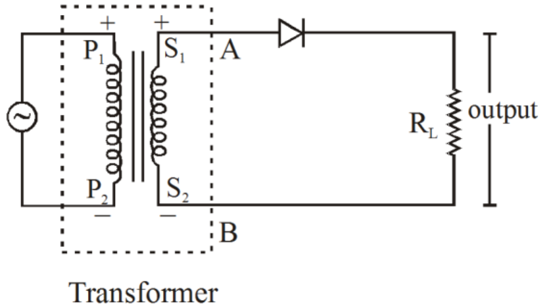
CBSE PRACTICE PAPER
CLASS XII
PHYSICS THEORY (SOLUTION)
TERM II
SESSION 2021 – 22

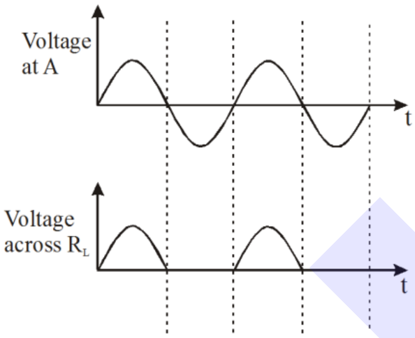
MM : 35 **TIME : 2 Hours**

SECTION-A

1. 

[1]

Half-wave rectifier :- Diode conducts during positive half cycle & does not conduct during negative half cycle. Hence ac is converted into unidirectional pulsating DC by diode. **[1]**



2. Given ground state energy $E_0 = -13.6$ eV

Energy in the first excited state = $E_1 = \dfrac{-13.6\,\text{eV}}{(2)^2} = -3.4$ eV

We know that, the de Broglie wavelength $\lambda = \dfrac{h}{mv} = \dfrac{h}{p} = \dfrac{h}{\sqrt{2mE}}$

But, $\dfrac{1}{2}mv^2 = E_1$ or $v = \sqrt{\dfrac{2E_1}{m}}$

$$\therefore \lambda = \frac{h}{m\sqrt{\dfrac{2E_1}{m}}}$$

$$\therefore \lambda = \frac{h}{\sqrt{2mE_1}} = \frac{6.63\times10^{-34}}{\sqrt{2\times(9.1\times10^{-31})(3.4\times1.6\times10^{-19})}}$$

$$\lambda = \frac{6.63\times10^{-34}}{9.95\times10^{-25}} = 6.6\times10^{-10}\,\text{m}$$ **[2]**

OR

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

(i) α–particle : $\frac{h}{\sqrt{2q_\alpha V m_\alpha}} = \lambda_\alpha$

proton : $\frac{h}{\sqrt{2q_p V m_p}} = \lambda_p$

Clearly, $\lambda_p > \lambda_\alpha$ as $m_\alpha > m_p$ & $q_\alpha > q_p$.

So, proton has greater de-Broglie wavelength. **[1]**

(ii) As $\frac{1}{2}mv^2 = qV$

$(K.E.)_p < (K.E.)_\alpha$ as $q_p < q_\alpha$.

So, proton has less K.E. **[1]**

3. (a) The current at 1 volt is 10 mA and at 1.2 volt it is 15 mA. The dynamic resistance in this region is $R = \frac{\Delta V}{\Delta i} = \frac{0.2\,\text{volt}}{5\,\text{mA}} = 40\ \Omega$ **[1]**

(b) The current at 2 volt is 400 mA and at 2.1 volt it is 800 mA. The dynamic resistance in the region is

$R = \frac{\Delta V}{\Delta i} = \frac{0.1\ \text{volt}}{400\,\text{mA}} = 0.25\ \Omega$. **[1]**

SECTION-B

4. Acc. to Rutherford nuclear model of the atom, the electrostatic force of attraction F_e between the revolving electron & the nucleus provides the requisite centripetal force (F_C).

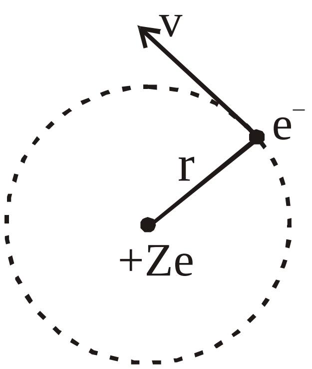
Thus, $F_C = F_e$

$$\frac{mv^2}{r} = \frac{1}{4\pi\varepsilon_0}\cdot\frac{e^2}{r^2} \quad (\because\ z = 1)$$

Thus the relation between the orbit radius and the e^- velocity is, $r = \frac{e^2}{4\pi\varepsilon_0 mv^2}$

The K.E. (K) & electrostatic potential energy (U) of electron in hydrogen atom are –

$K = \frac{1}{2}mv^2 = \frac{e^2}{8\pi\varepsilon_0 r}$



& $U = \frac{-e^2}{4\pi\varepsilon_0 r}$ (–ve sign shows, that nature of force is attractive)

Thus, the total mech. energy E of an e^- is,

$E = K + U = \frac{e^2}{8\pi\varepsilon_0 r} - \frac{e^2}{4\pi\varepsilon_0 r} = \frac{-e^2}{8\pi\varepsilon_0 r}$

Total energy (E) is –ve which shows that e^- is bound to the nucleus, if (E) were +ve then e^- would leave the the atom. **[3]**

5. (i) Solar cell works on the same principle (photovoltaic effect) as the photodiode, except that no external bias is applied & the junction area is kept larger for solar radiation to get more power.

Three basic processes involved in the generation of emf.

(a) generation of e-h pairs due to incident light ($h\upsilon > Eg$)

(b) separation of electrons & holes due to $\vec{E}$ of depletion region.

(c) electrons reaching the n-side are collected by the front contact & holes are collected at p side giving rise to photo-voltage. **[1½]**

(ii) Si & Ga As are preferred material because .

(a) Band gap (~ 1.0 to 1.8 eV)

(b) High optical absorption (10^4 cm^{-1})

(c) Electrical conductivity

(d) Availability of raw material

(e) Low cost. **[1½]**

6. The number of atoms in 1kg of $_{94}Pu^{239}$

$= \frac{6.023 \times 10^{23} \times 1000}{239}$

Energy released per fission = 180 MeV

Energy released by 1 kg of $_{94}Pu^{239}$

$= \frac{6.023 \times 10^{23} \times 1000}{239} \times 180 MeV$

$= 4.53 \times 10^{26}$ MeV **[3]**

7. Given, $y_1 = a\cos\omega t$, $y_2 = a\cos(\omega t + \phi)$

(a) Resultant displacement is given as :

$y = y_1 + y_2$

$= a\cos\omega t + a\cos(\omega t + \phi)$

$= a\cos\omega t + a\cos\omega t\cos\phi - a\sin\omega t\sin\phi$

$= a\cos\omega t(1 + \cos\phi) - a\sin\omega t\sin\phi$

Put $R\cos\theta = a(1 + \cos\phi)$ .....(i)

$R\sin\theta = a\sin\phi$ ....(ii)

By squaring & adding Eqs. (i) & (ii), we get

$R^2 = a^2(1+\cos^2\phi + 2\cos\phi) + a^2\sin^2\phi = 2a^2(1 + \cos\phi) = 4a^2\cos^2\phi/2$

$\therefore I = R^2 = 4a^2\cos^2\frac{\phi}{2} = 4I_0\cos^2\frac{\phi}{2}$ **[1½]**

(b) For constructive interference,

$\cos\frac{\phi}{2} = \pm 1$ or

$\frac{\phi}{2} = n\pi$ or

$\phi = 2n\pi$

For destructive interference,

$\cos\frac{\phi}{2} = 0$ or

$\frac{\phi}{2} = (2n + 1)\frac{\pi}{2}$ or

$\phi = (2n + 1)\pi$ **[1½]**

8. **(a)** Lens maker's formula, $\frac{1}{f} = (n-1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$

Assumptions –

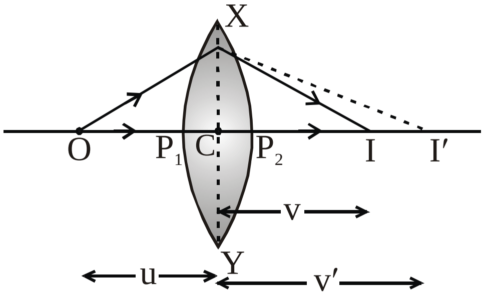
(a) Lens is considered as a thin lens.

(b) Object is a point object which is situated on the principal axis.

(c) Aperture of the lens is small.

(d) Incident & refracted ray makes small angle with pricipal axis.

Consider a thin convex lens of absolute refractive index n_2 placed in rarer medium of absolute refractive index n_1. Also R_1 & R_2 are the radii of curvature of surfaces XP_1Y & XP_2Y resp.



For refraction at surface XP_1Y : 'O' is the object & I' is its real image.

using formula, $\frac{n_2}{v}-\frac{n_1}{u}=\frac{n_2-n_1}{R}$ we get,

$$\frac{n_2}{v'}-\frac{n_1}{u}=\frac{n_2-n_1}{R_1} \qquad ....(1)$$

For refraction at surface XP_2Y :

I' is the virtual object & I is its real image (final image).

Using formula $\frac{n_1}{v}-\frac{n_2}{u}=\frac{n_1-n_2}{R}$

$$\frac{n_1}{v}-\frac{n_2}{v'}=\frac{n_1-n_2}{R_2} \qquad ....(2)$$

Adding equations (1) & (2), we get

$$n_1\left(\frac{1}{v}-\frac{1}{u}\right)=(n_2-n_1)\left[\frac{1}{R_1}-\frac{1}{R_2}\right]$$

$$\frac{1}{v}-\frac{1}{u}=\frac{n_2-n_1}{n_1}\left[\frac{1}{R_1}-\frac{1}{R_2}\right]$$

or $$\frac{1}{f}=\frac{1}{v}-\frac{1}{u}=\left(\frac{n_2}{n_1}-1\right)\left[\frac{1}{R_1}-\frac{1}{R_2}\right]$$

or $$\frac{1}{f}=(n-1)\left[\frac{1}{R_1}-\frac{1}{R_2}\right] \qquad \boxed{\because \frac{n_2}{n_1}=n_{21}=n}$$ **[2]**

(b) The refractive index of the liquid must be equal to refractive index of the lens for lens disappear in a liquid. i.e. $n_1 = n_2 = 1.47$ so refractive index of the liquid is 1.47.

Then, $n = \frac{n_2}{n_1} = 1$

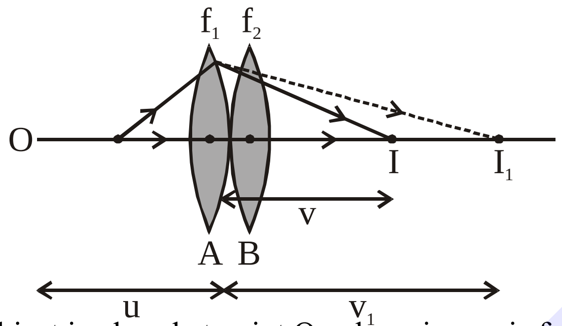
Now from lens maker's formula $\frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

$\frac{1}{f} = (1-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) \Rightarrow \frac{1}{f} = 0$ then $f = \infty$

So the lens in the liquid will act like a plane sheet of glass. **[1]**

OR

(a)



Object is placed at point O, whose image is formed at I_1 by first lens. As image I_1 is real, it works as a virtual object for second lens B, producing the final image at I.

Since the lenses are thin, assume the optical centres to be coincident. Let this central point is P.

For the image formed by the lens A,

$$\frac{1}{v_1} - \frac{1}{u} = \frac{1}{f_1} \quad \text{....(1)}$$

Similarly, for the lens B,

$$\frac{1}{v} - \frac{1}{v_1} = \frac{1}{f_2} \quad \text{....(2)}$$

Add (1) & (2) we get,

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

If two lens system is taken as equivalent to a single lens of focal length f, we get,

$$P = \frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2} \quad \text{....(3)}$$

In term of power, equation (3) can be written as,

$P = P_1 + P_2$ **[2]**

where P is the net power of this combination.

(b) Focal length of convex lens $f_1 = 30$ cm focal length of concave lens $f_2 = -20$ cm

Equivalent focal length of combination

$$\frac{1}{f}=\frac{1}{f_1}+\frac{1}{f_2} \Rightarrow \frac{1}{f}=\frac{1}{30}-\frac{1}{20}$$

$$\frac{1}{f}=-\frac{1}{60} \Rightarrow f=-60 \text{ cm}$$ **[1]**

The system is diverging.

9. (a) $E_{photon}=\frac{hc}{\lambda}$ ....(1)

$E_{electron}=\frac{h^2}{2m\lambda^2}$ ....(2) $\left(\because \lambda=\frac{h}{\sqrt{2mE_{electron}}}\right)$

Dividing (1) by (2), $\frac{E_{photon}}{E_{electron}}=\frac{2mc\lambda}{h}$ **[1½]**

(b) Intensity of radiation is defined as the energy associated with number of photons incident/emitted from a unit surface area in unit time.

i.e. Intensity $=\frac{\text{Energy}}{\text{Area}\times\text{Time}}$

S.I. Unit :- $\frac{\text{Joule}}{m^2-s}$ or watt $-m^{-2}$ **[1½]**

10. (a) Given : $\mu_1=1$, $\mu_2=1.5$, R = 20 cm, u = –100 cm

from $\frac{\mu_2}{v}-\frac{\mu_1}{u}=\frac{\mu_2-\mu_1}{R}$

$$\frac{1.5}{v}-\frac{1}{-100}=\frac{0.5}{20}$$

$$\frac{1.5}{v}=\frac{5}{200}-\frac{1}{100}=\frac{3}{200}$$

or v = 100 cm **[1½]**

(b) Given, $\delta_m = A$

from $\mu=\frac{\sin\left(\frac{A+\delta_m}{2}\right)}{\sin(A/2)} \Rightarrow \frac{\sqrt{3}}{1}=\frac{\sin\left(\frac{A+A}{2}\right)}{\sin(A/2)}=\frac{\sin A}{\sin A/2}$

$\Rightarrow \sqrt{3}=\frac{(2\sin A/2)(\cos A/2)}{\sin A/2}=\cos A/2 \Rightarrow \cos 30^\circ=\cos A/2 \Rightarrow 30^\circ = A/2$

$\boxed{A=60^\circ}$ **[1½]**

11. (a) Different waves of e.m.w. spectrum in ascending order of frequency :

Radio-waves, Microwaves, Infra-red, Visible, Ultra-violet, X-ray, gamma-ray. **[1]**

(b) **(i) Microwaves :** It is used in microwave oven for cooking purpose.

(ii) Infra-red waves : It is used in weather forecasting. **[1]**

(c) (i) Electromagnetic waves do not require any material medium for propagating.

(ii) These waves travel in free space with the speed of light. (3×10^8 m/s).

(iii) Electromagnetic waves are transverse in nature. **[1]**

(iv) Electromagnetic waves being unchanged are not deflected by electric and magnetic fields.

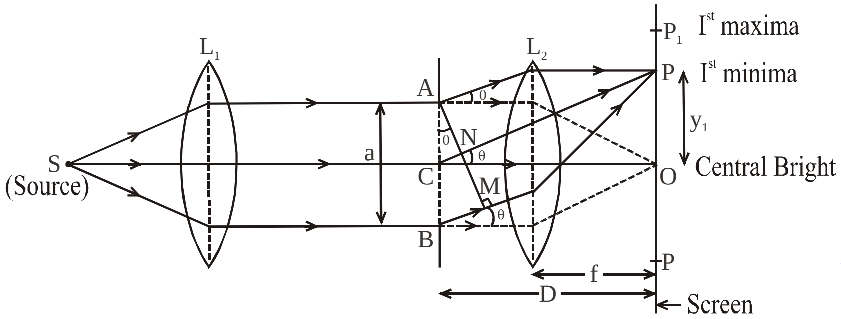
OR

Diffraction of light– The phenomenon of bending of light waves around corners or edges of aperture or obstacle is called diffraction of light. For diffraction of light waves, the size of aperture or obstacle is comparable to wavelength of light waves. **[½]**

$\boxed{a \approx \lambda}$

a ⇒ size of aperture or obstacle

Single slit diffraction :



If lens L_2 is very close to slit AB then $(D \approx f)$

Light rays from source S incident on lens L_1 it becomes parallel and plane wavefront is obtained. When plane wavefront is incident on single slit AB, after diffraction from AB, diffraction pattern will be obtained on screen.

Position of Ist minima– If the path difference between extreme rays from AB is λ at point P on the screen, then destructive interference will take place & first minima will be obtained.

Path difference,

$BM = a\sin\theta$

$a\sin\theta = \lambda$

If θ is very small, then $(\sin\theta \approx \theta)$

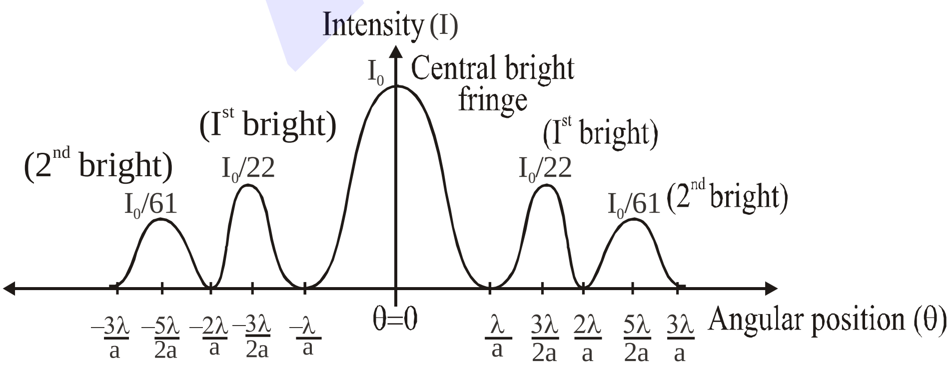
$a\theta = \lambda \Rightarrow \boxed{\theta = \lambda/a}$

Where, θ ⇒ angular position of first minima **[2]**

Intensity distribution graph :-

In Fraunhofer diffraction intensity is given by

$$I = \left[\frac{2}{(2n+1)\pi}\right]^2 I_0$$



[2]

SECTION-C

CASE STUDY

12. (i) (b)

Here, $f_0 = 2.0$, $f_e = 6.25$ cm, $u_0 = ?$

When the final image is obtained at the least distance of distinct vision : $v_e = -25$ cm

As $\frac{1}{v_e} - \frac{1}{u_e} = \frac{1}{f_e}$

$\therefore \frac{1}{u_e} = \frac{1}{v_e} - \frac{1}{f_e} = \frac{1}{-25} - \frac{1}{6.25}$

$= \frac{-1-4}{25} = \frac{-5}{25} = -\frac{1}{5}$

or $u_e = -5$ cm **[1]**

(ii) (b)

Distance between objective and eye-piece = 15 cm.

Distance of the image from objective is

$v_0 = 15 - 5 = 10$ cm

or $u_0 = -\frac{5}{2} = -2.5\,\text{cm}$

$\therefore$ Distance of object from objective = 2.5 cm **[1]**

(iii) (a) Magnifying power,

$$m = m_0 \times m_e = \frac{v_0}{u_0}\left(1 + \frac{D}{f_e}\right) = \frac{10}{2.5}\left(1 + \frac{25}{6.25}\right) = 20$$ **[1]**

(iv) (a)

The intermediate image formed by the objective of a compound microscope is real, inverted and magnified. **[1]**

(v) (d) **[1]**