ISC SEMESTER 2 EXAMINATION

SAMPLE PAPER - 4

PHYSICS PAPER 1 (THEORY)

Maximum Marks: 35

Time allowed: One and a half hour

*Candidates are allowed an additional **10 minutes** for **only** reading the paper.*

*They must **NOT** start writing during this time.*

***All questions are compulsory**.*

*This question paper is divided in **3 Sections A, B** and **C***

All working, including rough work, should be done on the same sheet as and adjacent to the rest of the answer.

Answers to sub parts of the same question must be given in one place only.
A list of useful physical constants is given at the end of this paper.

A simple scientific calculator without a programmable memory may be used for calculations.

Section-A

Question 1.

(i) What is the phase difference between any two points lying on the same?

(ii) What type of wavefront will emerge from (a) a point source? (b) a distant light source?

(iii) Is there any hole in n-type semiconductor? If yes, explain why?

(iv) For constructive interference to take place between two monochromatic light waves of wavelength λ, the path difference should be :

(a) $n\lambda$ (b) $(2n-1)\lambda/4$ (c) $(2n+1)\lambda/2$ (d) $(2n-1)\lambda/2$

(v) In Young's double-slit experiment, sodium lamp is replaced by a blue-light lamp then:

(a) the fringes will become brighter.
(b) the fringes will become fainter
(c) the fringe width will increase.
(d) the fringe width will decrease.

(vi) Ratio of longest to shortest wavelength in Balmer series is:

(a) 5 : 9 (b) 9 : 5 (c) 25 : 81 (d) 81 : 25

(vii) Photons of frequency ν are incident on the surfaces of metals A and B of threshold frequencies 3ν/4 and 2ν/3, respectively. The ratio of the maximum kinetic energy of electrons emitted from A to that from B is:

(a) 2: 3 (b) 3 : 4 (c) 1: 3 (d) 3 : 2

Section-B

Question 2.

(i) What are coherent sources of light? Why is it not possible to observe interference with non-coherent sources?

(ii) The wavelength of H_α line of Balmer series is 6553 Å. Calculate the Rydberg's constant.

Question 3.

(i) A compound microscope consists of two convex lenses having focal length of 1·5 cm and 5 cm. When an object is kept at a distance of 1·6 cm from the objective, the final image is virtual and lies at a distance of 25 cm from the eyepiece. Calculate magnifying power of the compound microscope in this set-up.

OR

(ii) The focal length of a concave lens is 20 cm. The focal length of a convex lens is 25 cm. These two are placed in contact with each other. What is the power of the combination? Is it diverging, converging or undeviating in nature?

Question 4.

(i) Define dispersive power of the material of a prism. The refractive indices of a prism for violet, yellow and red colors are 1·632, 1·620 and 1·613 respectively. Calculate the dispersive power of material of the prism.

(ii) State magnifying power of the lens.

Question 5.

Explain the following term:

(i) Photodiode

(ii) Drift velocity and Mobility

Question 6.

(i) The de-Broglie wavelength of electrons of kinetic energy E is λ. What will be its value if kinetic energy of electrons in made 4E?

OR

(ii) The work function of tungsten is 4.50 eV. Calculate the speed of fastest electron ejected when light whose photon energy is 5.80 eV shines on the surface.

Section-C

Question 7.

(i) Prove that in case of a prism, $i + e = A + \delta$, where the symbols have their usual meanings.

OR

(ii) Derive the law of reflection using Huygen's Wave Theory.

Question 8.

Explain the working of a simple microscope and show that its angular magnification is given by $M = 1 + (D/f)$, where D is the least distance of distinct vision.

Question 9.

A double convex lens of glass has a focal length 20 cm in air and the absolute refractive index of the material of lens is 1·5. What will be the focal length of this lens if it is immersed in a liquid of absolute refractive index 1·65? State the nature of the lens when immersed in the liquid.

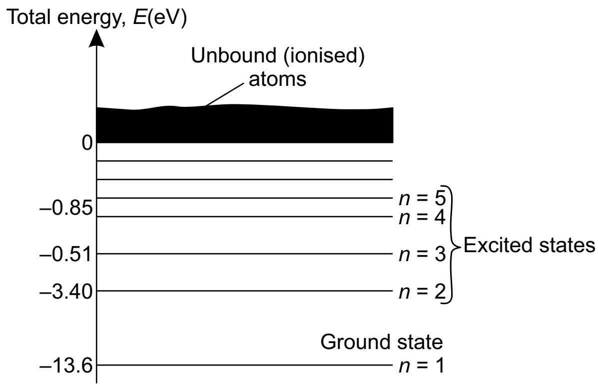
Question 10.

Derive an expression for the radius of the first orbit of hydrogen atom.

Question 11.

Read the passage given below and answer the questions that follow:

At room temperature, most of the H-atoms are in ground state. When an atom receives some energy (*i.e.*, by electron collisions), the atom may acquire sufficient energy to raise electron to higher energy state. In this condition, the atom is said to be in excited state. From the excited state, the electron can fall back to a state of lower energy emitting a photon equal to the energy difference of the orbit.



In a mixture of H—He^+ gas (He^+ is single ionized He atom), H-atoms and He^+ ions are excited to their respective first excited states. Subsequently, H-atoms transfer their total excitation energy to He^+ ions (by collisions).

(i) The quantum number *n* of the state finally populated in He^+ ions is:

(a) 2 (b) 3 (c) 4 (d) 5

(ii) The wavelength of light emitted in visible region by He^+ ions after collisions with H-atoms is:

(a) 6.5×10^{-7} m (b) 5.6×10^{-7} m (c) 4.8×10^{-7} m (d) 4.0×10^{-7} m

Question 12.

(i) Answer the following question:

(a) Draw a half-wave rectifier circuit using semiconductor.

(b) Draw the characteristic curve of Zener diode.

OR

(ii) With reference to the semiconductor physics:

(a) Explain the term 'forward bias' and 'reverse bias'.

(b) Majority carriers and minority carriers?

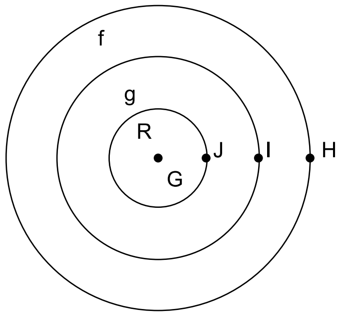
Answers

Section-A

Answer 1.

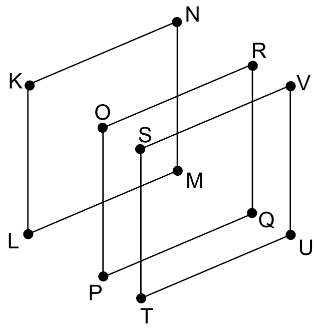
(i) Wave front is the locus of all the particles of a medium that are found vibrating in the same phase. The phase difference between any two points on a wavefront is zero.

(ii) (a) The wavefront emerging from a point sources is the spherical wavefront since the waves travel radially outwords from the source.



Hence the wavefront for a point source is spherical.

(b)



Hence, the wavefront emerging from a distant source is a plane wavefront.

(iii) Yes, in n–type semiconductor, holes are produced by breaking the covalent bonds. They are minority carriers.

(iv) (a) $n\lambda$

Explanation :

For constructive interference, the two monochromatic light waves should be in phase.

If the path difference is λ, then ϕ the phase difference is 2π.

Thus for constructive interference, the two waves will be in phase in ϕ is a multiple of 2π *i.e* $2n\pi$ where n is an integer.

Thus, 2π correspond to $n\lambda$ path difference.

(v) (d) the fringe width will decrease.

Explanation :

The fringe width in Young's double slit experiment is given by,

$$\beta = D\lambda/d$$

From formula, $\beta \propto \lambda$

If blue light is used instead of yellow light, we know that

$$\lambda_Y > \lambda_B$$

As the wavelength decreases due to blue light, fringe width will decrease.

(vi) (b) 9 : 5

Explanation :

For Balmer Series, $\frac{1}{\lambda} = R\left(\frac{1}{2^2} - \frac{1}{n^2}\right)$

For longest wavelength, $n = 3$

$$\frac{1}{\lambda_L} = R\left(\frac{1}{2^2} - \frac{1}{3^2}\right)$$

$$\frac{1}{\lambda_L} = \frac{5R}{36}$$

$$\lambda_L = \frac{36}{5R} \quad \text{...(i)}$$

For shortest wavelength, $n = \infty$

$$\frac{1}{\lambda_s} = R\left(\frac{1}{2^2} - \frac{1}{\infty^2}\right)$$

$$\Rightarrow \qquad \frac{1}{\lambda_s} = \frac{R}{2^2}$$

$$\Rightarrow \qquad \lambda_s = \frac{4}{R} \qquad \text{...(ii)}$$

Now from (i) and (ii)

$$\frac{\lambda_L}{\lambda_s} = \frac{\frac{36}{5R}}{\frac{4}{R}} \Rightarrow \frac{\lambda_L}{\lambda_s} = \frac{9}{5}$$

(vii) (b) 3 : 4

Explanation :

According to Einstein photoelectric equation

$$h\nu = h\nu_0 + K_{max}$$

For first metal $\qquad h\nu = h\left(\frac{3}{4}\nu\right) + K_1$

$$\Rightarrow \qquad K_1 = \frac{h\nu}{4}$$

For second metal $\qquad h\nu = h\left(\frac{2}{3}\nu\right) + K_2$

$$\Rightarrow \qquad K_2 = \frac{h\nu}{3}$$

Thus, the ratio is $\qquad \frac{K_1}{K_2} = \frac{h\nu/4}{h\nu/3} = \frac{3}{4}$

Section-B

Answer 2.

(i) Coherent sources of light are the sources which emit light waves of same frequency, same wavelength and have a constant initial phase difference.

Two independent light sources such as two bulbs or candles, cannot produce interference fringes, this is because the phase difference between the light waves emitted by such sources does not remain steady but varies continuously. This variation takes place so rapidly that due to persistence of vision, our eyes are unable to note it. The intensity of light to an eye at every point appears uniform, that's why interference pattern is not seen.

(ii) For Balmer Series, the wave number is :

$$\bar{\nu} = \frac{1}{\lambda} = R\left[\frac{1}{2^2} - \frac{1}{n^2}\right]$$

For H_α line, $n = 3$ and $\lambda = 6553$ Å. Hence

$$\frac{1}{6553 \times 10^{-10}} = R\left[\frac{1}{2^2} - \frac{1}{3^2}\right] = \frac{5}{36}R$$

or $\qquad R = \frac{36 \times 10^{10}}{5 \times 6553} = 10987334 \cdot 05 \text{ m}^{-1}$

Answer 3.

(i) Here, least distance of distinct vision

$$D = 25 \text{ cm}$$

$u_o = -1.6$ cm, $f_o = 1.5$ cm, $f_e = 5$ cm, M = ?

For objective :

$$-\frac{1}{u_o} + \frac{1}{v_o} = \frac{1}{f_o}$$

$$\Rightarrow \quad \frac{1}{v_o} = \frac{1}{f_o} + \frac{1}{u_o}$$

$$\Rightarrow \quad \frac{1}{v_o} = \frac{1}{1.5} + \left(\frac{1}{-1.6}\right)$$

$$\Rightarrow \quad \frac{1}{v_o} = 10\left[\frac{1}{15} - \frac{1}{16}\right] = \frac{10}{15 \times 16}$$

$$\Rightarrow \quad v_0 = \frac{16 \times 15}{10}$$

$$= 1.6 \times 15 \text{ cm} = 24 \text{ cm}$$

Now magnifying power

$$|M| = \frac{v_o}{|u_o|}\left(1 + \frac{D}{fe}\right) = \frac{1.6 \times 15}{1.6}\left[1 + \frac{25}{5}\right]$$

$$= 15 \times 6 = 90$$

OR

(ii) Given $f_1 = -20$ cm (concave lens), $f_2 = 25$ cm (convex lens)

The focal length of the combination is,

$$\frac{1}{F} = \frac{1}{f_1} + \frac{1}{f_2}$$

$$= \frac{1}{-20} + \frac{1}{25}$$

$$= -\frac{1}{100}$$

or $\quad F = -100 \text{ cm} = -1{\cdot}0 \text{ m}$

The lens system is a diverging lens.

Power of the lens system is

$$P = \frac{1}{F \text{ (in metre)}} = -\frac{1}{1{\cdot}0} = -1{\cdot}0 \text{ D}$$

Answer 4.

(i) **Dispersive power :** The dispersive power of the material of a prism for two colours, is defined as the ratio of the angular dispersion between two colours to the deviation produced by the mean colour.

i.e. $$\omega = \frac{\delta_V - \delta_R}{\delta_Y}$$

or $$\omega = \frac{\mu_V - \mu_R}{\mu_Y - 1}$$

Given, $\mu_V = 1.632$ (Refractive index for violet)

$\mu_Y = 1.620$ (Refractive index for yellow)

$\mu_R = 1.613$ (Refractive index for red)

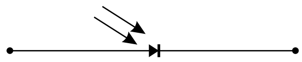
Thus, $$\omega = \frac{\mu_V - \mu_R}{\mu_Y - 1} = \frac{1.632 - 1.613}{1.620 - 1} = 0.03$$

(ii) Magnifying power (m) is defined as the ratio of visual angle subtended by the image at the eye (β) to the visual angle subtented by the object at the eye (α) when placed at least distance of distinct vision (D).

i.e
$$m = \frac{\beta}{\alpha}$$

Answer 5.

(i) It is a reverse biased p–n junction. Photodiode is an optoelectronic device. In this current carriers (electron and holes) are created by photon's through a process called photoconduction by light or photo excitation. It is made of photosensitive semiconducting materials.



Photodiode

Photodiode is also used in optical communication equipments.

(ii) Under an applied electric field both the current carriers, *i.e.*, electron's and holes acquire an average velocity, called drift velocity (v).

It is defined as the average velocity acquired by the charge carriers of the semiconductor under the influence of an electric field.

Drift velocity ∝ electric field.

i.e
$$v \propto E$$
$$v = \mu E$$

Where μ is the constant and called the mobility of charge carriers.

Answer 6.

(i) We know that,
$$\lambda = \frac{h}{\sqrt{2mE}} \quad \text{...(i)}$$

and
$$\lambda' = \frac{h}{\sqrt{2m \times 4E}} \quad \text{...(ii)}$$

Divided eq. (ii) by (i),

$$\therefore \quad \frac{\lambda'}{\lambda} = \frac{\dfrac{h}{\sqrt{2m \times 4E}}}{\dfrac{h}{\sqrt{2mE}}}$$
$$\frac{\lambda'}{\lambda} = \frac{1}{2}$$
$$\lambda' = \frac{\lambda}{2}$$

Therefore, the De-Broglie wavelength becomes half of the original.

OR

(ii) Given,
$$W_0 = 4.50 \text{ eV}, h\nu = 5.80 \text{ eV}$$

Since,
$$K.E_{max} = h\nu - W_0$$
$$K.E_{max} = (5.8 - 4.5) \text{ eV} = 1.3 \text{ eV}$$
$$K.E_{max} = 1.3 \times 1.6 \times 10^{-19} \text{ J}$$

From formula,
$$v_{max} = \sqrt{\frac{2K.E_{max}}{m}} \quad \left[\because KE = \frac{1}{2}mv^2\right]$$

$$\therefore \quad v_{max} = \sqrt{\frac{2 \times 1.3 \times 1.6 \times 10^{-19}}{9.1 \times 10^{-31}}}$$

$$\Rightarrow \quad v_{max} = \sqrt{\frac{2.6 \times 1.6}{9.1} \times 10^{12}}$$
$$= 0.676 \times 10^6 \text{ ms}^{-1}$$
$$v_{max} = 676 \text{ km s}^{-1}$$

Section-C

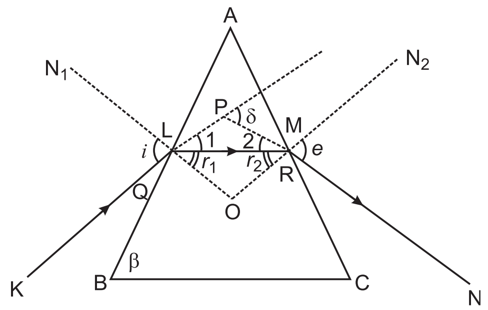
Answer 7.

(i) ΔABC is a principal section of the prism. A ray of light KL is incident on the face AB of the prism and the refracted ray LM is incident at r_2 on the face AC of the prism. The angle of deviation is δ.

In ΔPLM, $\delta = 1 + 2$ ...(i)

$i = 1 + r_1$ ...(ii)

$e = 2 + r_2$ ...(iii)



On adding equation (ii) and (iii), we get

or $i + e = 1 + 2 + r_1 + r_2$

$i + e = \delta + r_1 + r_2$ [from eq. (i)] ...(iv)

Again $A + \angle LOM = \angle 180°$ [opposite angles of a cyclic quadrilateral] ...(v)

and $r_1 + r_2 + \angle LOM = 180°$ ...(vi)

From equations (v) and (vi),

$A + \angle LOM = r_1 + r_2 + \angle LOM$

or $A = r_1 + r_2$ ...(vii)

Putting this value in (iv), we get

$i + e = \delta + A$

which is the required relation.

OR

(ii) Let XY be an plane reflecting surface and AMB, the incident plane wavefront. All the particles on AB will be vibrating in phase. Let i be the angle of incidence and r the angle of reflection. In the time, the disturbance at A reaches C, the secondary waves from the point B must travel a distance BD equal to AC. With the point B as centre and radius equal to AC a sphere is constructed.

From the point C, we draw tangents CD and CD′.

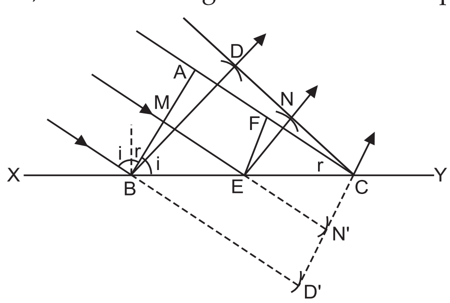
Then, BD = BD′

In ΔBAC and ΔBDC, BC is common, BD = AC and $\angle BAC = \angle BDC = 90°$

$\therefore$ $\Delta BAC \cong \Delta BDC$

and $\angle ABC = \angle BCD$

But $\angle ABC = i$ and $\angle BCD = r$, *i.e.*, $i = r$ or the angle of incidence is equal to the angle of reflection.

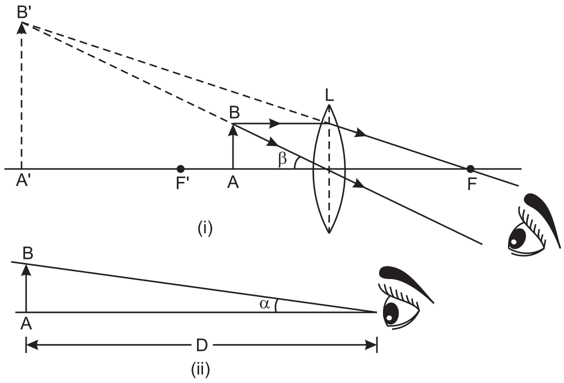


Since AB, AD and XY are in the same plane. Therefore, the incident ray, reflected ray and normal at the point of incidence are all in the same plane. This is the first law of reflection.

Answer 8.

A simple microscope is an optical instrument which forms large image of a close and minute object. This image subtends a large visual angle at the eye so that the object looks large.

In the simplest form, a simple microscope, or magnifying glass is just a thin, short-focus convex lens carrying a handle. The object to be seen is placed between the lens and its focus and the eye is placed just behind the lens. Then, the eye see a magnified, erect and virtual image on the same side as the object. The position of the object between the lens and its focus is so adjusted that the image is formed at the least distance of distinct vision (D) from the eye. The image is then seen most distinctly.



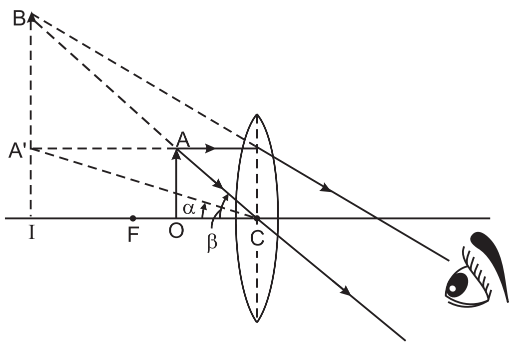
In Fig. (i) AB is a small object placed between a lens L and its first focus F′. Its magnified virtual image A′B′ is formed at distance D from the lens. Since the eye is just behind the lens, the distance of the image A′B′ from the eye is also D.

Magnifying power : Let ‘β’ be the angle subtended by the image A′ B′ at the eye and ‘α’ be the angle subtended by the object OA at the eye when placed directly at a distance D from the eye [fig. (iii)]. Then, the magnifying power of the simple microscope is given by

$$M = \frac{\text{Angle subtended by the image at the eye } (\beta)}{\text{Angle subtended by the object at the eye when placed at least distance of distinct vision } (\alpha)}$$

Since the object is small, the angles α and β are also small. Then, we may write

$\tan\beta \approx \beta$ and $\tan\alpha \approx \alpha$



From the triangle IBC,

$$\tan\beta = \frac{IB}{IC}$$

From the triangle IA′C,

$$\tan\alpha = \frac{IA'}{IC}$$

$$M = \frac{\tan\beta}{\tan\alpha} = \frac{IB}{IC} \times \frac{IC}{IA'}$$

$$M = \frac{IB}{IA'}$$

$$M = \frac{IB}{OA} \qquad [\because IA' = OA]$$

But $\frac{IB}{OA}$ = Linear magnification

Hence, when the simple microscope is adjusted such that the image is formed at the near point, the angular magnification is equal to the linear magnification. Applying new Cartesian sign convention, u is –ve, v is –ve and f is + ve.

Therefore, the lens equation is,

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

$$\Rightarrow \quad \frac{v}{v} - \frac{v}{u} = \frac{v}{f}$$

$$\Rightarrow \quad 1 - M = -\frac{D}{f} \qquad [\because v = -D]$$

$$M = 1 + \frac{D}{f}$$

Answer 9.

The focal length of the lens in air,

$$\frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

Where, $f = 20$ cm.

and $_an_g = n = 1{\cdot}5$

$$\Rightarrow \quad \frac{1}{20} = (1{\cdot}5 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) \qquad \text{...(i)}$$

Let the focal length of the lens in water is f'.

Also $$n' = {}_wn_g = \frac{_an_g}{_an_w} = \frac{1{\cdot}5}{1{\cdot}65}$$

Thus, $$\frac{1}{f'} = (n'-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$\Rightarrow \quad \frac{1}{f'} = \left(\frac{1{\cdot}5}{1{\cdot}65} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) \qquad \text{...(ii)}$$

Dividing equation (i) by equation (ii),

$$\frac{f'}{20} = \frac{(1{\cdot}5 - 1)}{\left(\frac{1{\cdot}5}{1{\cdot}65} - 1\right)}$$

$$\frac{f'}{20} = \frac{1{\cdot}65\,(1{\cdot}5 - 1)}{(1{\cdot}5 - 1{\cdot}65)}$$

$$\frac{f'}{20} = \frac{1{\cdot}65 \times 0{\cdot}5}{-0{\cdot}15}$$

$$\Rightarrow \quad f' = -\frac{1{\cdot}65 \times 0{\cdot}5}{0{\cdot}15} \times 20$$

$$= -110 \text{ cm.}$$

Thus, the lens will behave like a diverging (concave) lens.

Answer 10.

Expression for the radius of the first orbit of hydrogen atom : According to the third postulates of Bohr's theory, if an electron energy in the higher orbit be E_2 and that in the lower orbit be E_1, then the frequency ν of the radiated waves is given by,

$$h\nu = E_2 - E_1$$

At a distance r from the nucleus, the necessary centripetal force of the electron is provided by electrostatic force

$$\therefore \qquad \frac{mv^2}{r} = \frac{1}{4\pi\varepsilon_0}\frac{Ze^2}{r^2}$$

$$\text{or} \qquad mv^2 = \frac{1}{4\pi\varepsilon_0}\frac{Ze^2}{r} \qquad \ldots\text{(i)}$$

From the second postulate, the angular momentum of the electron is

$$mvr = n\frac{h}{2\pi} \qquad \ldots\text{(ii)}$$

Where, $n = 1, 2, 3 \ldots\ldots$ are quantum numbers.

Squaring equation (ii) and dividing by equation (i), we get

$$r = n^2 \frac{h^2\varepsilon_0}{\pi m Z e^2} \qquad \ldots\text{(iii)}$$

This is the equation for the radius of the permitted orbits.

According to this equation, the radius of the first orbit is :

$$r_1 = \frac{h^2\varepsilon_0}{\pi m Z e^2}$$

For Hydrogen atom, Z = 1

$$\text{So,} \qquad r_1 = \frac{h^2\varepsilon_0}{\pi m\, e^2}$$

Answer 11.

(i) (c) $E_n = \frac{-13.6}{n^2}$

In first excited state, $E_{H_2} = 3.4$ eV and $E_{He} = -13.6$ eV

So, H_2 atom gives excitation energy

(13.6 – 3.4 = 10.2 eV) to helium atom

Now, energy of He ion = – 13.6 + 10.2 = 3.4 eV

$$\text{Again,} \qquad E = \frac{-13.6}{n^2} \times Z^2$$

$$\Rightarrow \qquad -3.4 = \frac{-13.6}{n^2} \times (2)^2$$

$$\Rightarrow \qquad n = 4$$

(ii) (c)

$$\frac{1}{\lambda} = \frac{13.6\,Z^2}{hc}\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right] \qquad \ldots\text{(i)}$$

Here, $n_1 = 3$ and $n_2 = 4$

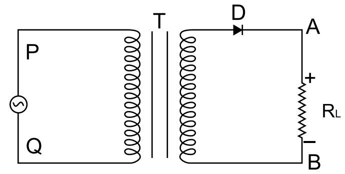
$\Rightarrow \qquad \lambda = 4.8 \times 10^{-7}$ m (on solving eqn (i))

Answer 12.

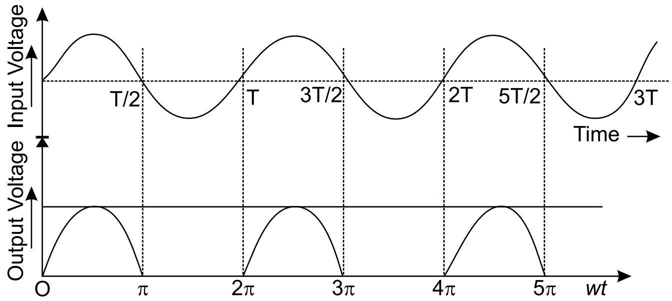
(i) (a) The process of converting alternating current into the direct current is called rectification, the device used is called rectifier. A *p–n* junction can use as rectifier.

Half-wave Rectifier :

If only one-half of A.C. is rectified, it is called half wave rectifier.

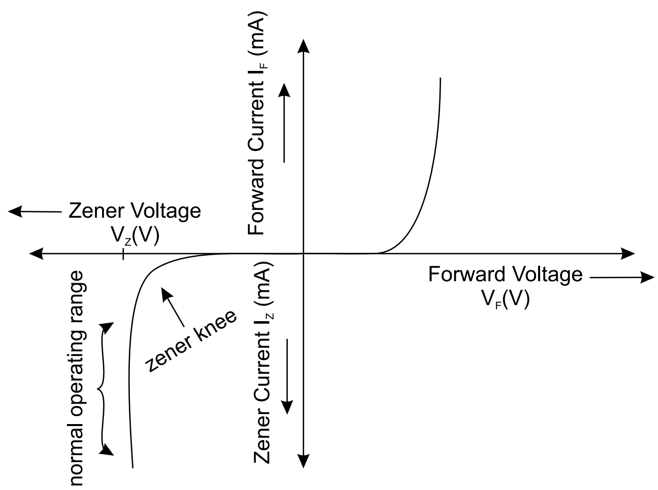


The input A.C. is applied across the primary of transformer T. The secondary is connected in the series to the *p-n* Junction diode D and external load resistance R_L.



(b) **Zener–diode**

The zener diode is properly doped *p-n* Junction diode, which has a sharp breakdown voltage. It is always reverse-biased. It is also called breakdown diode, because it works in breakdown region of characteristics.



A graph of current through Vs the voltage across the device is called characteristic of Zener diode. Once the reverse bias voltage become more than the Zener breakdown voltage, a significant amount of current starts flowing through the diode due to Zener breakdown the Zener diode does not get damaged despite the massive amount of current flowing it. This unique function makes it very useful for many applications.

OR

(ii) (a) A *p-n* junction diode is said to be forward biased when the positive terminal of a cell or battery is connected to the *p*-side of the junction and the negative terminal to the *n*-side.

When diode is forward-biased the depletion region narrows and consequently, the potential barrier is lowered. This causes the majority charge carriers of each region to cross into the other region. The electrons travel from the *n*-side to the *p*-side and go the positive terminal of the battery. The holes that travel from the *p*-side to the *n*-side combine with the electrons injected into the *n*-region from the negative terminal of the battery. This way the diode conducts when forward-biased.

A *p-n* junction diode is said to be reverse biased when the positive terminal of a cell or battery is connected to the *n*-side of the junction and the negative terminal to the *p*-side.

When reverse biased, the depletion region widens and the potential barrier is increased. The polarity of the battery extracts the majority charge carriers of each region. The holes in the *p*-region from the electrons injected into the *p*-region from the negative terminal of the battery. The electrons in the *n*-region go to the positive terminal of the battery. This way, the majority charge carrier concentration in each region decreases against the equilibrium values and the reverse biased junction diode has a high resistance. Thus, the diffusion current across the junction becomes zero. Thus, the diode not conduct when reverse biased and is said to be in a quiescent or non-conducting state *i.e.,* it acts as an open switch.

(b) Charge carrier created impure semiconductor through doping are called majority carriers. Charge carriers created through breaking of covalent bonds are called minority carriers for example, In *n*-type of semiconductor electrons are majority carriers and holes are minority carriers (in *p*-type this is reverse).

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