Class-XII

Physics(042)

2

Section - A

1.
(a)
(i)

ISOTOPES	ISOBARS
→ The atoms which have the same atomic number but different mass number are isotopes (atoms of ~~same elements~~)	→ The atoms which have different atomic number but same mass number are isobars (atoms of different elements)
→ Isotopes have same number of protons in them	→ Isobars have different number of protons in them
→ Their (p+n) no. is not constant	→ Their (P+n) number is constant.
→ Eg: H_1^1, H_1^2, H_1^3	→ Eg: Ar_{18}^{40}, Ca_{18}^{40}

(ii) Isotopes have same atomic number but different mass number. In other words isotopes have equal number of protons but only differ in number of neutrons.

Given two nuclei A_1 and A_2 have different mass numbers, These two nuclei can be isotope only if they have the same atomic number.

For eg: He_2^4 and H_1^2 have different mass number but they are not isotopes

H_1^1 and H_1^2 also have different mass number but they are isotopes

Ans: Thus, if two nuclei have different mass numbers A_1 and A_2 they cannot necessarily be isotopes of the same element.

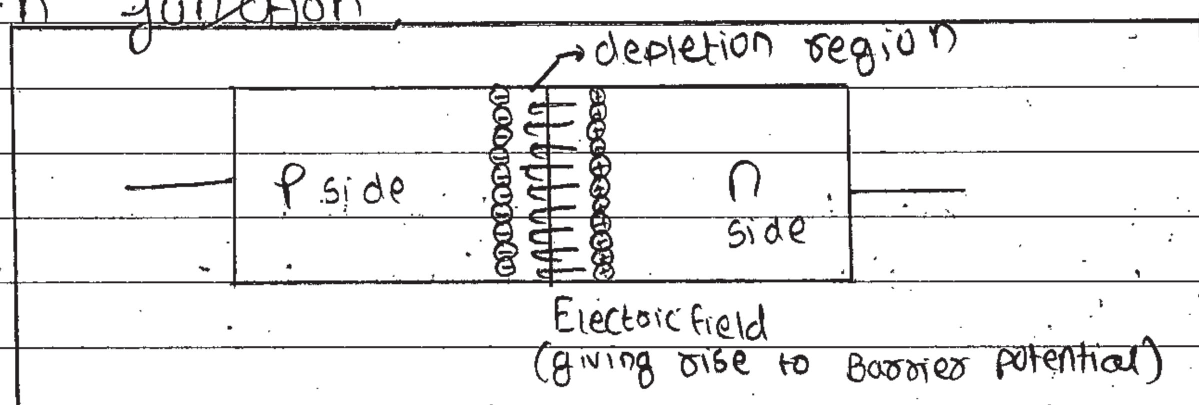
2 • When a p-n junction diode is formed, two process occur simultaneously : Diffusion and Drift.

• Diffusion: The p side has more holes than the n side and the n side has more electrons than the p side. Hence the holes from the p side and the electrons from the n side diffuse out to the n side and p side respectively due to concentration gradient.

• As the electrons from the n side diffuse to the p side, it leaves behind an ionised donor (positively charged). Hence a layer of positive charge starts to develop in the n side near the junction.

• Further, as the holes ~~electrons~~ from p side diffuse to n side, it leaves behind an Ionised acceptor atom (negatively charged). Hence a layer of negative charge starts to develop in the p side near the junction.

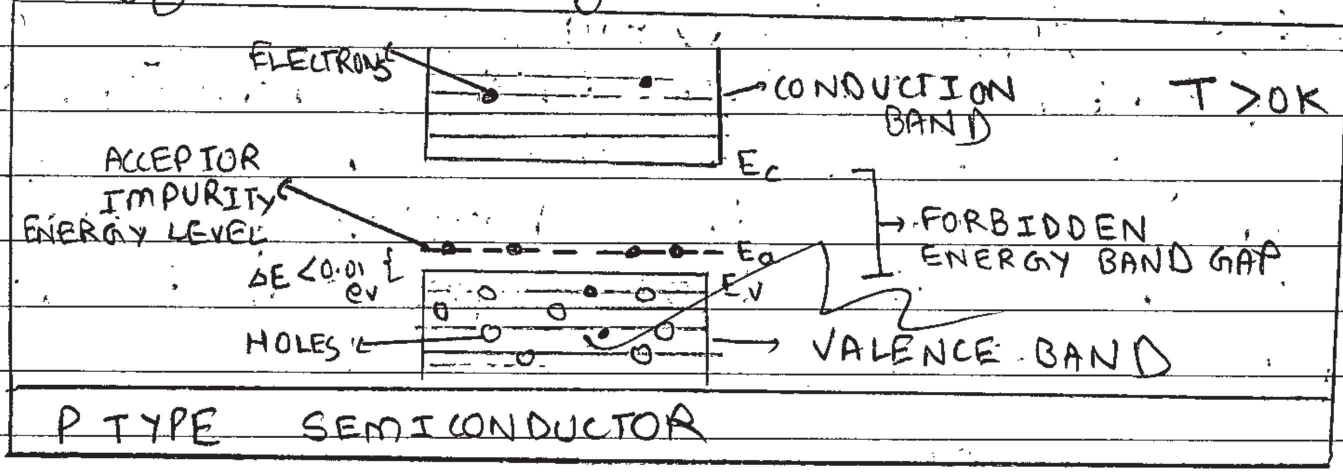
- The layers of opposite charges developed ~~the~~ create an electric field (from n side to p side) in between the junction region called the depletion region.
- Drift: Minority charge carriers of the either sides are swept by this electric field in the depletion region into their respective majority zones
- At equilibrium drift current and diffusion current are equal.
- The potential difference which is now developed due the layer of opposite charges in the depletion region is called the barrier potential.
- This is how the barrier potential is developed in a p-n junction



P-n junction

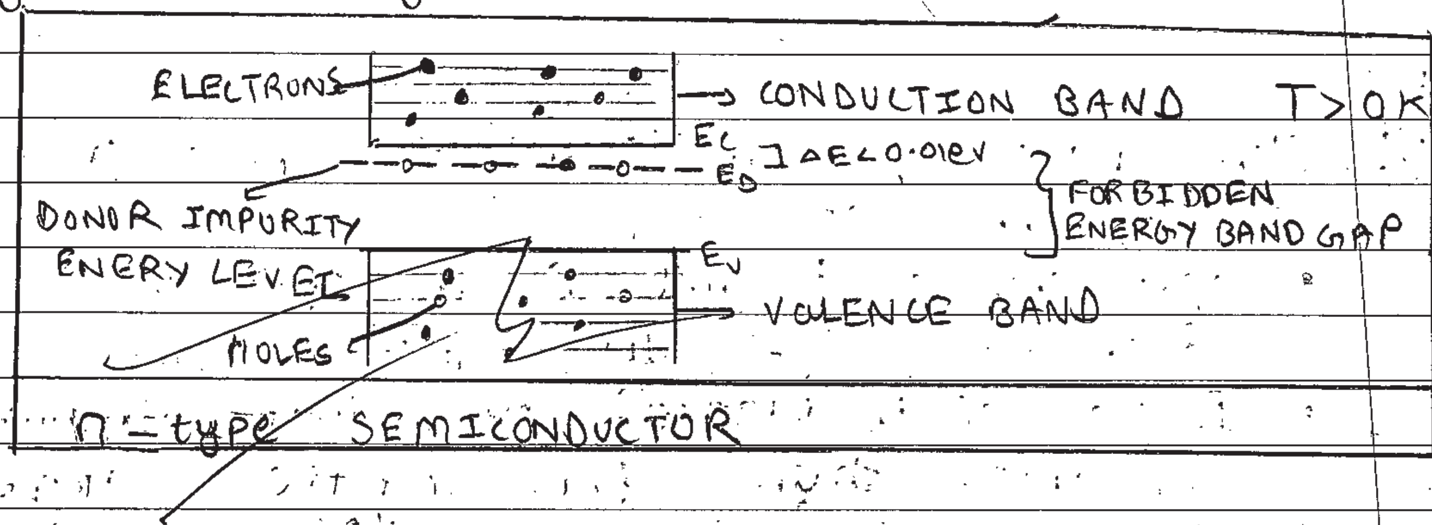
3. P-type extrinsic semiconductor is formed on doping a pure germanium with a trivalent impurity

Energy Band diagram



(ii) n-type extrinsic semiconductor is formed on doping ~~a~~ pure germanium with a pentavalent impurity.

Energy Band diagram:



PTO

7 Section -B

4

(a) Two necessary conditions for total internal reflection are:

- Light should travel from optically ~~rarer~~ denser to optically rarer medium
- Angle of incidence of light should be greater than the critical angle for the given pair of media

For eg: If light is traveling from medium n_1 to medium n_2 $(n_1 > n_2)$

$$\sin i > \sin C = \frac{n_2}{n_1} = n_{21}$$

(b) • For interface AB

As angle of incidence is zero, angle of refraction is also zero, hence ray will pass undeviated from the interface AB.

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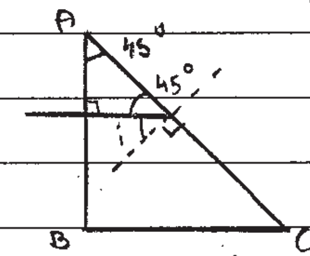
- For interface AC

Now ray incident on AC is parallel to line BC. Hence angle on indidence of ray is

$= 90 - 45° = 45°$



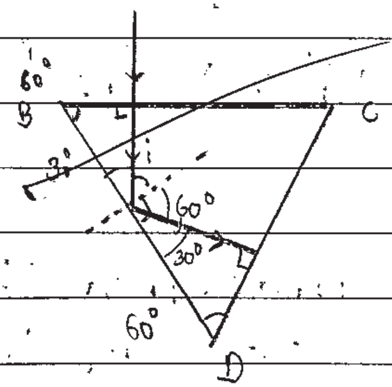
This angle is greater than the critical angle of the prism ABC w.r.t air ($i_c = 41.1°$), Hence the ray will get total internally reflected with angle of reflection $= 45°$. Thus the reflected ray would be parallel to AB and perpendicular to BC

- For interface BC

As angle of incidence is zero, angle of ~~reflect~~ refraction is also zero and hence deviation is also zero.

• For interface BD.

The incident light is perpendicular to BC hence its angle of incidence = 90° − (90 − 60)°
= 60°



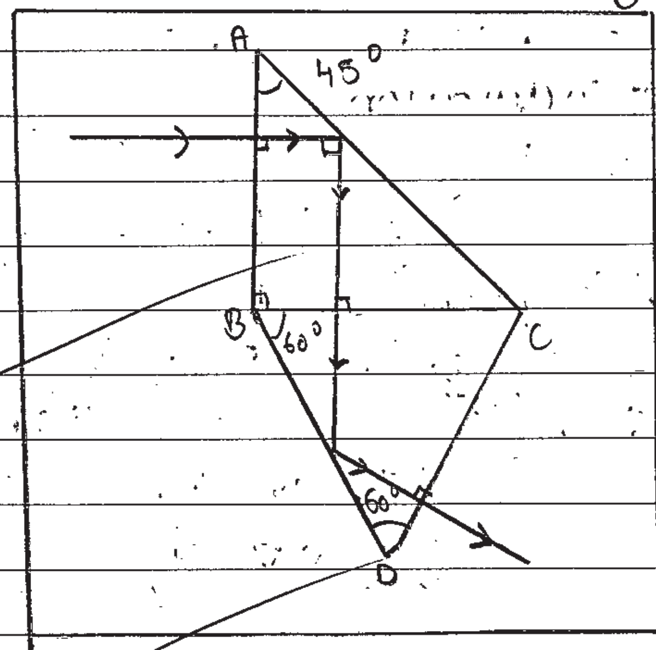
Again this angle is greater than the critical angle of prism BCD wrt air ($i_c = 45°$). Hence ray will get total internally reflected with angle of reflection = 60°. Now from the above figure, using geometry we find that the reflected wave is perpendicular to CD.

• For interface CD

As angle of incidence is zero, the wave will emerge out of CD into air with zero angle of refraction.

Here the pathe of ray is :

Ans :



5

(i) Given frequency of light = 6.4×10^{14} Hz

Hence energy of incident radiation = $h\nu$

$h \rightarrow$ Planck's constant $= 6.63 \times 10^{-34}$ J-s

$\nu \rightarrow$ frequency of incident light

$\rightarrow$ Energy $= 6.63 \times 10^{-34} \times 6.4 \times 10^{14}$ J

$= \dfrac{6.63 \times 10^{-34} \times 6.4 \times 10^{14}}{1.6 \times 10^{-19}}$ eV

[$\because$ 1 eV = 1.6×10^{-19} J]

$= \dfrac{26.52}{10} = 2.652$ eV

Ans: Thus energy of incident radiation = 2.652 eV

(ii) From photoelectric equation

$K_{max} = E - \phi$

$K_{max} \rightarrow$ maximum kinetic energy of electrons

E → energy of incident radiation (= 2.652 eV)
φ → Work function of metal (= 2.31 eV)

→ $K_{max} = (2.652 - 2.31)$ eV

∴ → $K_{max} = 0.342$ eV

Ans: Thus, maximum kinetic energy of emitted electrons is 0.342 eV.

(iii) Stopping potential of surface $= \frac{K_{max}}{e}$ [e → charge of electron]

$= \frac{0.342 \text{ eV}}{e}$

$= 0.342$ V

Ans: Thus, stopping potential of the surface is 0.342 V

6 Fringe width of any wavelength in Young's ~~dobl~~ double slit experiment is given by (β)

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

D → distance between slits and screen
λ → wavelength of light
d → distance between the slits

Hence,

- Fringe width of 600nm → $\beta_{600} = \frac{D\lambda}{d} = \frac{0.60 \times 600 \times 10^{-9}}{1.0 \times 10^{-3}}$

$= 3.6 \times 10^{-4}$ m

$\beta_{600} = 0.36$ mm

- Fringe width of 500nm → $\beta_{500} = \frac{D\lambda}{d} = \frac{0.6 \times 500 \times 10^{-9}}{1.0 \times 10^{-3}}$

$\beta_{500} = 0.30$ mm

(i) Position of second bright fringe of 500nm ⇒ $y_2 = 2\beta_{500}$
position of central maximum ⇒ $y_1 = 0$

⇒ Distance between second bright fringe and central maximum for $\lambda = 500nm$ $= y_2 - y_1 = 2\beta_{500}$
$= 0.6\,mm$
$= 6 \times 10^{-4}\,m$

Ans: Thus, the distance is 0.60mm (or $6 \times 10^{-4}\,m$)

(ii) Position of m^{th} bright fringe from central maxima for $\lambda = 500\,nm$ $= m\beta_{500}$
Position of n^{th} bright fringe from central maxima for $\lambda = 600\,nm$ $= n\beta_{600}$
If this position is same for both
$m\beta_{500} = n\beta_{600}$ ⇒ $m \times 0.30 = n \times 0.36$
$5m = 6n$ [where m, n are integers]

$\frac{m}{n} = \frac{6}{5}$

→ for smallest distance $m = 6$, $n = 5$

→ distance $= m\beta_{500} = n\beta_{600} = 6 \times 0.3$ mm
$= 5 \times 0.36$ mm
$= 1.8$ mm

Ans: Thus the least distance is 1.8 mm (or 1.8×10^{-3} m)

7
(a)

→ λ_1 is microwave ($\because$ 1mm $< \lambda_1 < 0.1$m).
→ λ_2 is UV (ultraviolet) wave ($\because$ 1nm $< \lambda_2 <$ 400nm)
→ λ_3 is infrared waves ($\because$ 700nm $< \lambda_3 <$ 1mm)

(ii) Sources:
→ λ_1 (microwave): Special ~~Vat~~ vacuum tubes like Klystons, magnetrons, Gunn diode.

→ λ_2 (UV rays) : Ultra Hot bodies like sun
: Electron transtions in inner shells of big atoms.

→ λ_3 (Infrared waves) : Vibrations of atoms and molecules

8 — Angular width of the Central maximun in single slit $(\theta) = \frac{2\lambda}{a}$

λ → wavelength of light
a → width of slit

(i) Orange light has greater wavelength than green light. As the angular width of the central maxima is directly proportial to wavelength of light, ~~the~~ its value will increase is orange light is used in place of green light.

$$\theta \propto \lambda$$

$$\lambda_{orange} > \lambda_{green}$$

$$\theta_{orange} > \theta_{green}$$

Ans: Increase in angular width.

(ii) The distance between the slit and screen is decreased when the screen is moved ~~cros~~ closer to slit. As the angular width is independent of the distance between the slit and screen, its value will not change

$$\theta \propto D^0$$

$$\theta_i = \theta_f$$

Ans: No change in angular width.

(iii) As the angular width is inversely proportial to slit width, it value will increase on decreasing width.

$$\theta \propto \frac{1}{a}$$

$$a_i > a_f$$

$$\boxed{\theta_f > \theta_i}$$

Ans: Increase in angular width.

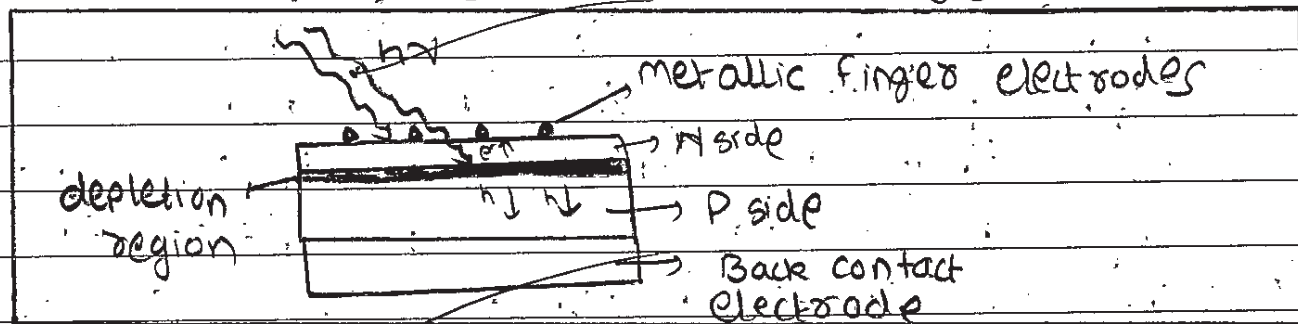
9 • Solar cell is the device which convert solar energy (light energy) to electrical energy.
• It is constructed by diffusing a very thin layer (0.3 μm thick) of n semiconductor over a 300 μm thick p semiconductor
• The p-side is connected to a back contact while the n type is connected to metallic finger electrodes
• No external biasing is done. The process of emf generation occurs in 3 steps.

(a) Generation: Light is irradiated on the cell. The ray reach the depletion ~~area~~ region and their energy is utilies in the generation of electro hole pairs (e-h) in the depletion region.

(b) Separation: The generated electrons and holes and swept away by the junction electric field before they can recombine The electrons reach n side and the holes reach p side.

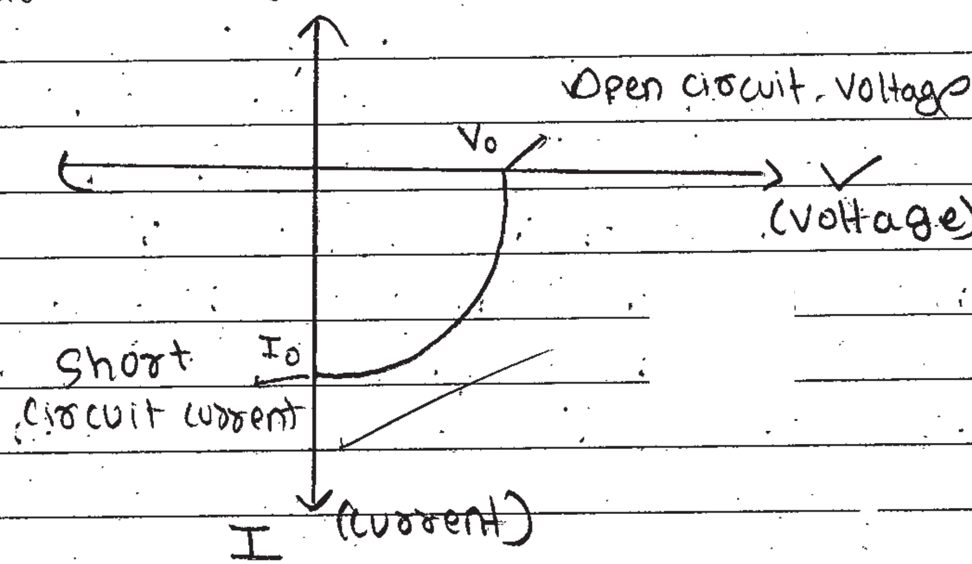
(c) Collection: This causes increase in concentration of electrons on nside and holes on p side near the junction. Hence these majority charges diffuse towards the electrodes and therby ~~ba~~ make the back contact (P side) positively charged and the metallic finger electrode (n side) negatively charged giving rise to photovoltage.

- When a load is connected between these two electrodes current would flow and thus the light energy is converted to electrical energy.



TS OF WORKING SOLAR CELL

→ I-V characteristics



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(a) • Initially it was thought that photons were emitted when Beryllium nuclei were bombarded with alpha particles. This observation was made on the fact that the emitted radiation didnot deflect by any electric or magnetic field.

• However James Chadwick, on carefull experimentation managed to slow down the particles of the emitted radiation and Claimed ~~to~~ that they had definite rest mass [roughly that of a proton)

• Moreover ~~of~~ spectrochemical mass analysis of the products revealed that C^{12} was formed as a product instead of C^{13}. Based on the above two facts he conclude that the emitted radiation were neutrons (~~massless~~ chargeless particles with mass) and not photons (mass less)

• Hence the reaction would be.

$$Be_4^9 + He_2^4 \longrightarrow C_6^{12} + n_0^1$$

(neutron)

Hence neutrons were discovered

(b) Radius of a nuclei is given by:

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

where $R_0 = 1.2 \times 10^{-15}$ m

A = mass number of the nucleus
= No of nucleons in the nucleus (n+p)

Let two nuclei are there A and B,
A has n_1 neutrons and p_1 protons
B has n_2 neutrons and p_2 protons

Such that $n_2 \neq n_1$; $P_2 \neq P_1$
and

$$n_1 + P_1 = n_2 + P_2$$

⇒ Mass number of A = Mass number of B

but if two nuclei have same mass numbers they would have equal radius

$$\boxed{R_A = R_B}$$

Ans. Hence two nuclei having different number of protons and neutrons may have the same radius. [Equality holds if the sum of the number of proton and neutrons in both of them are same]

11 (a) From Bohr's postulate, we have

$$\frac{Ke^2}{r^2} = \frac{mv^2}{r}$$ [1st postulate]

[electrostatic force applies the required centripetal force]

$K = \frac{1}{4\pi\varepsilon_0} = 9\times10^9$

$e \Rightarrow$ charge of electron

$r \Rightarrow$ radius of orbit

$m \Rightarrow$ mass of electrons

$v \Rightarrow$ velocity of electrons in the orbit.

$$\Rightarrow mv^2 = \frac{Ke^2}{r}$$

Now kinetic energy of electron in an orbit (KE) $= \frac{1}{2}mv^2 = \frac{Ke^2}{2r} = KE$

Potential energy (PE) of electron in the orbit $= \frac{K(e)(-e)}{r} = \frac{-Ke^2}{r} = P.E.$

Total energy of electron (TE) = P.E + KE

$\Rightarrow$ $TE = -\frac{ke^2}{r} + \frac{ke^2}{2r}$

$$TE = -\frac{ke^2}{2r}$$

Given that energy of electron in Hydrogen atom is $= -1.51 eV$

$= -\frac{ke^2}{2r}$

$\Rightarrow$ $\frac{ke^2}{r} = 3.02 eV$

$\Rightarrow$ $PE = -\frac{ke^2}{r} = -3.02 eV$, $KE = \frac{ke^2}{2r} = +1.51 eV$

Ans: Thus,

$KE = +1.51 eV$

$PE = -3.02 eV$

(b) Given radius of atom (r_a) = radius of electron orbit = 5.3×10^{-11} m

radius of nucleus (r_n) = $\frac{\text{diameter}}{2}$ = $\frac{1.0 \times 10^{-15} \text{ m}}{2}$ = 5×10^{-16} m

Volume of atom = $\frac{4}{3}\pi r_a^3$

Volume of nucleus = $\frac{4}{3}\pi r_n^3$

⇒ Fraction of its volume occupied by the nucleus = $\frac{(\text{Volume})_{\text{nucleus}}}{(\text{Volume})_{\text{atom}}} = \frac{\frac{4}{3}\pi r_n^3}{\frac{4}{3}\pi r_a^3}$

$= \left(\frac{r_n}{r_a}\right)^3$

$= \left(\frac{5}{5.3} \times 10^{-5}\right)^3$

$= \frac{125}{5.3 \times 5.3 \times 5.3} \times 10^{-15}$

$$= \frac{125}{148.877} \times 10^{-15}$$

$$= \boxed{8.395 \times 10^{-16}}$$

Ans: Thus, fraction of volume Volume of hydrogen atom occupied by its nucleus

$$= \boxed{8.395 \times 10^{-16}}$$

Section- C

12.

I. (B) real, virtual

II. (A) the aperture of the objective and the eye-piece

III. (D) The microscop can be used as a ~~teles~~ telescope by interchanging the two lenses

IV. (D) 200

V. (C) 200