مـــدرسة دلهـــي الخــاصة ذ.م.م.
DELHI PRIVATE SCHOOL L.L.C.
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D P S
SHARJAH

EEE CONSORTIUM

PRE-BOARD EXAM (2021-22) SET-3

ANSWER KEY

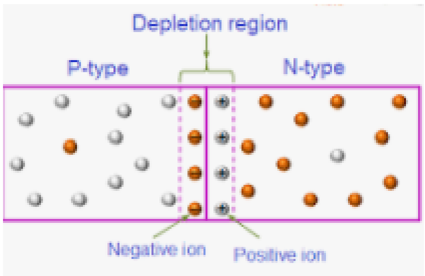
PB-T2/EEE-PHYAK/1221/A **10-MAR-2022**

Subject: Physics **Max. Marks:35**

Grade:12 **Time: 2 hours**

Section – A

1. *p-n* junction is formed, the holes from the *p*-region diffuse into the *n*-region and electrons from *n*-region diffuse into *p*-region. This results in the development of ***potential barrier*** V_B across the junction which opposes the further diffusion of electrons and holes through the junction. The small region in the vicinity of the junction which is depleted of free charge carriers and has only immobile ions is called the ***depletion region***. 1



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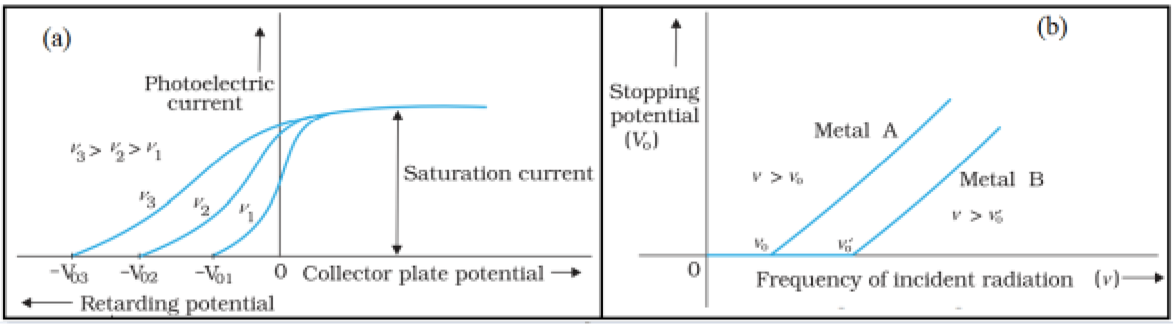
2. 1



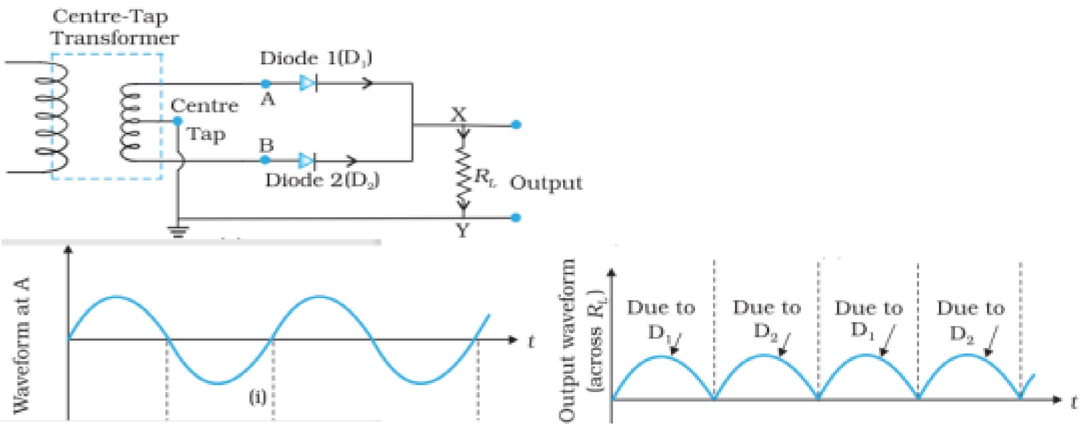
1

OR

No 1

$E_n = -13.6/n^2$ and electrons having different energies belong to different levels having different values of 'n' so their corresponding angular momenta will be different as $L = nh/2\pi$ 1

3. 1



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Section – B

4. **Ans.** For transition 1

$\Delta E = 0 - (-4.5) = 4{\cdot}5$ eV

or $\Delta E = 4.5 \times 1.6 \times 10^{-19}$ J **1**

$= 7.2 \times 10^{-19}$ J

$\therefore \quad \lambda = \dfrac{hc}{\Delta E}$ 1

$= \dfrac{6{\cdot}6\times10^{-34}\times3\times10^{8}}{7{\cdot}2\times10^{-19}}$

$= 275$ nm **1**

As $\lambda \propto \dfrac{1}{\Delta E}$, so λ will be minimum for transition D (ΔE = 8 eV) and maximum for transition A (ΔE = 2 eV). **1** 1

5. a) Photodiode ½

Solution Consider the case of an n-type semiconductor. Obviously, the majority carrier density (n) is considerably larger than the minority hole density p (i.e., $n >> p$). On illumination, let the excess electrons and holes generated be Δn and Δp, respectively:

$n' = n + \Delta n$ 1

$p' = p + \Delta p$

Here n' and p' are the electron and hole concentrations* at any particular illumination and n and p are carriers concentration when there is no illumination. Remember $\Delta n = \Delta p$ and $n >> p$. Hence, the fractional change in the majority carriers (i.e., $\Delta n/n$) would be much less than that in the minority carriers (i.e., $\Delta p/p$). In general, we can state that the fractional change due to the photo-effects on the *minority carrier dominated reverse bias current* is more easily measurable than the fractional change in the forward bias current.

b) When the photodiode is illuminated with light (photons) with energy (h+) greater than the energy gap (E g) of the semiconductor, then electron-hole pairs are generated due to the absorption of photons. The diode is fabricated such that the generation of e-h pairs takes place in or near the depletion region of the diode. Due to electric field of the junction, electrons and holes are separated before they recombine. The direction of the electric field is such that electrons reach n-side and holes reach p-side. Electrons are collected on n-side and holes are collected on p-side giving rise to an emf. When an external load is connected, current flows. 1.5

6. a)

½

Nuclear density,

$$\rho = \frac{\text{Mass of nucleus}}{\text{Volume of nucleus}} = \frac{mA}{\frac{4}{3}\pi\left(R_0 A^{1/3}\right)^3}$$ ½

Or $\rho = \frac{mA}{\frac{4}{3}\pi R_0^3 A} \Rightarrow \rho = \frac{m}{\frac{4}{3}\pi R_0^3}$

So as per above formula, density of nucleus does not depend on mass number of nucleus rather it is same for all the atoms and it is roughly in the order of 10^{17} kg/m^3 which is very large as compared to our everyday observed densities.

b) 1

${}_7N^{14}$ nucleus contains 7 protons and 7 neutrons.

Mass of 7-protons $= 7m_H = 7 \times 1.00783$ u $= 7.05481$ u

Mass of 7-neutrons $= 7m_n = 7 \times 1.00867\ u = 7.06069\ u$

$\therefore$ Mass of nucleons in ${}^{14}_{7}N = 7.05481 + 7.06069 = 14.11550$ u

Mass of nucleus ${}^{14}_{7}N = m_N = 14.00307$ u 1

$\therefore$ Mass defect = mass of nucleons – mass of nucleus

$= 14.11550 - 14.00307 = 0.11243$ u

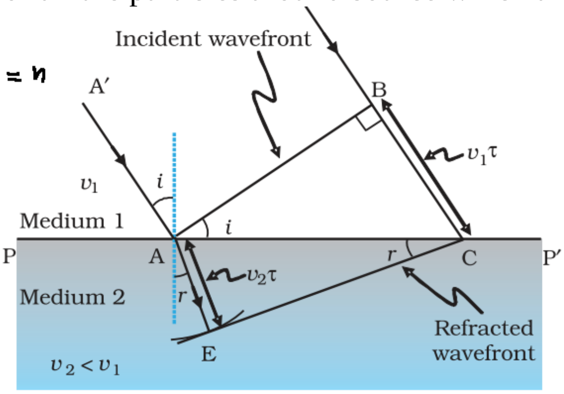
Total Binding energy $= 0.11243 \times 931$ MeV $= 104.67$ MeV

7. Wavefront: Locus of all the particles around source which are vibrating in same phase. 1

Proof:-

$\frac{\sin i}{\sin r} = \frac{v_1 \tau}{v_2 \tau} = n_{21} = n$

Hence Proved.



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8. a) 2F

b)

Here, $u_1 = -6$ cm, $f_1 = 24$ cm, $v_1 = ?$

Using lens formula,

$$\frac{1}{v_1} - \frac{1}{u_1} = \frac{1}{f_1} \Rightarrow \frac{1}{v_1} = \frac{1}{f_1} + \frac{1}{u_1}$$

$$\Rightarrow \frac{1}{v_1} = \frac{1}{24} - \frac{1}{6} = \frac{-3}{24} = -\frac{1}{8}$$ ½

$\therefore$ $v_1 = -8$ cm (*i.e.*, image is virtual formed on same side of lens 1) ½

Image formed by lens 1 acts as an object for lens 2.

Therefore final image is formed by lens 2. ½

Here, $u_2 = -|v_1 + L| = -(8 + 10) = -18$ cm

$f_2 = 9$ cm, $v_2 = ?$ ½

Using lens formula,

$$\frac{1}{v_2} = \frac{1}{f_2} + \frac{1}{u_2} \Rightarrow \frac{1}{v_2} = \frac{1}{9} - \frac{1}{18} = \frac{1}{18}$$

$\Rightarrow$ $v_2 = 18$ cm

(OR)

a)

Power of combination $P = P_1 + P_2 = \frac{1}{f} - \frac{1}{f} = 0$ 1

$\frac{1}{f_2} = ({}_w\mu_s - 1)\left(\frac{1}{R_1} + \frac{1}{R_2}\right)$ ....(i)

In air, $\frac{1}{f_1} = (\omega_g - 1)\left(\frac{1}{R_1} + \frac{1}{R_2}\right)$ ....(ii) 1

Dividing Eq. (ii) by Eq. (i), we have

$$\frac{f_2}{f_1} = \frac{({}_a\mu_g - 1)}{({}_w\mu_g - 1)} = \frac{(1.6-1)}{\left(\frac{1.6}{1.3}-1\right)} = \frac{0.6\times1.3}{0.3}$$

$\frac{f_2}{f_1} = 2.6$ 1

New focal length, $f_2 = 2.6 \times f_1 = 2.6 \times 20$

$f_2 = 52$ cm

9. The de-Broglie wavelength is given by the equation:

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

Substituting the value of v, we get

$\lambda = \frac{h}{\sqrt{2mqV}}$ 1

This is analogous to the equation of a straight line passing through the origin: y = mx where m is the slope of the line.

Hence, we can see that if we plot the graph of λ vs V, we would get a straight line with slope:

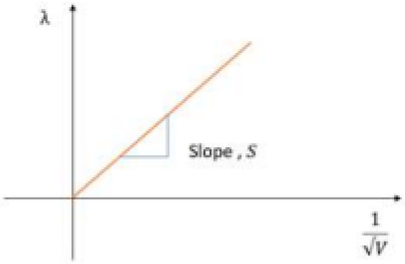
$S = \frac{h}{\sqrt{2mq}}$

On rearranging, 1

$q = \frac{h^2}{2mS^2}$

Hence, as we know q, h and we can determine S from the graph, we can calculate the magnitude of charge on the particle.

The graph is drawn below:



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10. a)

$P = \frac{1}{f} = \left(\frac{n_2-n_1}{n_2}\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ 1

$= \left(\frac{n_2-n_1}{n_2}\right)\left(-\frac{2}{R}\right)$ for diverging lens

$=$ negative

i. If $n_1 > n_2$

$\frac{n_2-n_1}{n_1}$ becomes negative

$\therefore P = \frac{1}{f}$ becomes positive

or lens become converging

b)

2

(b) Using $\frac{1}{v_o} - \frac{1}{u_o} = \frac{1}{f_o}$

$$\frac{1}{v_o} - \frac{1}{-2.5} = \frac{1}{1.25}$$

$$\frac{1}{v_o} = \frac{1}{1.25} - \frac{1}{2.5}$$

$$\frac{1}{v_o} = \frac{4}{5} - \frac{2}{5}$$

$$\frac{1}{v_o} = \frac{4}{5} - \frac{2}{5}$$

$$v_o = 2.5 \text{ cm}$$

L= Vo + fe = 2.5 +5 = 7.5 cm

11 (i) Micro waves : Special tubes like klystrons, gunn diodes. 1

(ii) Infra red : Atomic/molecular vibrations. 1

(iii) X-rays :By bombarding heavy element targets like tungsten. 1

OR

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

(i) As $\beta \propto D$, so when screen is moved away from the slits, fringe width increases. 1

(ii) As $\beta \propto 1/d$, so when the separation between the slits is increased, fringe width decreases. 1

(iii) When widths of slits are doubled, contrast between maxima and minima decreases due to the overlapping of interference patterns formed by various narrow pairs of the two slits. 1

Section – C

12a) (ii) The refractive index of the material of the core is less than that of the cladding. 5

b) (iii)

c) (iv)1.8 x 10^8 m/s

d) (iv)$\mu_1 > \mu_2$

e) (i) $36/\sqrt{7}$

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