Mock Board Exam
ISC SEMESTER 2 EXAMINATION
PHYSICS

SECTION A

Answer 1:

(i) Plane and convex mirrors can produce real images as well. If the object is virtual, i.e., if the light rays converging at a point behind a plane mirror (or a convex mirror) are reflected to a point on a screen placed in front of the mirror, then a real image will be formed.

(ii) The angular momentum (L) of an electron in a Bohr orbit is given as $L = \frac{nh}{2\pi}$. It is an integral multiple of $\frac{h}{2\pi}$.

For example, in first Bohr orbit, the angular momentum of electron is $L = \frac{h}{2\pi}$.

In second Bohr orbit, the angular momentum of electron is $L = \frac{2h}{2\pi} = \frac{h}{\pi}$.

(iii) **Advantages of Newtonian Telescope are**

- They are free of **chromatic aberration** found in refracting telescopes.
- Newtonian telescopes are usually less expensive for any given objective diameter (or **aperture**) than comparable quality telescopes of other types.
- Since there is only one surface that needs to be ground and polished into a complex shape, overall fabrication is much simpler than other telescope designs (**Gregorian's**, **Cassegrain's**, and early refractors had two surfaces that need **figuring**. Later **achromatic** refractor objectives had four surfaces that have to be figured).
- A short **focal ratio** can be more easily obtained, leading to wider **field of view**.
- The eyepiece is located at the top end of the telescope. Combined with short **f-ratios** this can allow for a much more compact mounting system, reducing cost and adding to portability.

(iv) Ans: B

In fission process, some energy will be used in breaking the nucleus of X. So, binding energy relation will be $E_Y + E_z > E_x$

(v) Ans: B

A simple Microscope uses a convex lens for magnification.

When we place the object inside the focal point (f) of the lens, then a virtual, erect and magnified image is formed at a near point ($D = 25$ cm) from the eye.

The linear magnification $m = \frac{v}{u}$

Where v is the image distance and u is the object distance from the lens.

Using Lens formula

$1/f = 1/v - 1/u$

$m = v(1/v - 1/f)$

$m = 1 - (v/f)$

$m = 1 + (D/f)$

(vi) Ans: B

When the object is kept at the far point, its image will form on the retina.

Let the far point of the person be x

So, $u = -x$ cm, $v = 2.00$ cm and $f = 1.96$ cm

Using lens formula,

$1/f = 1/v - 1/u$

$\Rightarrow 1/1.96 = 1/2.0 - 1/(-x)$

$x = 98$ cm

(vii) For α −decay: ${}_{x}A^{y} \rightarrow {}_{x-2}B^{y-4} + \alpha$

For β^- −decay: ${}_{x}A^{y} \rightarrow {}_{x-1}B^{y} + {}_{-1}\beta^{0}$

For β^+decay: ${}_{x}A^{y} \rightarrow {}_{x-1}B^{y} + {}_{1}\beta^{0}$

For K −capture, there will be no change in the number of protons. Hence, only case in which number of protons increases is β^-decay.

SECTION B

Answer 2:

De-Broglie wave length is $\lambda = \frac{h}{\sqrt{2mE}}$ ... (i)

Where, E is the kinetic energy of the electron. The cut-off wave length is $\lambda_0 = \frac{hc}{E}$

From equation (i):

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

Hence, $\lambda_0 = \frac{2mc\lambda^2}{h}$

Answer 3:

(i) Cadmium and boron are used as control rods. They absorb an excess number of thermal neutrons released and bring the fission reaction under control.

(ii) The function of moderators is to slow down the fast-moving neutrons and again involving in the nuclear fission reaction. Control rods can then be inserted into the reactor core to reduce the reaction rate or withdrawn to increase it.

Answer 4:

According to Bohr's atom model,

$T \propto \frac{n^3}{Z^2}$

For Hydrogen atom $Z = 1$

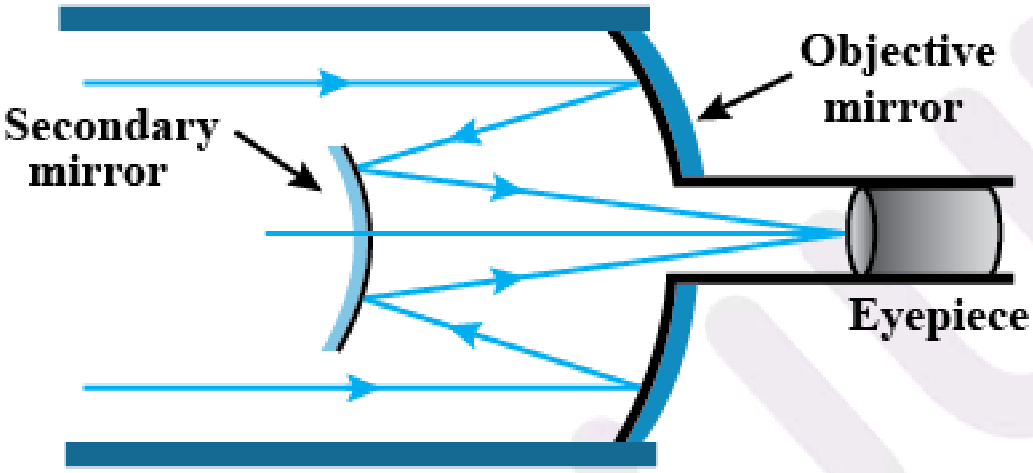
Therefore,

$T \propto n^3$

$\frac{T_1}{T_2} = \left(\frac{n_1}{n_2}\right)^3 = \left(\frac{1}{2}\right)^3$

$\frac{T_2}{T_1} = \frac{8}{1}$

Answer 5:
Reflecting type telescope:



Magnifying power m of a telescope is the ratio of the angle β subtended at the eye by the image to the angle α subtended at the eye by the object.

$m = \frac{\beta}{\alpha} = \frac{f_0}{f_e}$

Where f_0 and f_e are the focal lengths of the objective and eyepiece, respectively.

Answer 6:
Given: $\lambda = 6000$ Å, $\beta = 2$ mm, $\mu = 4/3$
Initially the fringe width is given by:

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

When the apparatus is immersed in liquid the new fringe width is given by,

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

Taking ratio of both the width

$\frac{\beta}{\beta'} = \frac{\lambda}{\lambda'}$

Also,

$\mu = \frac{\lambda}{\lambda'}$

Therefore,

$\frac{\beta}{\beta'} = \mu \Rightarrow \beta' = \frac{2\times3}{4} \Rightarrow \beta' = 1.5$ mm

SECTION C

Answer 7:

(i) P is NAND gate

Q is OR gate

A	B	X'	X
0	0	1	1
0	1	1	1
1	0	1	1
1	1	0	1

(ii) NAND and NOR gate are called universal gate because any gate can be formed by using these two gates.

Answer 8:

(i) Given: $\lambda = 5000$ Å $= 5000 \times 10^{-10}\ m$

$t = 2 \times 10^{-6} m$

$\mu = 1.5$

Fringe shift due to mica sheet is given by:

Fringe shift $= \frac{\beta}{\lambda}(\mu - 1)t$

$= \frac{\beta}{5000\times10^{-10}}(1.5 - 1)2 \times 10^{-6}$

$= 2\ \beta$

The central maximum will shift 2 fringes upward.

(ii) Path difference generated due to introduction of the plate.

$\Delta x = (\mu - 1)t$

For the intensity at the center to be zero, path difference generated should be

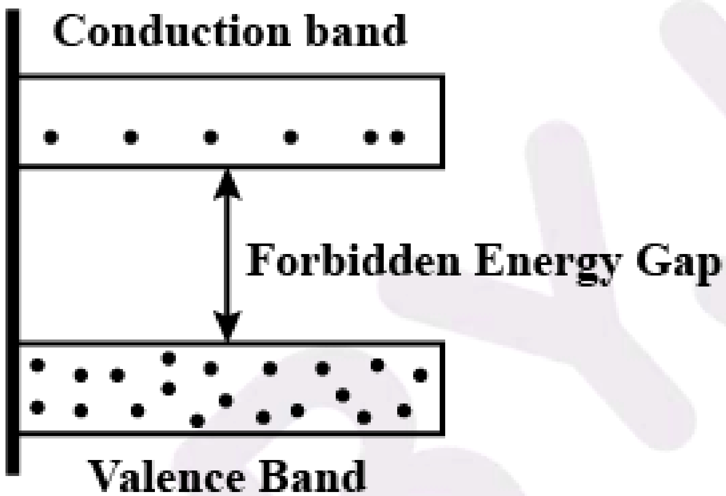
$\Delta x = \frac{\lambda}{2}$

$\Rightarrow (\mu - 1)t = \frac{\lambda}{2}$

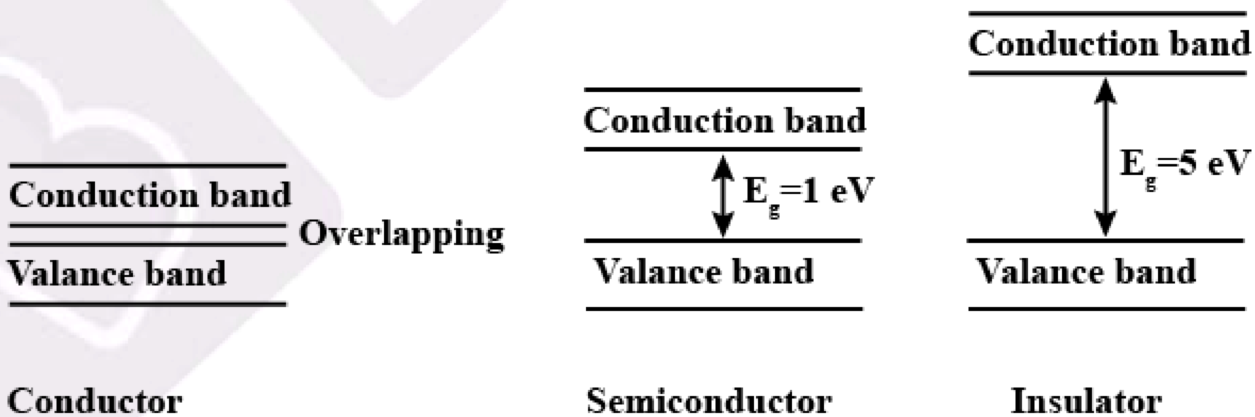
$\Rightarrow t = \frac{\lambda}{2(\mu-1)}$

Answer 9:

(1) Forbidden energy gap, also known as band gap refers to the energy difference (eV) between the top of valence band and the bottom of the conduction band in materials. Current flowing through the materials is due to the electron transfer from the valence band to the conduction band.



(2)



Energy band diagrams for conductor, semiconductor and insulator are shown above.

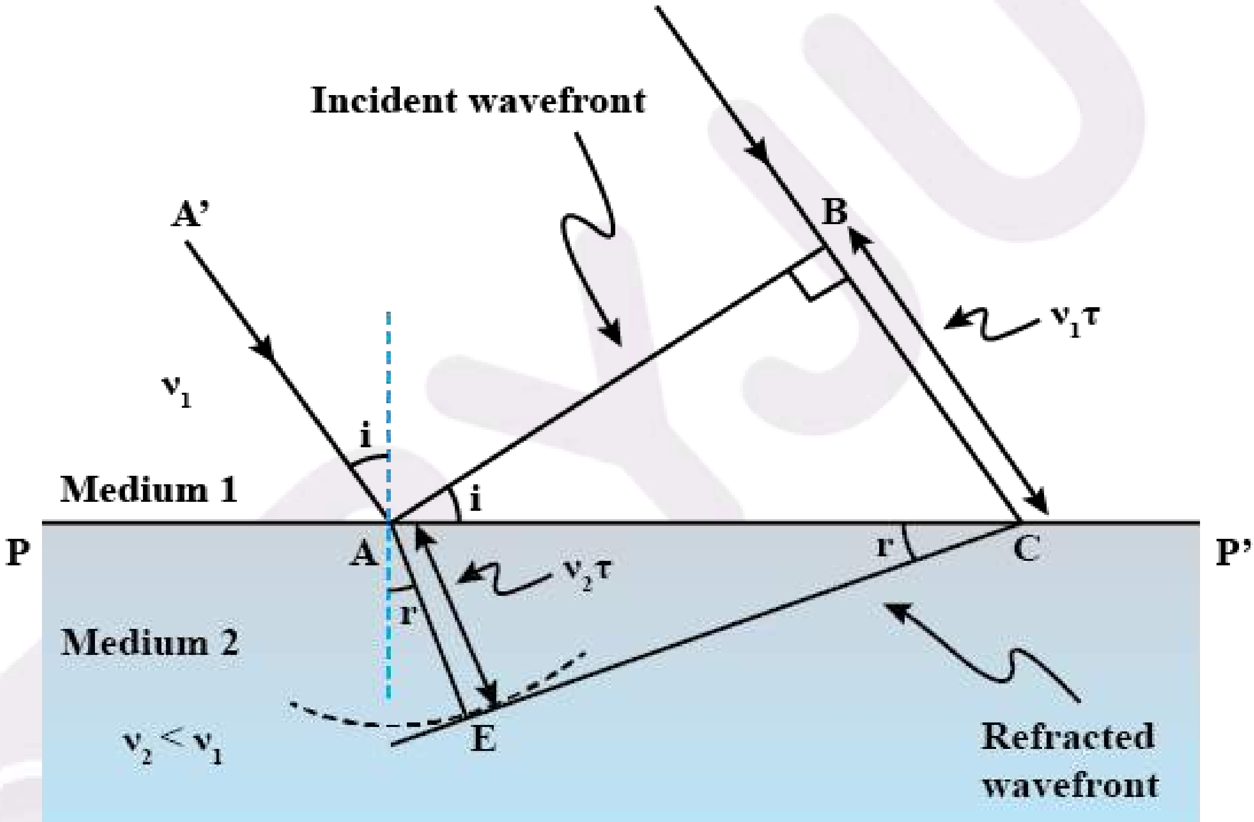
In conductors, both the valance band and conduction band overlap each other.

So there is zero band gap in a conductor.

In semiconductor, there is a small band gap approximately of 1 eV.

In an insulator, there is a large band gap of nearly 5 eV.

Answer 10:
Every point on a given wavefront (called primary wavefront) acts as a fresh source of new disturbance, called secondary wavelets which travel in all directions with the velocity of light in the medium.
The forward envelope of these secondary wavelets gives the new wavefront at any instance. This is called secondary wave front.



Let v_1 and v_2 represent the speed of light in medium 1 and medium 2 respectively.
Let wavefront AB be incident on the interface at an angle i.
If τ is the time taken by the wavefront to travel distance BC, i.e., $BC = v_1\tau$
Draw a sphere of radius $v_2\tau$ from point A in the second medium.
CE is the tangent plane drawn from point C on to the sphere. CE is the refracted wavefront.
$AE = v_2\tau$
Consider ΔABC and ΔAEC,
$\sin i = \frac{BC}{AC} = \frac{v_1\tau}{AC}$

$\sin r = \frac{AE}{AC} = \frac{v_2\tau}{AC}$

$\Rightarrow \frac{\sin i}{\sin r} = \frac{v_1}{v_2}$

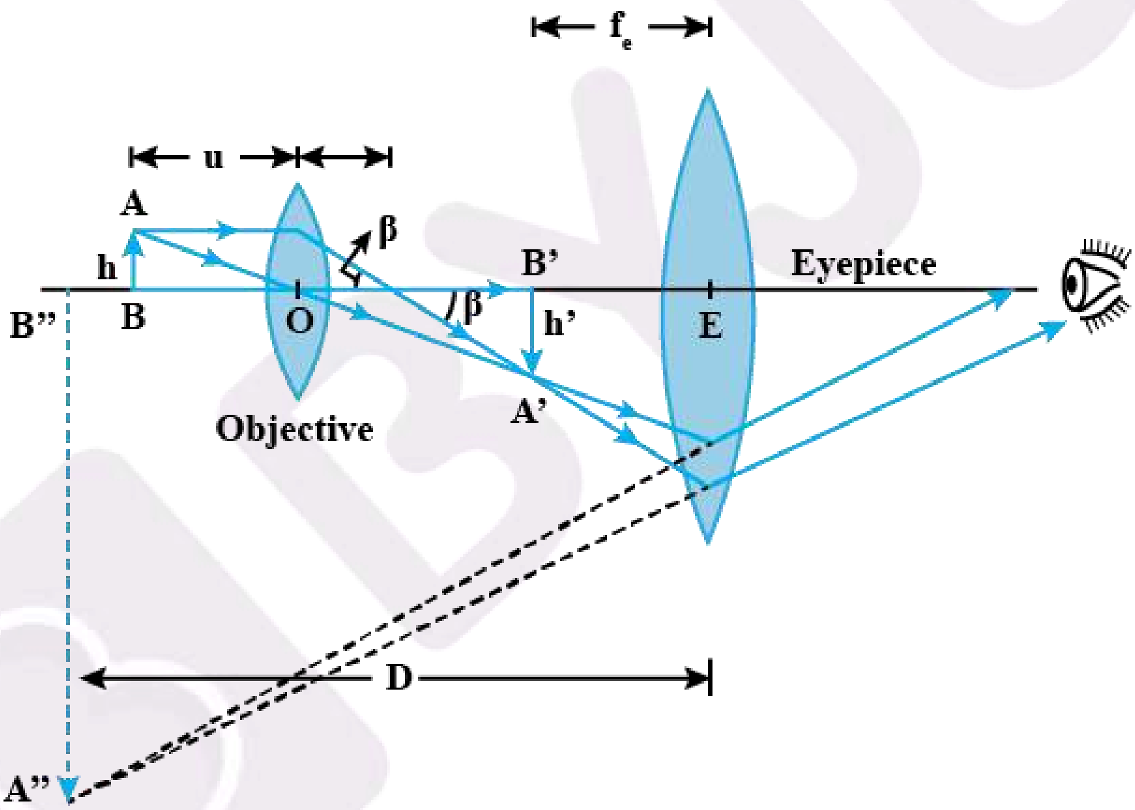
For medium 1, $n_1 = \frac{C}{v_1}$

For medium 2, $n_2 = \frac{C}{v_2}$

$\Rightarrow n_1 \sin i = n_2 \sin r$

This is Snell's law of refraction.

Answer 11:



A schematic diagram of a compound microscope is shown in Fig. The lens nearest the object, called the objective, forms a real, inverted, magnified image of the object. This serves as the object for the second lens, the eyepiece, which functions essentially like a simple microscope or magnifier, produces the final image, which is enlarged and virtual. The first inverted image is thus near (at or within) the focal plane of the eyepiece, at a distance appropriate for final image formation at infinity, or a little closer for image formation at the near point. Clearly, the final image is inverted with respect to the original object.

For magnification, $m_0 = \frac{h'}{h} = \frac{L}{f_0}$

Where we have used the result,

$\tan\beta = \frac{h}{f_0} = \frac{h'}{L}$

Here h' is the size of the first image, the object size being h and f_o being the focal length of the objective. The first image is formed near the focal point of the eyepiece. As the first inverted image is near the focal point of the eyepiece.

$m_e = 1 + \frac{D}{f_e}$

When the final image is formed at infinity, the angular magnification due to the eyepiece.

$m_e = \frac{D}{f_e}$

Thus, the total magnification when the image is formed at infinity, is

$m = m_0 m_e = \frac{L}{f_0}\frac{D}{f_e}$

Answer 12:

$\frac{1}{\lambda} = R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$

For Balmer series

$n_1 = 2$

$n_2 = 3, 4, \dots, \infty$

For shortest wavelength

$n_1 = 2$

$n_2 = \infty$

$\therefore \frac{1}{\lambda} = 1 \times 10^7 \left[\frac{1}{2^2} - \frac{1}{\infty}\right]$

$\frac{1}{\lambda} = \frac{1\times10^7}{4}$

$\lambda = 4 \times 10^{-7}$ or 4200 Å

For longest wavelength

$n_1 = 2$

$n_2 = 3$

$\therefore \frac{1}{\lambda} = 1 \times 10^7 \left[\frac{1}{2^2} - \frac{1}{3^2}\right]$

$$\frac{1}{\lambda} = 1 \times 10^7 \left[\frac{9-4}{36}\right]$$
$$\frac{1}{\lambda} = 10^7 \times \frac{5}{36}$$
$$\lambda = \frac{36 \times 10^{-7}}{5}$$
$\lambda = 7.2 \times 10^{-7}$ or 7200 Å