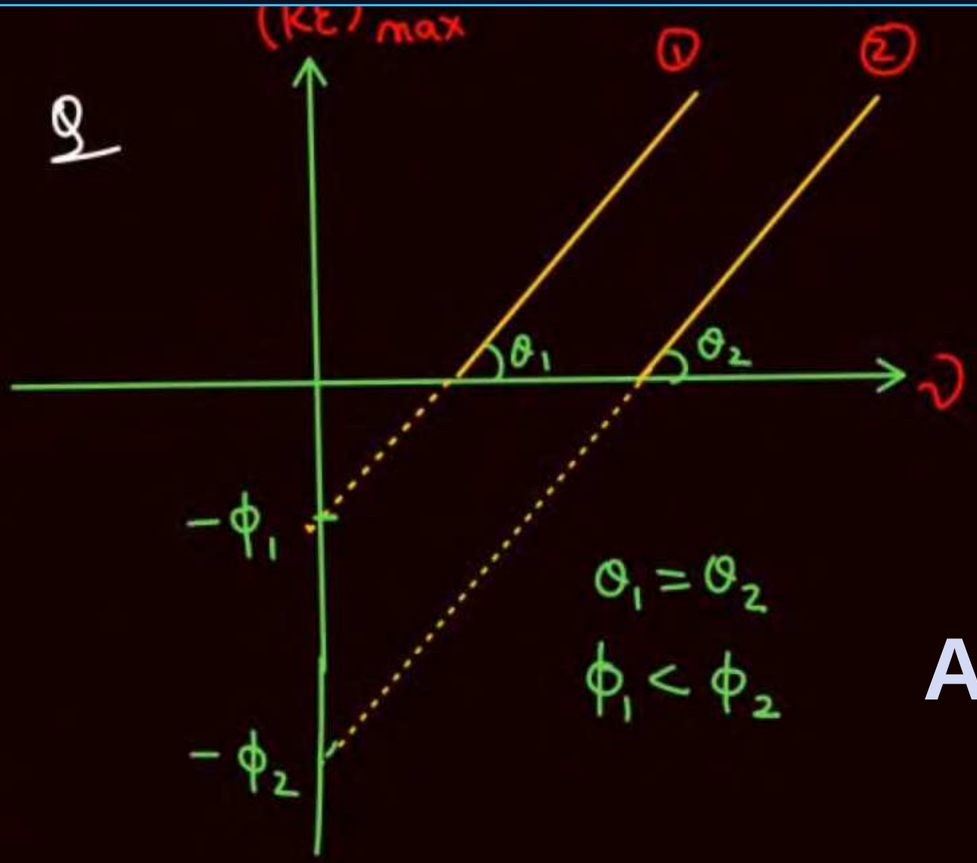
$$E = \phi + K\varepsilon_{max}$$

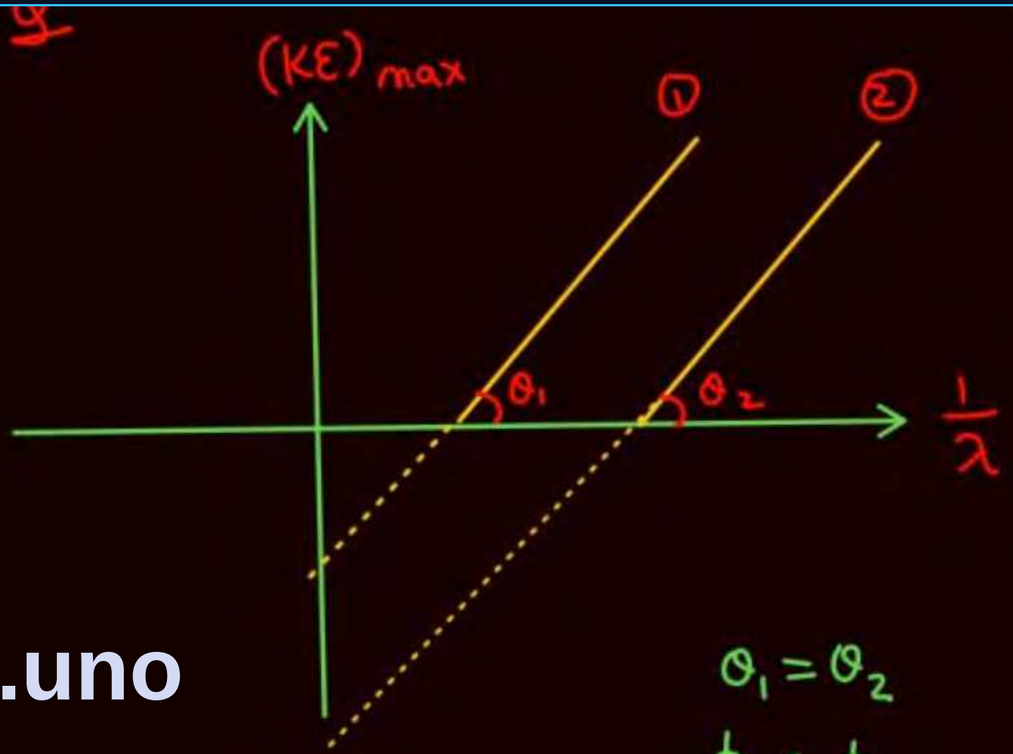
$$\frac{hc}{\lambda} = \phi + (K\varepsilon)_{max}$$

$$(K\varepsilon)_{max} = \frac{hc}{\lambda} - \phi$$

$$y = mx - c$$

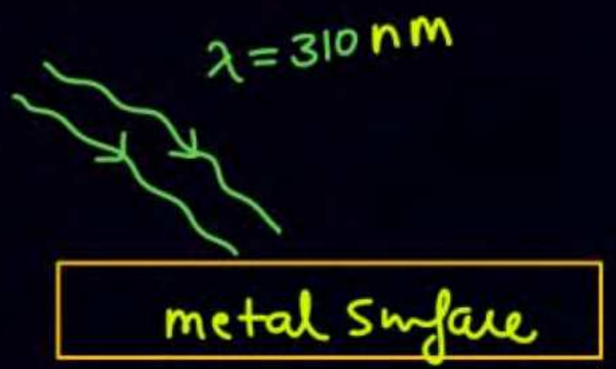






$$\text{photoelectron efficiency} = \frac{\text{No. of photoelectron emitted per Unit time}}{\text{No. of photon incident per Unit time}}$$

Q A monochromatic beam of light of $\lambda = 310\,nm$ is incident on a material of work function 2.5 eV



① Find Energy of one photon

② Threshold wavelength

③ Threshold frequency

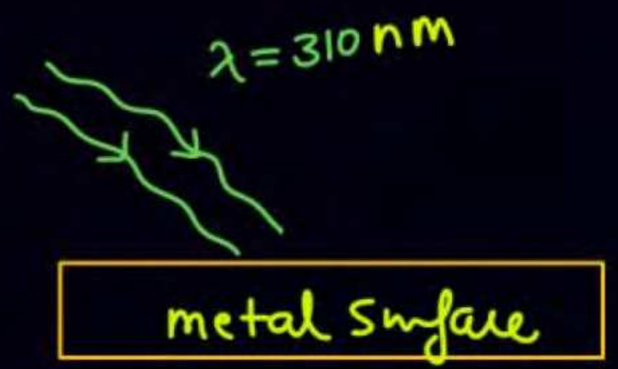
④ Max. K.E possible

ax

⑤ λ_d for electron having max (K.E)

Q

A monochromatic beam of light of $\lambda = 310\,nm$ is incident on a material of work function 2.5 eV



① Find Energy of one photon

$$E = \frac{hc}{\lambda} = \frac{1240}{\lambda_{(nm)}} = \frac{1240}{310} = 4\,eV$$

② Threshold wavelength

$$\phi = \frac{hc}{\lambda_0} = \frac{1240}{\lambda_0}\,eV \quad (\lambda_0 \text{ in nm})$$

$$2.5 = \frac{1240}{\lambda}$$

$$\boxed{\lambda = \frac{1240}{2.5}\,nm}$$

③ Threshold frequency

$$\phi = h\nu_0$$

$$\nu_0 = \frac{\phi}{h} = \frac{2.5 \times 1.6 \times 10^{-19}}{6.6 \times 10^{-34}}$$

④ Max. K.E possible

$$E = \phi + (KE)_{max}$$

$$\frac{1240}{310} = 2.5 + (KE)_{max}$$

$$(KE)_{max} = 1.5\,eV$$

⑤ λ_d for electron having max (K.E)

$$\lambda = \frac{h}{\sqrt{2m\,(KE)}}$$

Q Electricfield corresponding to Electromagnetic wave falling on metal surface of work function 3eV is given by $E = E_0 \sin(2\pi \times 10^{15} t - kx)$.

find max KE of photo electron possible.

Soln

$$E = \phi + (K\varepsilon)_{max}$$

$$4.125 = 3 + (K\varepsilon)_{max}$$

$$(K\varepsilon)_{max} = 1.125 \text{ eV}$$

$$\omega = 2\pi f = 2\pi \times 10^{15}$$

$$f = 10^{15}$$

$$E = h\nu = hf = 6.6 \times 10^{-34} \times 10^{15}$$

$$= 6.6 \times 10^{-19} \text{ Joule}$$

$$= \frac{6.6 \times 10^{-19}}{1.6 \times 10^{-19}} \text{ eV} = 4.125 \text{ eV}$$

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

Q If frequency of incident photon is doubled then value of $(KE)_{max}$ will be

(1) more than double

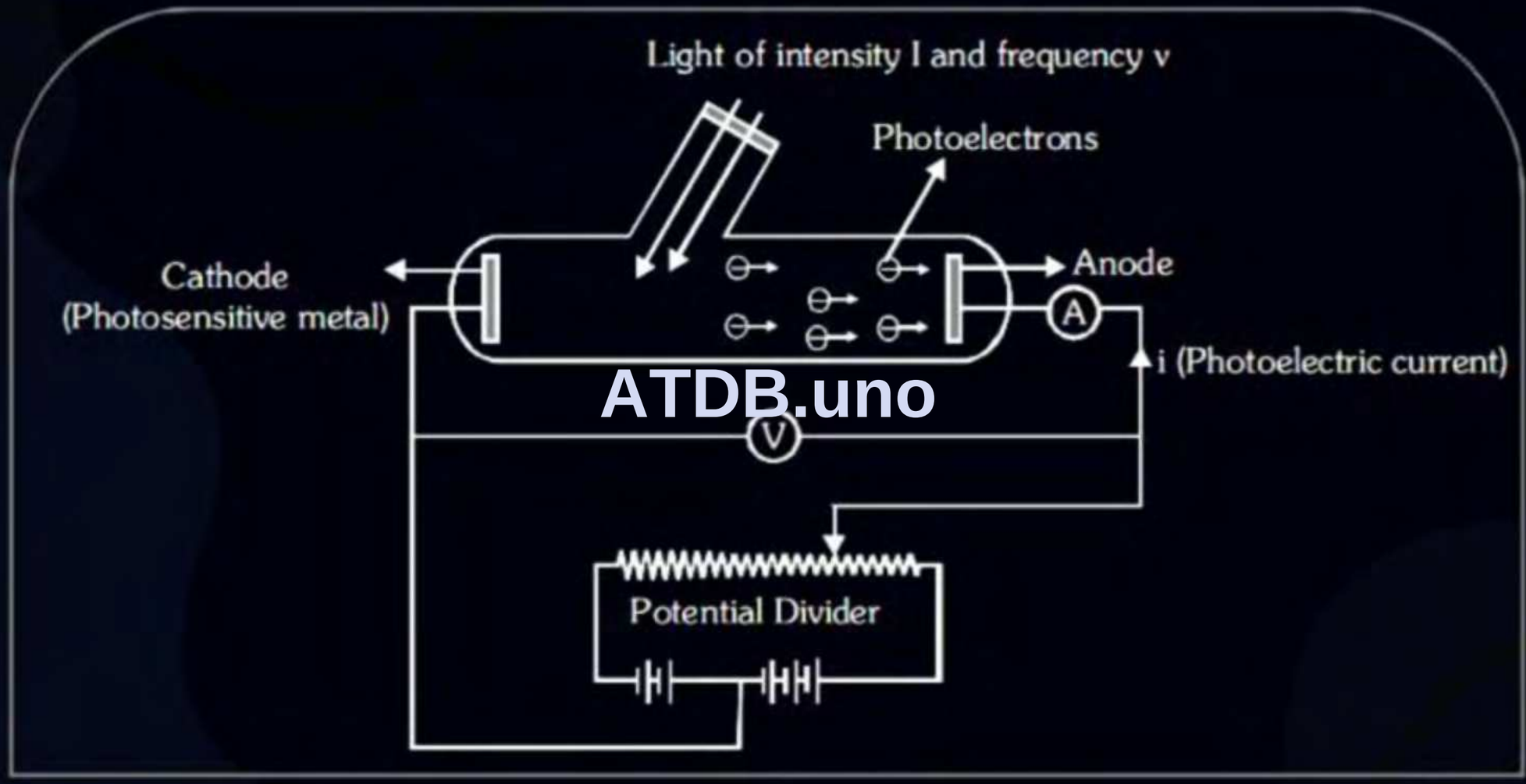
(2) Double

(3) half

(4) Less than double but more than previous value.

Experimental study of photoelectric Effect :

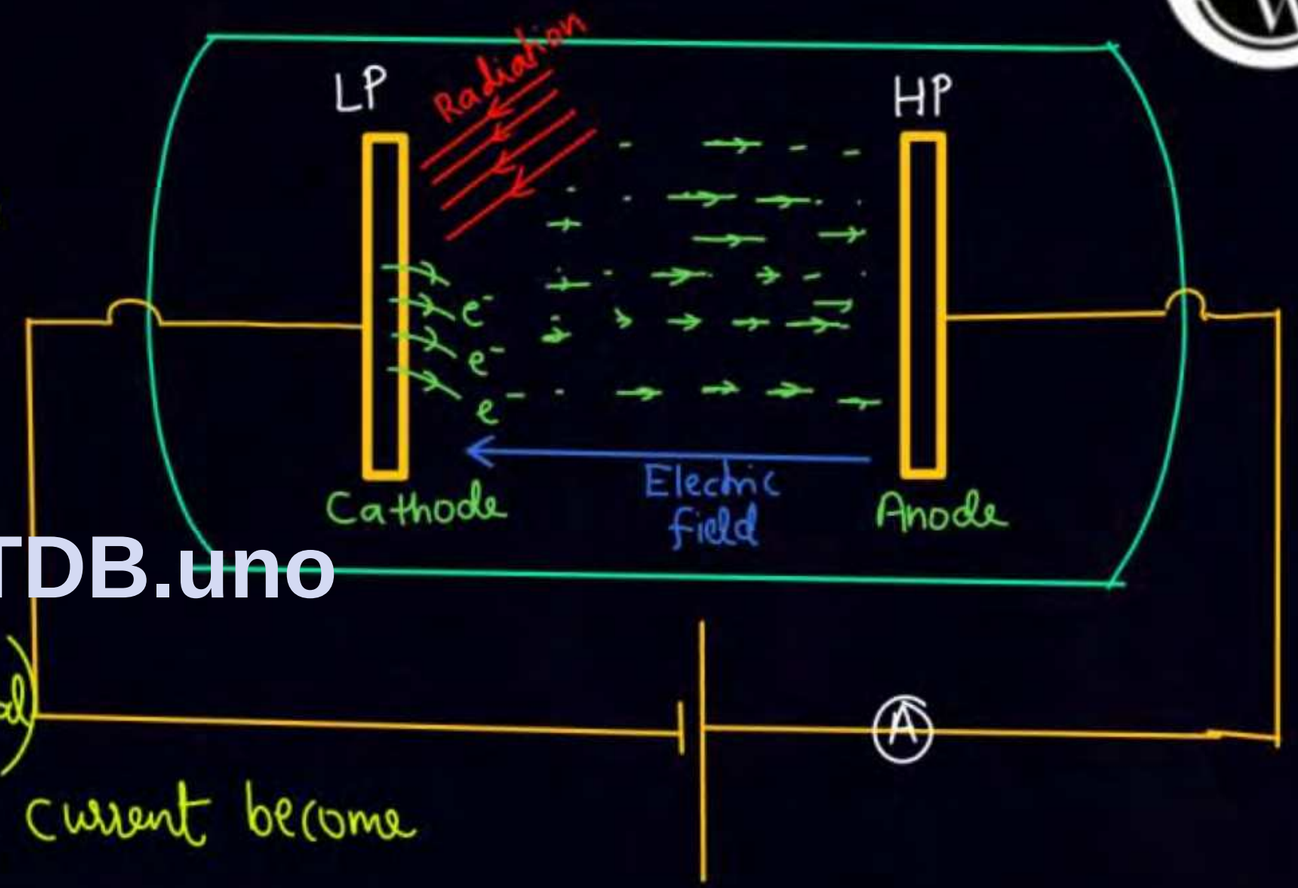
When light of frequency Q and intensity I falls on the cathode, electrons are emitted from it. The electrons are collected by the anode and a current flows in the circuit. This current is called photoelectric current. This experiment is used to study the variation of photoelectric current with different factors like intensity, frequency and the potential difference between the anode and cathode.



IMPORTANT POINTS

- Einstein's Photo Electric equation is based on conservation of energy.
- Einstein explained P.E.E. on the basis of quantum theory, for which he was awarded noble prize.
- According to Einstein one photon can eject one e^- only. But here the energy of incident photon should greater or equal to work function.
- In photoelectric effect all photoelectrons do not have same kinetic energy. Their KE range from zero to E_{max} which depends on frequency of incident radiation and nature of cathode.
- The photo electric effect takes place only when photons strike bound electrons because for free electrons energy and momentum conservations do not hold together.

→ when monochromatic light of sufficient energy falls on cathode plate, eletron are emitted from it & current flows in circuit.



→ when emf of battery is zero, we got some current and when potential difference between anode & cathode is increase (by keeping Anode at high potential) Current also increases and finally current become Const. called saturation current.

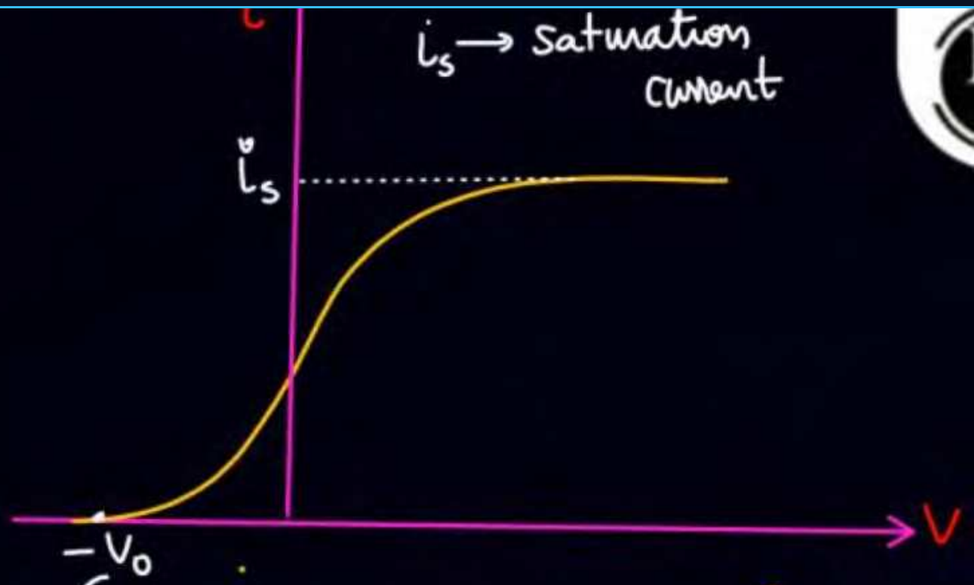
here

- max. value of photoelectric current is called saturation current

– If polarity of battery reversed such that anode plate become low potential (LP) with respect to cathode potential

now on increasing the pot. difference b/w Cathode & anode, electric field between plates retards the electron & current decreases. and at a certain value of this potential difference between anode & cathode current is completely stopped.

Smallest magnitude of the anode potential (wrt cathode) which just stop photocurrent is called stopping potential.



$\hookrightarrow$ stopping potential $= V_0 = \frac{(K\varepsilon)_{max}}{e}$

(Next page)

Calculation for stopping potential

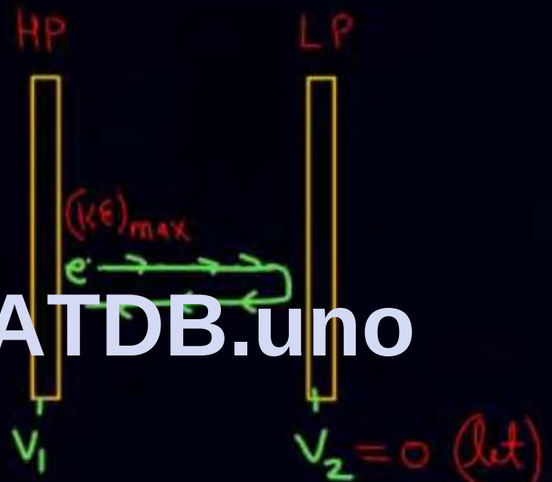
* pot. diff required so that even fast moving electron fail to reach at anode.
  $(V_c - V_a)$

* Stopping potential $(V_0) = \frac{(K\varepsilon)_{max}}{e}$

* $V_0 = \frac{(K\varepsilon)_{max}}{e} \Rightarrow \boxed{(K\varepsilon)_{max} = eV_0}$

* $E = \phi + (K\varepsilon)_{max}$

$E = \phi + eV_0$ → stopping potential



$K_i + U_i = K_f + U_f$

$(K\varepsilon)_{max} + (-eV_1) = 0 + 0$

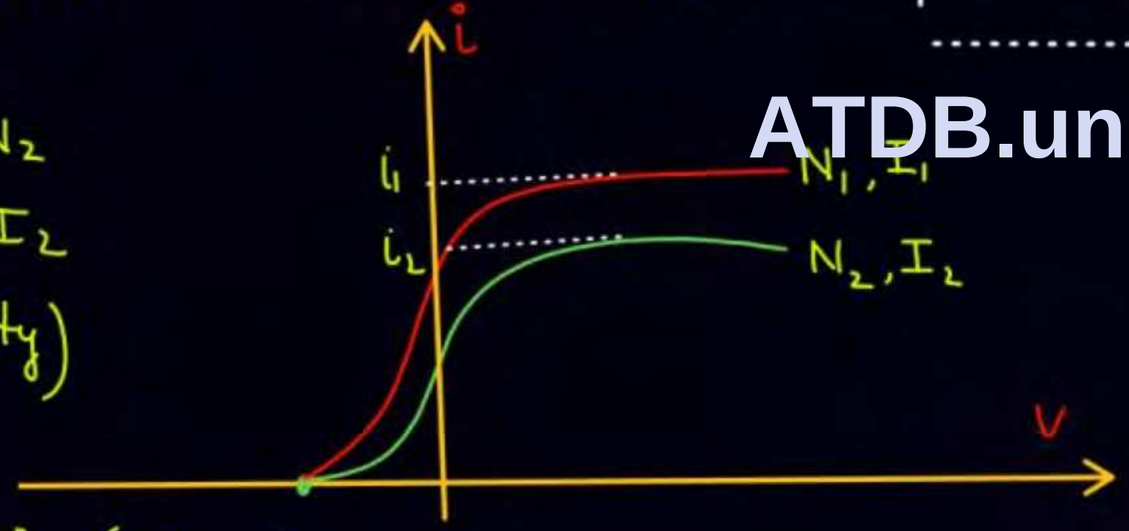
$(K\varepsilon)_{max} = eV$

If

① By keeping freq. of photon fix and No. of photon increases.

* Saturation current increases, $V_0 \longrightarrow$ Same

bcz * Saturation Current $\propto$ No. of photon



$N_1 > N_2$

$I_1 > I_2$ (Intensity)

$i_1 > i_2$ (Saturation Current)

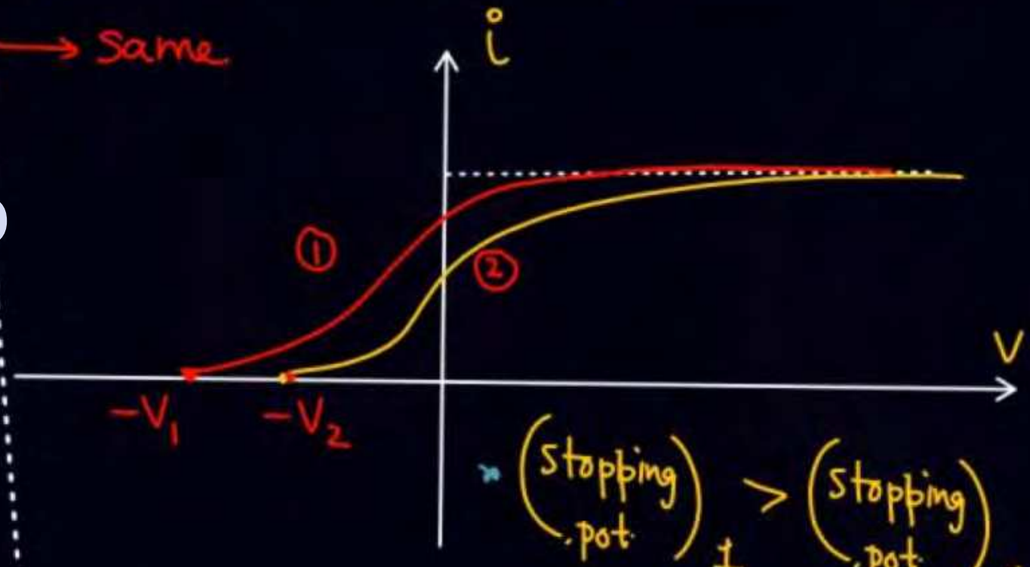
$V_0 \longrightarrow$ Same

Saturation Current $\propto$ No. of photon

② If no. of photon kept same and freq. of each photon increases

$\Rightarrow \nu \uparrow \Rightarrow E \uparrow \Rightarrow$ Stopping potential $V_0 \uparrow$

$i_s \longrightarrow$ Same



* $\left(\text{Stopping pot.}\right)_1 > \left(\text{Stopping pot.}\right)_2$

$\because \nu_1 > \nu_2$

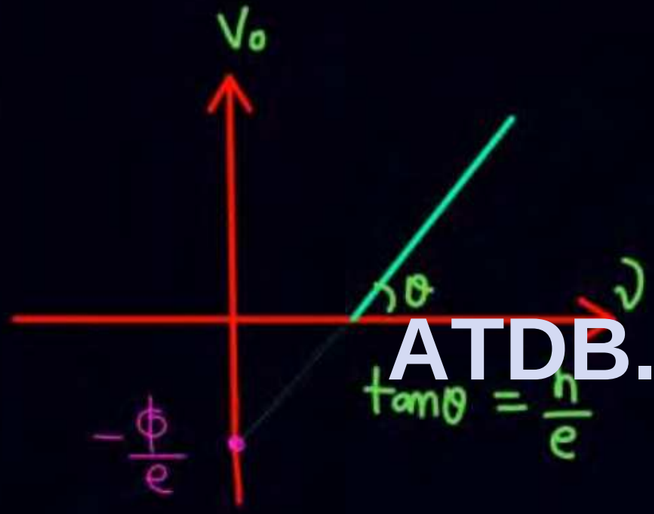
Plot the graph b/w stopping V_s ν of photon potential

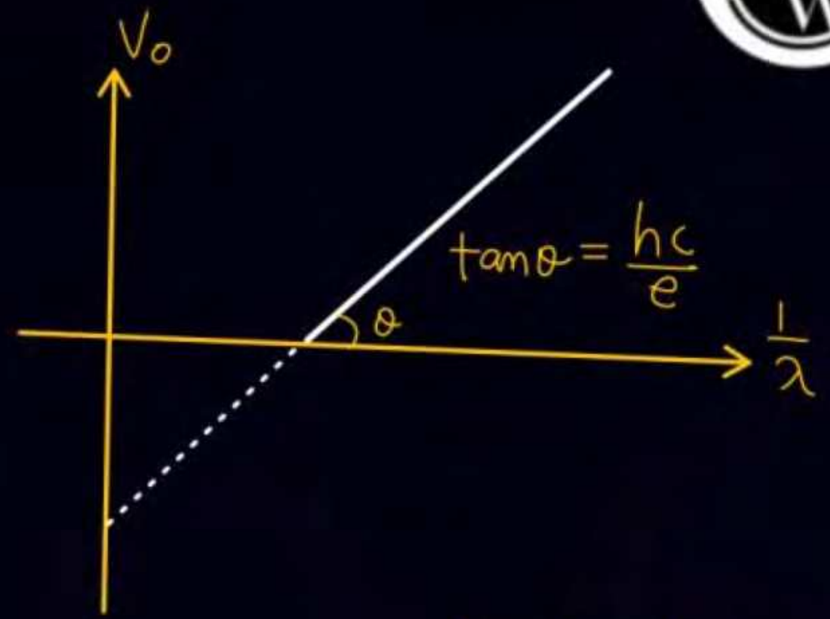
$$E = \phi + (K\varepsilon)_{max}$$

$$h\nu = \phi + eV_0$$

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

$$y = mx - c$$





$$E = \phi + (K\varepsilon)_{max}$$

$$E - \phi = (K\varepsilon)_{max}$$

$$\frac{hc}{\lambda} - \phi = eV_0$$

$$\boxed{V_0 = \frac{hc}{e} \times \frac{1}{\lambda} - \frac{\phi}{e}}$$

Eq

$$E = \phi + (K\varepsilon)_{max}$$

$$(K\varepsilon)_{max} = eV_0$$

$$E = h\nu$$

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

$$\phi = h\nu_0$$

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

$$E = \phi + (K\varepsilon)_{max}$$

$$E = \phi + eV_0$$

$$\frac{hc}{\lambda} = \phi + eV_0$$

$$h\nu = \phi + eV_0$$

Q A monochromatic light of wavelength 620 A° is incident on metal of work function ·5eV. find

$E, \lambda, \phi, \Rightarrow (K\varepsilon)_{max} \Rightarrow \checkmark = eV_0$

① $(K\varepsilon)_{max}$

② stopping potential

$r_{max} = \frac{mv}{qB} = \frac{\sqrt{2m(K\varepsilon)_{max}}}{qB}$

$\lambda = \frac{h}{\sqrt{2m(K\varepsilon)_{max}}}$

③ Debroglie wavelength of fastest photoelectron

④ If uniform magnetic field is applied around metal of magnitude 10T find max. radius.

Q A monochromatic light of wavelength 620 A° is incident on metal of work function ·5eV. find

$$E = \frac{12400}{620} = 20\,eV$$

$$\phi = \cdot 5$$

$$(K\varepsilon)_{max} = 19.5\,eV = eV_0 \Rightarrow \boxed{V_0 = 19.5\,Volt}$$

① $(K\varepsilon)_{max}$

② stopping potential

③ Debroglie wavelength of fastest photoelectron $\lambda = \frac{h}{\sqrt{2m(K\varepsilon)_{max}}} = \frac{6.6\times10^{-34}}{\sqrt{2\times9.1\times10^{-31}\times19.5\times1.6\times10^{-19}}}$

④ If uniform magnetic field is applied around metal of magnitude 10T find max. radius.

$$r = \frac{mv}{qB} = \frac{P}{qB} = \sqrt{\frac{2m(K\varepsilon)_{max}}{q^2B^2}} = \sqrt{\frac{2\times9.1\times10^{-31}\times19.5\times1.6\times10^{-19}}{(1.6\times10^{-19})^2\times100}}$$

③ or $\sqrt{\frac{150}{19.5}}$

OP Qus

After saturation $\Rightarrow n_{e^-\text{ from cathode}} = n_{e^-\text{ to the anode}} = n$ (Let)

n → no. of photoelectron per sec

$\Rightarrow i_{saturation} = ne$

$\Rightarrow i_s \propto n \propto N$

No. of photon per sec $\propto i_s$

N

$$\text{Intensity} = \frac{N h\nu}{\text{Area}}$$

N → No. of photon per sec

QUESTION

From the photoelectric effect experiment, following observations are made. Identify which of these are correct

A. The stopping potential depends only on the work function of the metal.

B. The saturation current increases as the intensity of incident light increases.

C. The maximum kinetic energy of a photo electron depends on the intensity of the incident light.

D. Photoelectric effect can be explained using wave theory of light.

Choose the correct answer from the options given below:

[24 January 2023 - Shift 1]

1. B, C only
2. A, C, D only
3. B only
4. A, B, D only

Ans. (3)

QUESTION

Given below are two statements:

Statement I: Stopping potential in photoelectric effect does not depend on the power of the light source.

Statement II: For a given metal, the maximum kinetic energy of the photoelectron depends on the wavelength of the incident light.

In the light of above statements, choose the most appropriate answer from the options given below.

[25 January 2023 - Shift 2]

1. Statement I is incorrect but statement II is correct
2. Both Statement I and Statement II are incorrect
3. Statement I is correct but statement II is incorrect
4. Both statement I and statement II are correct

Ans. (4)

QUESTION

If the two metals A and B are exposed to radiation of wavelength 350 nm. The work functions of metals A and B are 4.8eV and 2.2 eV. Then choose the correct option.

[31 January 2023 - Shift 2]

1. Metal B will not emit photo-electrons
2. Both metals A and B will emit photo-electrons
3. Both metals A and B will not emit photoelectrons
4. Metal A will not emit photo-electrons

Ans. (4)

QUESTION

The threshold frequency of metal is f_0. When the light of frequency $2f_0$ is incident on the metal plate, the maximum velocity of photoelectron is v_1. When the frequency of incident radiation is increased to $5f_0$. the maximum velocity of photoelectrons emitted is v_2. The ratio of v_1 to v_2 is:

[01 February 2023 - Shift 2]

1. $\frac{v_1}{v_2} = \frac{1}{2}$
2. $\frac{v_1}{v_2} = \frac{1}{8}$
3. $\frac{v_1}{v_2} = \frac{1}{16}$
4. $\frac{v_1}{v_2} = \frac{1}{4}$

Ans. (1)

QUESTION

The work functions of Aluminium and Gold are 4.1eV and 5.1eV respectively. The ratio of the slope of the stopping potential versus frequency plot for Gold to that of Aluminium is _____.

[06 April 2023 - Shift 2]

1. 1.24
2. 2
3. 1
4. 1.5

Ans. (3)

QUESTION

In photoelectric effect

A. The photocurrent is proportional to the intensity of the incident radiation.

B. Maximum kinetic energy with which photoelectrons are emitted depends on the intensity of incident light.

C. Max K.E. with which photoelectrons are emitted depends on the frequency of incident light.

D. The emission of photoelectrons require a minimum threshold intensity of incident radiation.

E. Max K.E. of the photoelectrons is independent of the frequency of the incident light.

Choose the correct answer from the options given below: **[08 April 2023 - Shift 2]**

1. A and B only
2. A and E only
3. A and C only
4. B and C only

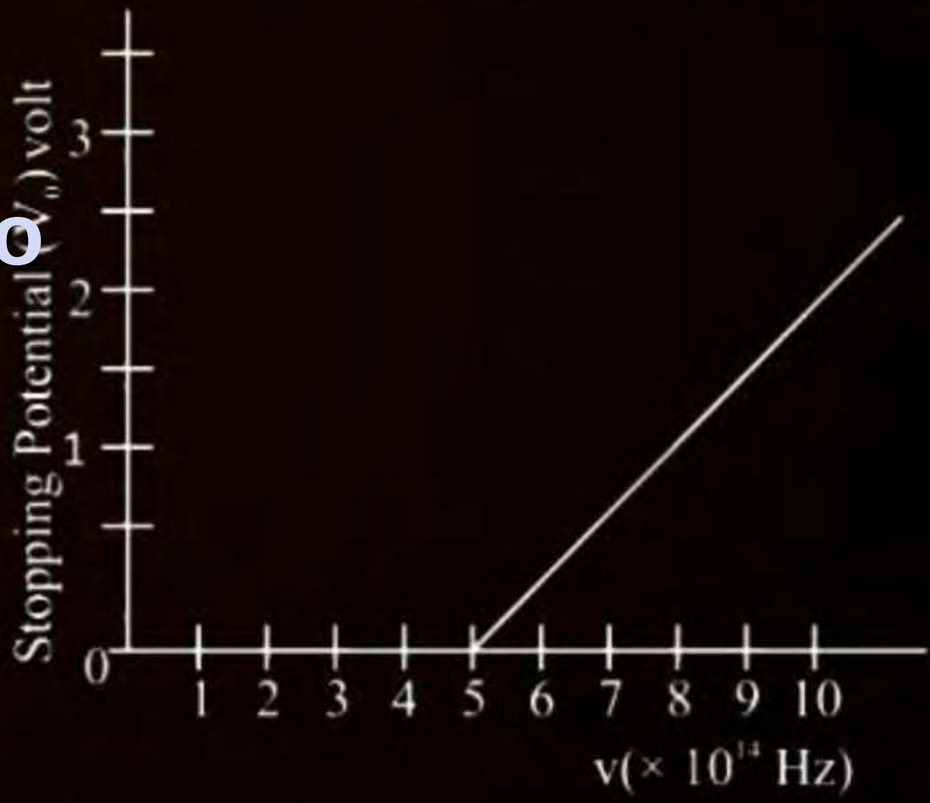
Ans. (3)

QUESTION

The variation of stopping potential (V_0) as a function of the frequency (ν) of the incident light for a metal is shown in figure. The work function of the surface is:

[10 April 2023 - Shift 2]

1. 2.98 eV
2. 2.07 eV
3. 1.36 eV
4. 18.6 eV



Ans. (2)

QUESTION

A metallic surface is illuminated with radiation of wavelength λ, the stopping potential is V_0. If the same surface is illuminated with radiation of wavelength 2λ, the stopping potential becomes $\frac{V_0}{4}$. The threshold wavelength for this metallic surface will be _____.

[11 April 2023 - Shift 1]

1. 3λ
2. 4λ
3. $\frac{3}{2}\lambda$
4. $\frac{\lambda}{4}$

Ans. (1)

QUESTION

The difference between threshold wavelengths for two metal surfaces A and B having work function $\phi_A = 9$ eV and $\phi_B = 4.5$ eV in nm is: [Given, hc = 1242 eVnm]

[13 April 2023 - Shift 1]

1. 540
2. 276
3. 264
4. 138

Ans. (4)

QUESTION

The threshold frequency of a metal with work function 6.63 eV is:

[27 Jan. 2024 - Shift 2]

1. 16×10^{15} Hz
2. 16×10^{12} Hz
3. 1.6×10^{12} Hz
4. 1.6×10^{15} Hz

Ans : (4)

QUESTION

Two sources of light emit with a power of 200 W. The ratio of number of photons of visible light emitted by each source having wavelengths 300 nm and 500 nm respectively, will be:

[29 Jan. 2024 - Shift 2]

1. 1 : 5
2. 1 : 3
3. 5 : 3
4. 3 : 5

Ans : (4)

QUESTION

The work function of a substance is 3.0 eV. The longest wavelength of light that can cause the emission of photoelectrons from this substance is approximately:

[30 Jan. 2024 - Shift 1]

1. 215 nm
2. 414 nm
3. 400 nm
4. 200 nm

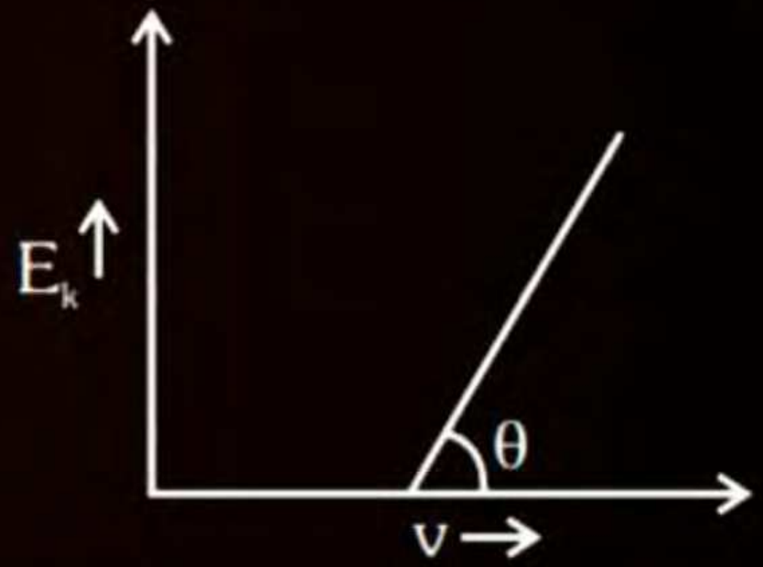
Ans : (2)

QUESTION

For the photoelectric effect, the maximum kinetic energy (E_k) of the photoelectrons is plotted against the frequency (v) of the incident photons as shown in figure. The slope of the graph gives.

[30 Jan. 2024 - Shift 2]

1. Ratio of Planck's constant to electric charge
2. Work function of the metal
3. Charge of electron
4. Planck's constant



Ans : (4)

QUESTION

When a metal surface is illuminated by light of wavelength λ, the stopping potential is 8 V. When the same surface is illuminated by light of wavelength 3λ, stopping potential is2 V. The threshold wavelength for this surface is: **[31 Jan. 2024 - Shift 1]**

1. 5λ
2. 3λ
3. 9λ
4. 4.5λ

Ans : (3)

QUESTION

In a photoelectric effect experiment a light of frequency 1.5 times the threshold frequency is made to fall on the surface of photosensitive material. Now if the frequency is halved and intensity is doubled, the number of photo electrons emitted will be:

[31 Jan. 2024 - Shift 2]

1. Doubled
2. Quadrupled
3. Zero
4. Halved

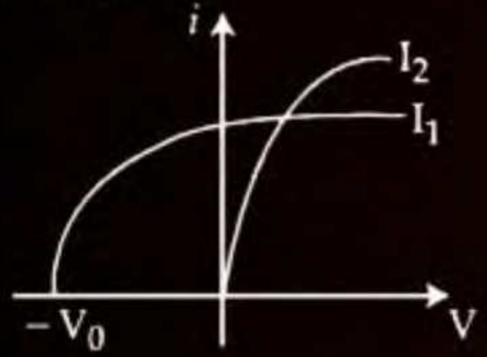
Ans : (3)

QUESTION

Which figure shows the correct variation of applied potential difference (V) with photoelectric current (I) at two different intensities of light ($I_1 < I_2$) of same wavelengths:

[04 Apr. 2024 - Shift 1]

1



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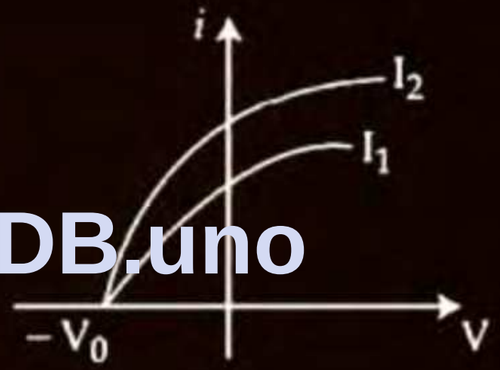
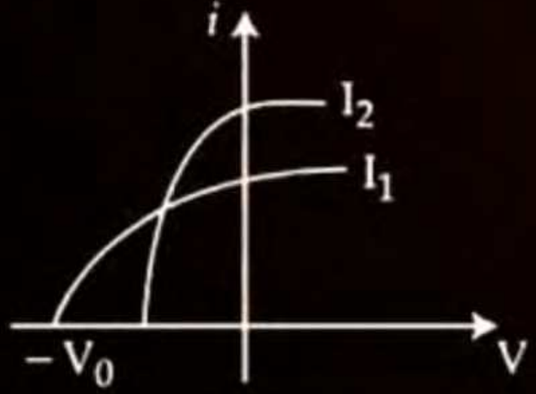
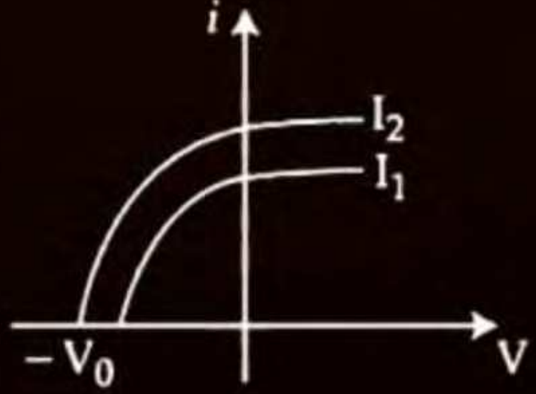


3



4



Ans : (2)

QUESTION

Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason R.

Assertion A: Number of photons increases with increase in frequency of light.

Reason R: Maximum kinetic energy of emitted electrons increases with the frequency of incident radiation.

In the light of the above statements, choose the most appropriate answer from the options given below:

[04 Apr. 2024 - Shift 2]

1. Both A and R are correct and R is the correct explanation of A.
2. Both A and R are correct and R is NOT the correct explanation of A.
3. A is not correct but R is correct.
4. A is correct but R is not correct.

Ans : (3)

QUESTION

Given below are two statements:

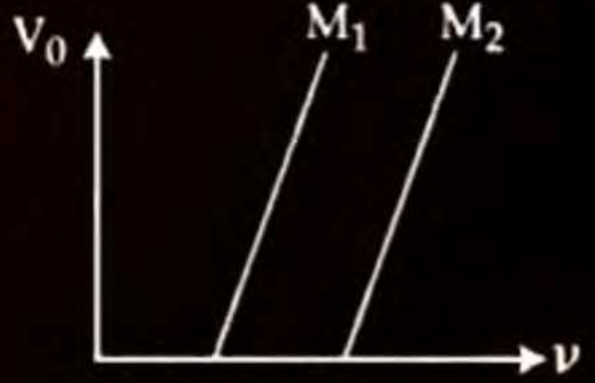
Statement I : Figure shows the variation of stopping potential with frequency (ν) for the two photosensitive materials M_1 and M_2. The slope gives value of h/e, where h is Planck's constant, e is the charge of electron.

Statement II : M_2 will emit photoelectrons of greater kinetic energy for the incident radiation having same frequency.

In the light of the above statements, choose the most appropriate answer from the options given below.

[05 Apr. 2024 - Shift 1]

1. Both Statement I and Statement II are correct
2. Statement I is incorrect but Statement II is correct
3. Both Statement I and Statement II are incorrect
4. Statement I is correct and Statement II is incorrect



Ans : (4)

QUESTION

Which of the following statement is not true about stopping potential (V_0)?

[05 Apr. 2024 - Shift 2]

1. It is 1/e times the maximum kinetic energy of electrons emitted.
2. It increases with increase in intensity of the incident light.
3. It depends on the nature of emitter material.
4. It depends upon frequency of the incident light.

Ans : (2)

QUESTION

In photoelectric experiment energy of 2.48 eV irradiates a photo sensitive material. The stopping potential was measured to be 0.5 V. Work function of the photo sensitive material is:

[06 Apr. 2024 - Shift 1]

1. 1.68 eV
2. 2.48 eV
3. 1.98 eV
4. 0.5 eV

Ans : (3)

QUESTION

Which of the following phenomena does not explain by wave nature of light.

A. reflection

B. diffraction

C. photoelectric effect

D. Interference

E. polarization

Choose the most appropriate answer from the options given below:

[06 Apr. 2024 - Shift 1]

1. E only
2. B, D only
3. C only
4. A, C only

Ans : (3)

QUESTION

When UV light of wavelength 300 nm is incident on the metal surface having work function 2.13 ev, electron emission takes place. The stopping potential is:
(Given hc = 1240 eV nm).

[06 Apr. 2024 - Shift 2]

1. 1.5 V
2. 4.1 V
3. 2 V
4. 4 V

Ans : (3)

QUESTION

UV light of 4.13 eV is incident on a photosensitive metal surface having work function 3.13 eV. The maximum kinetic energy of ejected photoelectrons will be:

[09 Apr. 2024 - Shift 2]

1. 4.13 eV
2. 3.13 eV
3. 1 eV
4. 7.26 eV

Ans : (3)

Question

A beam of electromagnetic radiation of intensity 6.4×10^{-5} W/cm^2 is comprised of wavelength, $\lambda = 310$ nm. It falls normally on a metal (work function $\varphi = 2$eV) of surface area of 1 cm^2. If one in 10^3 photons ejects an electron, total number of electrons ejected in 1 s is 10^x. ($hc = 1240$eVnm, 1eV = 1.6×10^{-19} J), then x is_____.

(JEE Main-2020)

Ans : (11)

Question

When photon of energy 4.0 eV strikes the surface of a metal A, the ejected photo electrons have maximum kinetic energy T_A eV end de-Broglie wavelength λ_A. The maximum kinetic energy of photoelectrons liberated from another metal B by photon of energy 4.50 eV is $T_B = (T_A - 1.5)$eV. If the de-Broglie wavelength of these photoelectrons $\lambda_B = 2\lambda_A$, then the work function of metal B is:

(JEE Main-2020)

(A) 3 eV

(B) 2 eV

(C) 4 eV

(D) 1.5 eV

Ans : (C)

Question

Radiation, with wavelength 6561Å falls on a metal surface to produce photoelectrons. The electrons are made to enter a uniform magnetic field of 3×10^{-4} T. If the radius of the largest circular path followed by the electrons is 10 mm, the work function of the metal is close to: **(JEE Main-2020)**

(A) 1.8 eV

(B) 1.1 eV

(C) 0.8 eV

(D) 1.6 eV

Ans : (B)

Question

When radiation of wavelength λ is used to illuminate a metallic surface, the stopping potential is V. When the same surface is illuminated with radiation of wavelength 3λ, the stopping potential is $\frac{V}{4}$. If the threshold wavelength for the metallic surface is $n\lambda$ then value of n will be _____.

(JEE Main-2020)

Ans : (9)

Question

When the wavelength of radiation falling on a metal is changed from 500 nm to 200 nm, the maximum kinetic energy of the photoelectrons becomes three times larger. The work function of the metal is close to: **(JEE Main-2020)**

(A) 0.61 eV

(B) 0.52 eV

(C) 0.81 eV

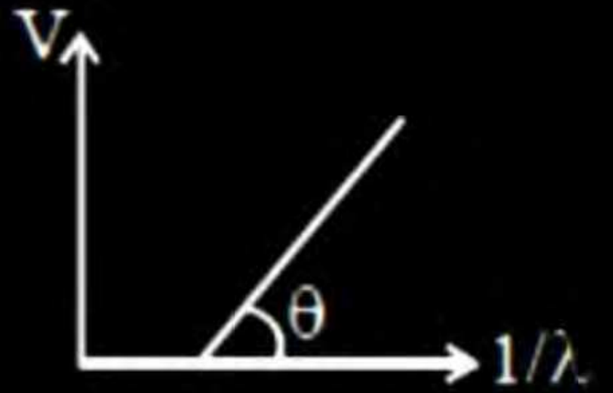
(D) 1.02 eV

Ans : (A)

Question

In a photoelectric effect experiment, the graph of stopping potential V versus reciprocal of wavelength obtained is shown in the figure. As the intensity of incident radiation is increased:

(JEE Main-2020)



(A) Slope of the straight line get more steep

(B) Straight line shifts to left

(C) Graph does not change

(D) Straight line shifts to right

Ans : (C)

Question

The surface of a metal is illuminated alternately with photons of energies $E_1 = 4\text{eV}$ and $E_2 = 2.5$ eV respectively. The ratio of maximum speeds of the photoelectrons emitted in the two cases is 2. The work function of the metal in (eV) is _____.

(JEE Main-2020)

Ans : (2.00)

Question

The stopping potential for electrons emitted from a photosensitive surface illuminated by light of wavelength 491 nm is 0.710 V. When the incident wavelength is changed to a new value, the stopping potential is 1.43 V. The new wavelength is:

(JEE Main-2021)

(A) 329 nm

(B) 309 nm

(C) 382 nm

(D) 400 nm

Ans : (C)

Question

A certain metallic surface is illuminated by monochromatic radiation of wavelength λ. The stopping potential for photoelectric current for this radiation is $3V_0$. If the same surface is illuminated with a radiation of wavelength 2λ, the stopping potential is V_0. The threshold wavelength of this surface for photoelectric effect is____λ.

(JEE Main-2021)

Ans : (4)

Question

When radiation of wavelength λ is incident on a metallic surface, the stopping potential of ejected photoelectrons is 4.8 V. If the same surface is illuminated by radiation of double the previous wavelength, then the stopping potential becomes 1.6 V. The threshold wavelength of the metal is: **(JEE Main-2021)**

(A) 2λ

(B) 4λ

(C) 8λ

(D) 6λ

Ans : (B)

Question

A light beam of wavelength 500 nm is incident on a metal having work function of 1.25 eV, placed in a magnetic field of intensity B. The electrons emitted perpendicular to the magnetic field B, with maximum kinetic energy are bent into circular arc of radius 30 cm. The value of B is _____ $\times 10^{-7}$ T.

Given $hc = 20 \times 10^{-26}$ J-m, mass of electron $= 9 \times 10^{-31}$ kg

(JEE Main-2021)

Ans : (125)

Question

An electron and proton are separated by a large distance. The electron starts approaching the proton with energy 3 eV. The proton captures the electrons and forms a hydrogen atom in second excited state. The resulting photon is incident on a photosensitive metal of threshold wavelength 4000 Å. What is the maximum kinetic energy of the emitted photoelectron? **(JEE Main-2021)**

(A) 7.61 eV

(B) 1.41 eV

(C) 3.3 eV

(D) No photoelectron would be emitted

Ans : (B)

Question

In a photoelectric experiment ultraviolet light of wavelength 280 nm is used with lithium cathode having work function $\phi = 2.5$ eV. If the wavelength of incident light is switched to 400 nm, find out the change in the stopping potential. ($h = 6.63 \times 10^{-34}$ Js, $c = 3 \times 10^{8}$ ms^{-1})

(JEE Main-2021)

(A) 1.3 V

(B) 1.1 V

(C) 1.9 V

(D) 0.6 V

Ans : (A)

Question

In a photoelectric experiment, increasing the intensity of incident light:

(JEE Main-2021)

(A) increases the number of photons incident and also increases the K.E. of the ejected electrons

(B) increases the frequency of photons incident and increases the K.E. of the ejected electrons.

(C) increases the frequency of photons incident and the K.E. of the ejected electrons remains unchanged

(D) increases the number of photons incident and the K.E. of the ejected electrons remains unchanged

Ans : (D)

Question

A monochromatic neon lamp with wavelength of 670.5 nm illuminates a photo-sensitive material which has a stopping voltage of 0.48 V. What will be the stopping voltage if the source light is changed with another source of wavelength of 474.6 nm?

(JEE Main-2021)

(A) 0.96 V

(B) 1.25 V

(C) 0.24 V

(D) 1.5 V

Ans : (B)

Question

A metal exposed to light of wavelength 800 nm and emits photoelectrons with a certain kinetic energy. The maximum kinetic energy of photo-electron doubles when light of wavelength 500 nm is used. The work function of the metal is (take $hc = 1230$ eV-nm)

(JEE Main-2022)

(A) 1.537 eV

(B) 2.46 eV

(C) 0.615 eV

(D) 1.23 eV

Ans : (C)

Question

With reference to the observations in photo-electric effect, identify the correct statement from below :

(A) The square of maximum velocity of photoelectrons varies linearly with frequency of incident light.

(B) The value of saturation current increases on moving the source of light away from the metal surface.

(C) The maximum kinetic energy of photo-electrons decreases on decreasing the power of LED (Light emitting diode) source of light

(D) The immediate emission of photoelectrons out of metal surface cannot be explained by particle nature of light/electromagnetic waves.

(E) Existence of threshold wavelength cannot be explained by wave nature of light/electromagnetic waves.

Choose the correct answer from the options given below: **(JEE Main-2022)**

A (A) and (B) only

B (A) and (E) only

C (C) and (E) only

D (D) and (E) only

Ans : (B)

Question

When light of frequency twice the threshold frequency is incident on the metal plate, the maximum velocity of emitted election is v_1. When the frequency of incident radiation is increased to five times the threshold value, the maximum velocity of emitted electron becomes v_2. If $v_2 = x\ v_1$, the value of x will be _____.

(JEE Main-2022)

Ans : (2)

Question

The light of two different frequencies whose photons have energies 3.8 eV and 1.4 eV respectively, illuminate a metallic surface whose work function is 0.6 eV successively. The ratio of maximum speeds of emitted electrons for the two frequencies respectively will be:

(JEE Main-2022)

A 1 : 1

B 2 : 1

C 4 : 1

D 1 : 4

Ans : (B)

Question

The stopping potential for photoelectrons emitted from a surface illuminated by light of wavelength 6630Å is 0.42 V. If the threshold frequency is $x \times 10^{13}$/s, where x is _____ (nearest integer)

(Given, speed light = 3×10^8 m/s, Planck's constant = 6.63×10^{-34} Js)

(JEE Main-2022)

Ans : (35)

Question

Let K_1 and K_2 be the maximum kinetic energies of photo-electrons emitted when two monochromatic beams of wavelength λ_1 and λ_2, respectively are incident on a metallic surface. If $\lambda_1 = 3\lambda_2$ then :

(JEE Main-2022)

(A) $K_1 > \frac{K_2}{3}$

(B) $K_2 < \frac{K_2}{3}$

(C) $K_1 = \frac{K_2}{3}$

(D) $K_2 = \frac{K_1}{3}$

Ans : (B)

Question

Given below are two statements: One is labelled as Assertion A and other is labelled as Reason R.

Assertion A : The photoelectric effect does not take place, if the energy of the incident radiation is less than the work function of a metal.

Reason R : Kinetic energy of the photoelectrons is zero, if the energy of the incident radiation is equal to the work function of a metal.

In the light of the above statements, choose the most appropriate answer from the options given below.

(JEE Main-2022)

(A) Both A and R are correct and R is the correct explanation of A

(B) Both A and r are correct but R is not the correct explanation of A

(C) A is correct but R is not correct

(D) A is not correct but R is correct

Ans : (B)

Question

The electric filed at the point associated with a light wave is given by $E = 200[\sin(6 \times 10^{15})t + \sin(9 \times 10^{15})t]C = \text{Vm}^{-1}$ If this light falls on a metal surface having a work function of 2.50 eV, the maximum kinetic energy of the photoelectrons will be:

Given : $h = 4.14 \times 10^{-15}$ eVs

(JEE Main-2022)

(A) 1.90 eV

(B) 3.27 eV

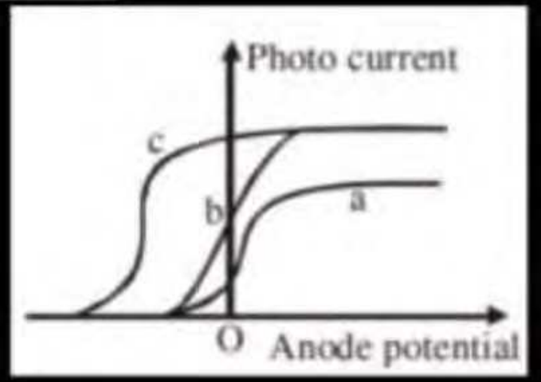
(C) 3.60 eV

(D) 3.42 eV

Ans : (D)

three different radiations. Let I_a, I_b and I_c be the intensities and f_a, f_b and f_c be the frequencies for the curves a, b and c respectively. Choose correct options

(A) $f_a = f_b$ (B) $I_a < I_b$ (C) $f_c < f_b$ (D) $I_c > I_b$



Ans. (A, B, D)