# PRACTICE PAPER 2*

***Time allowed : 2 hours*** ***Maximum marks : 35***

***General Instructions :***

*(i) All questions are compulsory. There are 16 questions in all.*

*(ii) This question paper has five sections: Section A, Section B, Section C, Section D and Section E.*

*(iii) Section A contains five very short answer questions and two assertion reasoning MCQs of 1 mark each. Section B has one case based question of 4 marks, Section C contains four short answer questions of 2 marks each, Section D contains two short answer questions of 3 marks each and Section E contains two long answer questions of 5 marks each.*

*(iv) There is no overall choice. However internal choice is provided. You have to attempt only one of the choices in such questions.*

## SECTION - A

**All questions are compulsory. In case of internal choices, attempt any one of them.**

**1.** Do electromagnetic waves carry energy and momentum?

**2.** The maximum kinetic energy of a photoelectron is 3 eV. What is its stopping potential?

**OR**

What is the difference between kinetic energies of photoelectrons emitted from a surface by light of wavelength 2500 Å and 5000 Å ?

**3.** Two coherent monochromatic light beams of intensities $I$ and $4I$ are superimposed. What is the maximum and minimum possible resulting intensities?

**4.** The 6563 Å $H_\alpha$ line emitted by hydrogen in a star is found to be red-shifted by 15 Å. Find the speed with which the star is receding from the earth.

**OR**

How is the radius of a nucleus related to its mass number $A$?

**5.** How is the speed of em-waves in vacuum determined by the electric and magnetic fields?

**For question numbers 6, 7 two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.**

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

(b) Both A and R are true but R is NOT the correct explanation of A

(c) A is true but R is false

(d) A is false and R is also false

**6.** **Assertion (A) :** Graph of density of nuclei with mass number is a straight line parallel to mass number axis.

**Reason (R) :** Radius of nucleus is directly proportional to the cube root of mass number.

**7.** **Assertion (A) :** Energy is released in nuclear fusion and fission.

**Reason (R) :** In any nuclear reaction the reactants and resultant products obey the law of conservation of mass and energy only.

**The paper is for practice purpose. CBSE has yet not released the official sample paper. So, the pattern is suggestive only. For latest information visit www.cbse.gov.in.*

## SECTION - B

**Questions 8 is a Case Study based question and is compulsory. Attempt any 4 sub parts from this question. Each part carries 1 mark.**

**Fringe Width**

**8.** Distance between two successive bright or dark fringes is called fringe width.

$$\beta = Y_{n+1} - Y_n = \frac{(n+1)\lambda D}{d} - \frac{n\lambda D}{d} = \frac{\lambda D}{d}$$

Fringe width is independent of the order of the maxima. If whole apparatus is immersed in liquid of refractive index $\mu$ then $\beta = \frac{\lambda D}{\mu d}$ (fringe width decreases). Angular fringe width ($\theta$) is the angular separation between two consecutive maxima or minima

$$\theta = \frac{\beta}{D} = \frac{\lambda}{d}$$

**(i)** The maximum number of possible interference maxima for slit separation equal to twice the wavelength in Young's double-slit experiment, is
(a) infinite (b) five (c) two (d) zero

**(ii)** In Young's double – slit experiment if yellow light is replaced by blue light, the interference fringes become
(a) wider (b) brighter (c) narrower (d) darker

**(iii)** In Young's double slit experiment, if the separation between the slits is halved and the distance between the slits and the screen is doubled, then the fringe width compared to the unchanged one will be
(a) Unchanged (b) Halved (c) Doubled (d) Quadrupled

**(iv)** When the complete Young's double slit experiment is immersed in water, the fringes
(a) remain unaltered (b) become wider (c) become narrower (d) disappear

**(v)** In a two slit experiment with white light, a white fringe is observed on a screen kept behind the slits. When the screen is moved away by 0.05 m, this white fringe
(a) does not move at all (b) gets displaced from its earlier position
(c) becomes coloured (d) disappears.

## SECTION - C

**All questions are compulsory. In case of internal choices, attempt anyone.**

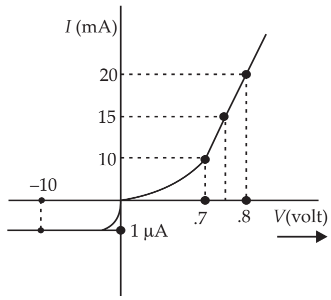
**9.** If light ray with small angle of incidence falls on glass surface having speed of light in glass as 4/5 of speed of light in air, find the angle of deviation after refraction from first surface.

**OR**

Write the relationship between angle of incidence '*i*', angle of prism '*A*' and angle of minimum deviation $\delta_m$ for a triangular prism. A ray of light falling at an angle of 50° is refracted through a prism and suffers minimum deviation. If the angle of prism is 60°, find the angle of minimum deviation.

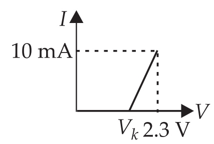
**10.** Draw a plot of potential energy of a pair of nucleons as a function of their separation. Write two important conclusions which you can draw regarding the nature of nuclear forces. A ray of light falling at an angle of incidence of 50° is refracted through a prism and suffers minimum deviation. It the angle of prism is 60° then find the angle of minimum deviation.

**11.** The $V$-$I$ characteristic of a diode is shown in the figure. Find the ratio of forward to reverse bias resistance.




**OR**

Find the resistance of a germanium junction diode whose $V - I$ is shown in figure. ($V_k = 0.3$ V)

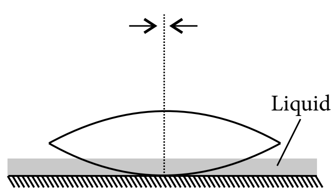



**12.** Three photo diodes $D_1$, $D_2$ and $D_3$ are made of semiconductors having band gaps of 2.5 eV, 2 eV and 3 eV respectively. Which of them will not be able to detect light of wavelength 600 nm?

# SECTION - D

**All questions are compulsory. In case of internal choices, attempt any one.**

**13.** An equiconvex lens with radii of curvature of magnitude $R$ each, is put over a liquid layer poured on top of a plane mirror. A small needle, with its tip on the principal axis of the lens, is moved along the axis until its inverted real image coincides with the needle itself. The distance of the needle from the lens is measured to be $a$. On removing the liquid layer and repeating the experiment the distance is found to be $b$.




Given that two values of distances measured represent the focal length values in the two cases, obtain a formula for the refractive index of the liquid.

**OR**

A compound microscope uses an objective lens of focal length 4 cm and eye lens of focal length 10 cm. An object is placed at 6 cm from the objective lens
(a) Calculate the length of the compound microscope.
(b) Calculate magnifying power of the compound microscope, if the final image is formed at the near point.

**14.** In a full wave junction diode rectifier the input ac has rms value of 20 V. The transformer used is a step up transformer having primary and secondary turn ratio 1 : 2. What would be the dc voltage in the rectified output?

# SECTION - E

**All questions are compulsory. In case of internal choices, attempt any one.**

**15.** (a) Draw a ray diagram to show the formation of the image of an object placed on the axis of a convex refracting surface of radius of curvature '$R$', separating the two media of refractive indices '$n_1$' and '$n_2$' ($n_2 > n_1$). Use this diagram to deduce the relation $\frac{n_2}{v}-\frac{n_1}{u}=\frac{n_2-n_1}{R}$, where $u$ and $v$ represent respectively the distance of the object and the image formed.

(b) A convex lens of focal length $f_1$ is kept in contact with a concave lens of focal length $f_2$. Find the focal length of the combination.

**OR**

(a) Draw a ray diagram showing the image formation by an astronomical telescope when the final image is formed at infinite.

(b) (i) A small telescope has an objective lens of focal length 140 cm and an eyepiece of focal length 5.0 cm. Find the magnifying power of the telescope for viewing distant objects when the telescope is in normal adjustment and the final image is formed at the least distance of distinct vision.

(ii) Also find the separation between the objective lens and the eyepiece in normal adjustment.

**16.** (a) How does one explain the emission of electrons from a photosensitive surface with the help of Einstein's photoelectric equation?

(b) The work function of the following metals is given : Na = 2.75 eV, K = 2.3 eV, Mo = 4.17 eV and Ni = 5.15 eV. Which of these metals will not cause photoelectric emission for radiation of wavelength 3300 Å from a laser source placed 1 m away from these metals? What happens if the laser source is brought nearer and placed 50 cm away?

**OR**

(a) Draw a graph showing the variation of stopping potential with frequency of incident radiation for two photosensitive materials having work functions $W_1$ and $W_2 (W_1 > W_2)$. Write two important conclusions that can be drawn from the study of these plots.

(b) Draw a plot showing the variation of photoelectric current with collector plate potential for two different frequencies, $\upsilon_1 > \upsilon_2$, of incident radiation having the same intensity. In which case will the stopping potential be higher? Justify your answer.

## ANSWERS

**1.** Yes, electromagnetic waves carry energy and momentum.

**2.** $\frac{1}{2}mv_{max}^2 = 3\text{ eV}$ or $eV_0 = 3\text{ eV}$ or $V_0 = 3\text{ V}$.

**OR**

$$\Delta E=\frac{hc}{\lambda_1}-\frac{hc}{\lambda_2}=\frac{hc(\lambda_2-\lambda_1)}{\lambda_1\lambda_2}\ (\text{in eV})$$

$$=\frac{6\cdot62\times10^{-34}\times3\times10^{8}\times(5000-2500)\times10^{-10}}{2500\times5000\times10^{-20}\times1\cdot6\times10^{-19}}$$

= 2.48 eV

**3.** The maximum and minimum intensities are given by $(a+b)^2$ and $(a-b)^2$ for the superposition of two coherent sources. $a$, $b$ are amplitudes of superposing waves.

Let $\sqrt{I}=x$

The amplitude $a=\sqrt{I}=x,\ b=\sqrt{4I}=2x$

$\therefore$ Maximum intensity = $(a+b)^2 = 9x^2 = 9I$

Minimum intensity = $(a-b)^2 = x^2 = I$

**4.** Wavelength of $H_\alpha$ line, $\lambda$ = 6563 Å = $6563\times10^{-10}$ m

Red shift observed in star is

$(\lambda'-\lambda) = 15\text{ Å} = 15\times10^{-10}$ m

and speed of light, $c = 3 \times 10^8$ m s$^{-1}$
Let the velocity of the star with which it is receding away from the earth be $v$

$\therefore$ Red shift relation

$$\lambda' - \lambda = \frac{v}{c}\lambda$$

$$\therefore \quad v = \frac{c}{\lambda} \times (\lambda' - \lambda) = \frac{3\times10^8 \times 15\times10^{-10}}{6563\times10^{-10}} = 6.86\times10^5 \text{ m s}^{-1}$$

**OR**

The volume of the nucleus is directly proportional to the number of nucleons (mass number) constituting the nucleus.

$\frac{4}{3}\pi R^3 \propto A$ Where $R \rightarrow$ radius

$R \propto A^{1/3}$ $A \rightarrow$ Mass number

$R = R_0 A^{1/3}$

**5.** The speed of em-waves in vacuum determined by the electric ($E_0$) and magnetic fields ($B_0$) as, $c = \frac{E_0}{B_0}$

**6.** (a) : Experimentally, it is found that the average radius of a nucleus is given by

$R = R_0 A^{1/3}$ where $R_0 = 1.1 \times 10^{-15}$ m = 1.1 fm
and $A$ = mass number

The volume of a nucleus is $V = \frac{4}{3}\pi R^3 = \frac{4}{3}\pi R_0^3 A$.

Now as the masses of a proton and a neutron are roughly equal, say $m$, the mass of a nucleus is also roughly proportional to the mass number $A$, $M = mA$ Hence density within a nucleus, $\rho = \frac{M}{V} = \frac{mA}{\frac{4}{3}\pi R_0^3 A} = \frac{m}{\frac{4}{3}\pi R_0^3}$

is independent of the mass number $A$.

**7. (c) :** In both fission and fusion large amounts of energy is released. The reason is correct. Charge, mass, momentum and energy, all are conserved.

**8. (i) (b) :** The condition for possible interference maxima on the screen is, $d\sin\theta = n\lambda$
where $d$ is slit separation and $\lambda$ is the wavelength.
As $d = 2\lambda$ (given) $\therefore$ $2\lambda\sin\theta = n\lambda$ or $2\sin\theta = n$
For number of interference maxima to be maximum, $\sin\theta = 1$ $\therefore$ $n = 2$
The interference maxima will be formed when
$n = 0, \pm 1, \pm 2$
Hence the maximum number of possible maxima is 5.

**(ii) (c) :** Fringe width, $\beta = \frac{\lambda D}{d}$

$\therefore$ If we replace yellow light with blue light, *i.e.*, longer wavelength with shorter one, therefore the fringe width decreases.

**(iii) (d) :** $d' = \frac{d}{2}$ and $D' = 2D$

Fringe width, $\beta = \frac{\lambda D}{d}$

New fringe width $\beta' = \lambda\left(\frac{2D}{d/2}\right) = 4\beta$

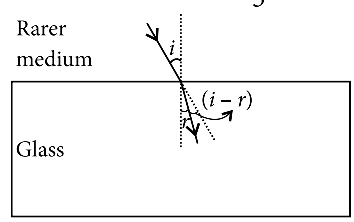
**(iv) (c) :** When Young's double slit experiment is repeated in water, instead of air. $\lambda' = \frac{\lambda}{\mu}$, *i.e.*, wavelength decreases. $\beta = \frac{\lambda' D}{d}$, *i.e.*, fringe width decreases.

$\therefore$ The fringe become narrower.

**(v) (a) :** Using white light, we get white fringe at the centre *i.e.*, white fringe is the central maximum. When the screen is moved, its position is not changed.

**9.** Let velocity of light in rarer medium be $v$.

Then velocity of light in glass is $\frac{4v}{5}$.




$\therefore$ Refractive index of glass with respect to given rarer medium is $\mu = \frac{v}{4v/5} = \frac{5}{4}$

From Snell's law, $\mu = \frac{\sin i}{\sin r} \approx \frac{i}{r}$

($\because$ for small angles, $\sin\theta \approx \theta$)

$\therefore$ $\frac{i}{r} = \frac{5}{4}$ or $r = \frac{4i}{5}$

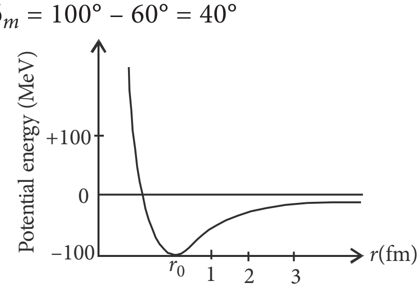
$\therefore$ Angle of deviation $= i - r = i - \frac{4i}{5} = \frac{i}{5}$

**OR**

The relation between the angle of incidence $i$, angle of prism $A$, and the angle of minimum deviation $\delta_m$, for a triangular prism is given by, $i = \frac{A + \delta_m}{2}$

$A + \delta_m = 100°$
$\delta_m = 100° - 60° = 40°$

**10.**



From the above plot, following conclusions can be drawn.

(i) Nuclear forces are short range forces.

(ii) For a separation greater than $r_0$, the nuclear forces are attractive and for separation less than $r_0$, the nuclear forces are strongly repulsive.

**11.** Forward bias resistance,

$$R_1 = \frac{\Delta V}{\Delta I_{for}} = \frac{0.8-0.7}{(20-10)\times10^{-3}} = \frac{0.1}{10\times10^{-3}} = 10$$

Reverse bias resistance, $R_2 = \frac{10}{1\times10^{-6}} = 10^7$

then, the ratio of forward to reverse bias resistance,

$$\frac{R_1}{R_2} = \frac{10}{10^7} = 10^{-6}$$

**OR**

From graph,

Resistance of the germanium junction diode,

$$R = \frac{\Delta V}{\Delta I} = \frac{2.3\text{ V}-0.3\text{ V}}{10\text{ mA}-0} = \frac{2\text{ V}}{10\times10^{-3}\text{ A}} = 0.2\text{ k}\Omega$$

**12.** Given, $\lambda = 600$ nm $= 6\times10^{-7}$ m

$$E = \frac{hc}{\lambda} = \frac{6.6\times10^{-34}\times3\times10^{8}}{6\times10^{-7}\times1.6\times10^{-19}}\text{ eV} = 2.06\text{ eV}$$

As, energy gaps of diodes $D_1$ and $D_3$ are greater than the given energy of the incident radiation. Hence diodes $D_1$ and $D_3$ will not be able to detect light of wavelength 600 nm.

**13.** Clearly, equivalent focal length of equiconvex lens and water lens $f = a$

Focal length of equiconvex lens, $f_1 = b$

Focal length $f_2$ of water lens is given by

$$\frac{1}{f_2} = \frac{1}{f} - \frac{1}{f_1} = \frac{1}{a} - \frac{1}{b} = \frac{b-a}{ab} \text{ or } f_2 = \frac{ab}{b-a}$$

The water lens formed between the plane mirror and the equiconvex lens is a planoconcave lens. For this lens,

$R_1 = -R$ and $R_2 = \infty$

Using lens maker's formula,

$$\frac{1}{f_2} = (\mu-1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$$

or $\frac{b-a}{ab} = (\mu-1)\left[\frac{1}{-R} - \frac{1}{\infty}\right]$ or $\mu = 1 + \frac{(a-b)R}{ab}$

**OR**

(a) For object lens : $f_0 = +4$ cm and $u_0 = -6$ cm

$$\frac{1}{f} = \frac{1}{v_0} - \frac{1}{u_0} \text{ or } \frac{1}{v_0} = \frac{1}{f_0} + \frac{1}{u_0} = \frac{1}{4} - \frac{1}{6} = \frac{1}{12}$$

or $v_0 = +12$ cm

For eye lens : $f_e = +10$ cm and $v_e = -25$ cm

$$\frac{1}{f_e} = \frac{1}{v_e} - \frac{1}{u_e} \text{ or } \frac{1}{u_e} = \frac{1}{v_e} - \frac{1}{f_e} = -\frac{1}{25} - \frac{1}{10} = \frac{-7}{50}$$

or $u_e = -7.14$ cm

Length of microscope tube is,

$L = |v_0| + |u_e| = 12 + 7.14 = 19.14$ cm

(b) Magnifying power of microscope is,

$$M = -\frac{L}{f_0}\left(1 + \frac{D}{f_e}\right)$$

or $M = -\frac{19.14}{4}\left(1 + \frac{25}{10}\right) = -4.785\times3.5$

or $M = -16.75$

**14.** Here, input $V_{rms} = 20$ V

Peak value of input voltage

$$V_o = \sqrt{2}\,V_{rms} = \sqrt{2}\times20 = 28.28\text{ V}$$

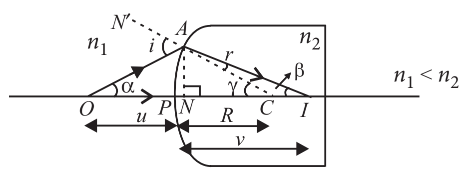
Since the transformer is a step up transformer having transformer ratio 1 : 2, the maximum value of output voltage of the transformer applied to the diode will be

$$V_0' = 2\times V_o = 2\times28.28\text{ V}$$

$\therefore$ dc voltage $= \frac{2V_0'}{\pi} = \frac{2\times2\times28.28}{22/7} = 36$ V

**15.** (a) Refraction at convex spherical surface

When object is in rarer medium and image formed is real.




In $\Delta OAC$, $i = \alpha + \gamma$

and in $\Delta AIC$, $\gamma = r + \beta$ or $r = \gamma - \beta$

$\therefore$ By Snell's law, ${}^1n_2 = \frac{\sin i}{\sin r} \approx \frac{i}{r} = \frac{\alpha+\gamma}{\gamma-\beta}$

or $\frac{n_2}{n_1} = \frac{\alpha+\gamma}{\gamma-\beta}$ or $n_2\gamma - n_2\beta = n_1\alpha + n_1\gamma$

or $(n_2 - n_1)\gamma = n_1\alpha + n_2\beta$ ...(i)

As $\alpha$, $\beta$ and $\gamma$ are small and $P$ and $N$ lie close to each other,

So, $\alpha \approx \tan\alpha = \frac{AN}{NO} \approx \frac{AN}{PO}$

$$\beta \approx \tan\beta = \frac{AN}{NI} \approx \frac{AN}{PI}$$

$$\gamma \approx \tan\gamma = \frac{AN}{NC} \approx \frac{AN}{PC}$$

On using them in equation (i), we get

$$(n_2 - n_1)\frac{AN}{PC} = n_1 \frac{AN}{PO} + n_2 \frac{AN}{PI}$$

or $$\frac{n_2 - n_1}{PC} = \frac{n_1}{PO} + \frac{n_2}{PI}$$

where, $PC = + R$, radius of curvature

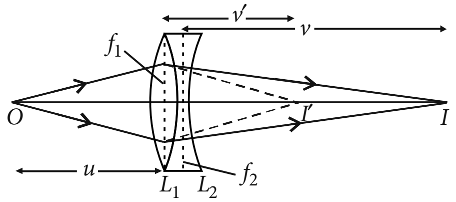
$PO = - u$, object distance

$PI = + v$, image distance

So, $\frac{n_2 - n_1}{R} = \frac{n_1}{-u} + \frac{n_2}{v}$ or $\frac{n_2 - n_1}{R} = \frac{n_2}{v} - \frac{n_1}{u}$

This gives formula for refraction at spherical surface when object is in rarer medium.

(b)




For convex lens

$$\frac{1}{f_1} = \frac{1}{v'} - \frac{1}{u} \quad ...(i)$$

For concave lens ($f_2$ = –ve)

$$-\frac{1}{f_2} = \frac{1}{v} - \frac{1}{v'} \quad ...(ii)$$

Adding equations (i) and (ii)

$$\frac{1}{f_1} - \frac{1}{f_2} = -\frac{1}{u} + \frac{1}{v}$$

Also, $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

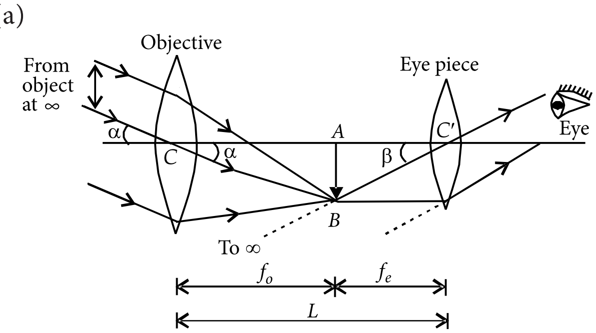
where $f$ = focal length of combination

$$\therefore \quad \frac{1}{f_1} - \frac{1}{f_2} = \frac{1}{f}$$

So, $f = \frac{f_1 f_2}{f_2 - f_1}$

**OR**

(a)




(b) (i) Given $f_0$ = 140 cm, $f_e$ = 5 cm

When final image is at infinity, magnifying power,

$$m = \frac{-f_0}{f_e} = -\frac{140}{5.0}$$

$m = -28$

Negative sign shows that the image is inverted.

When final image is at the least distance of distinct vision,

magnifying power, $m = \frac{-f_0}{f_e}\left(1 + \frac{f_e}{D}\right)$

$$= \frac{-140}{5.0}\left(1 + \frac{5.0}{25}\right) = -33.6$$

(ii) Separation between objective and eyepiece when final image is formed at infinity,

$L = f_0 + f_e$

$L$ = 140 cm + 5.0 cm = 145 cm

**16.** (a) The Einstein's photoelectric equation is given as

$K_{max} = h\upsilon - \phi_0$

Since $K_{max}$ must be non-negative implies that photoelectric emission is possible only if $h\upsilon > \phi_0$

or $\upsilon_f > \upsilon_0$ where $\upsilon_0 = \frac{\phi_0}{h}$,

This shows that the greater the work function $\phi_0$, higher the threshold frequency $\upsilon_0$ needed to emit photoelectrons. Thus, there exists a threshold frequency $\upsilon_0 = \frac{\phi_0}{h}$ for the metal surface, below which no photoelectric emission is possible.

(b) Condition for photo electric emission,

$h\upsilon > \phi_0$

or $\frac{hc}{\lambda} > \phi_0$

for $\lambda$ = 3300 Å

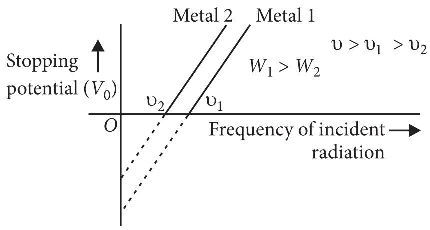
$$\frac{hc}{\lambda} = \frac{1.989 \times 10^{-25}}{3300 \times 10^{-10}} = \frac{6.03 \times 10^{-19}}{1.6 \times 10^{-19}} = 3.77 \text{ eV}$$

$\therefore$ Mo and Ni will not cause photoelectric emission.

If the laser source is brought nearer and placed 50 cm away, then photoelectric emission will not effect, since it depends upon the work function and threshold frequency.

**OR**

(a) The graph showing the variation of stopping potential ($V_0$) with the frequency of incident radiation ($\upsilon$) for two different photosensitive materials having work functions $W_1$ and $W_2$ ($W_1 > W_2$) is shown in figure.




(i) Slope of the line $= \frac{\Delta V}{\Delta \upsilon} = \frac{h}{e}$ $[\because e\Delta V = h\Delta\upsilon]$

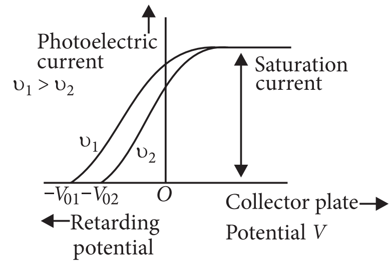
$\therefore$ Slope of the line $= \frac{h}{e}$ *i.e.*, it is a constant quantity and does not depend on nature of metal surface.

(ii) Intercept of graph 1 on the stopping potential axis

$= \frac{\text{work function}(W)}{e} = -\frac{h\upsilon_0}{e}$

$\therefore$ Intercept of the line depends upon the stopping function of the metal surface.

(b) The stopping potential is more negative for higher frequencies of incident radiation. Therefore, stopping potential is higher for $\upsilon_1$.




$(KE)_{max} = eV_0 = h\upsilon - \phi$

$\Rightarrow V_0 = \frac{h}{e}\upsilon - \frac{\phi}{e}$

From this equation we can conclude that $V_0$ will increase if $\upsilon$ increases.

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