Aakash + BYJU'S

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MM : 70 **Time : 180 min.**

Mock Test Paper

CBSE Board Exam.-2024

Class-XII

PHYSICS

Complete Syllabus of Class XII

SECTION-A

1. Answer (2) **[1]**
2. Answer (2) **[1]**
3. Answer (4) **[1]**
4. Answer (4) **[1]**
5. Answer (3) **[1]**
6. Answer (2) **[1]**
7. Answer (2) **[1]**
8. Answer (4) **[1]**
9. Answer (1) **[1]**
10. Answer (2)

$F = \frac{Kq_1q_2}{r^2}$

1^{st} case:

$12 = K\frac{2\ \mu C \times 6\ \mu C}{r^2}$ …(i)

2^{nd} case:

q_1 = +2 μC – 4 μC = – 2μC

q_2 = +6 μC – 4 μC = + 2μC

$F = K \times \frac{(-2\ \mu C) \times (+2\ \mu C)}{r^2}$ …(ii)

Divide equation (i) and (ii)

$\frac{12}{F} = \frac{12}{-4} \Rightarrow F = -4$ N

Charges are of opposite sign, hence force is attractive. **[1]**

11. Answer (1)

Change in potential energy $\Rightarrow \Delta U = \Delta V \times q$

ΔV is positive

$\therefore$ ΔU will also be positive. **[1]**

12. Answer (2)

Energy of photon $\Rightarrow E = \frac{12400}{4000}\text{ eV} = 3.1\text{ eV}$

Photoelectric equation,

$E = \phi + KE_{max} \Rightarrow KE_{max} = 3.1\text{ eV} - 2.0\text{ eV}$

KE_{max} = 1.1 eV **[1]**

13. Answer (4)

An electromagnetic wave cannot be deflected by magnetic or electric since it is not consist of charge particles. **[1]**

14. Answer (3)

- Faraday's law is, in fundamental, a consequence of energy conservation.
- In purely resistive circuit, the current and emf are in phase. **[1]**

15. Answer (2)

- An electric charge always produce electric field whether it is in rest or in motion.
- A moving charge produces magnetic field along with electric field. **[1]**

16. Answer (1)

$\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ **[1]**

SECTION-B

17. An electron revolving in an orbit of H-atom, has both kinetic energy and electrostatic potential energy. Kinetic energy of the electron revolving in a circular orbit of radius r is $E_K = \frac{1}{2}mv^2$

Since, $\frac{mv^2}{r} = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{r^2}$

$\therefore \quad E_K = \frac{1}{2} \times \frac{1}{4\pi\varepsilon_0}\frac{e^2}{r}$ or $E_K = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{2r}$ ...(i) **[½]**

Electrostatic potential energy of electron of charge –e revolving around the nucleus of charge +e in an orbit of radius r is

$E_P = \frac{1}{4\pi\varepsilon_0}\frac{+e \times -e}{r}$ or $E_P = -\frac{1}{4\pi\varepsilon_0}\frac{e^2}{r}$ ...(ii)

So, total energy of electron in orbit of radius r is

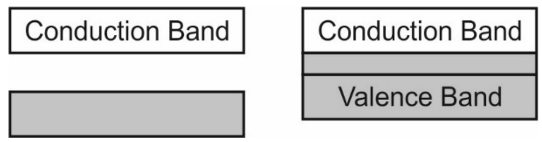
$E = E_K + E_P$ or $E = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{2r} - \frac{1}{4\pi\varepsilon_0}\frac{e^2}{r}$

or $E = -\frac{1}{4\pi\varepsilon_0}\frac{e^2}{2r}$ **[1]**

The –ve sign of the energy of electron indicates that the electron and nucleus together form a bound system *i.e.*, electron is bound to the nucleus. **[½]**

18. **Metals:**

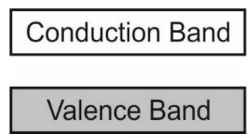
(a) For metals, the valence band is completely filled and the conduction band can have two possibilities-either it is partially filled with an extremely small energy gap between the valence and conduction bands or it is empty, with the two bands overlapping each other as shown below



On applying even a small electric field, metals can conduct electricity. **[1]**

Insulators:

(a) For insulator, the energy gap between the conduction and valence bands is very large. Also, the conduction band is practically empty, as shown below:



When an electric field is applied across such a solid, the electron find it difficult to acquire such a large amount of energy to reach the conduction band. Thus, the conduction band continues to be empty. That is why no current flows through insulators. **[1]**

19. (i) A dielectric whose molecules posses electric dipole moment even when electric field is not applied is called polar dielectric. **[1]**

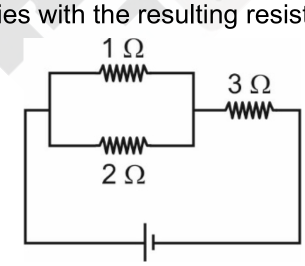
(ii) On the other hand a dielectric, whose molecule do not posses permanent dipole moment, is called non-polar dielectric. **[1]**

20. For dc, capacitor is an open circuit because $X_C = \frac{1}{\omega C} = \infty,$ the lamp will not glow at all, even if C is reduced. **[1]**

For ac, the lamp will glow because capacitor conducts ac. If C is reduced, the reactance X_c will increase and the brightness of the lamp will decrease further. **[1]**

OR

(a) To get the equivalent resistance of $\frac{11}{3}\Omega,$ the resistance of 1 Ω and 2 Ω must be in parallel and resistance of 3 Ω should be connected in series with the resulting resistance.



Equivalent resistance of the parallel combination of 1 Ω and 2 Ω is given by

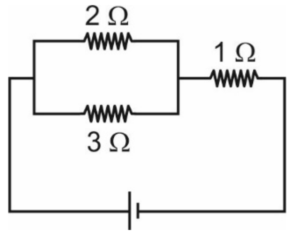
$$\frac{1}{R} = \frac{1}{1} + \frac{1}{2} \Rightarrow \frac{1}{R} = \frac{3}{2} \Rightarrow R = \frac{2}{3}$$

Now, resistance 3 Ω is connected in series to the resultant resistance. Here, the equivalent resistance is given by

$$R' = R + 3 \Rightarrow R' = \frac{2}{3} + 3$$

$$\Rightarrow R' = \frac{11}{3}\Omega$$ (The required value of equivalent resistance) **[1]**

(b) To get the equivalent resistance of $\frac{11}{5}\Omega$, the resistance of 2 Ω and 3 Ω must be in parallel and resistance of 1 Ω should be connected in series with the resulting resistance.



Equivalent resistance of the parallel combination of 2 Ω and 3 Ω is

$\frac{1}{R}=\frac{1}{2}+\frac{1}{3} \Rightarrow \frac{1}{R}=\frac{5}{6} \Rightarrow R=\frac{6}{5}$

Now, resistance 1 Ω is connected in series to the resultant resistance.

Here, the equivalent resistance is given by

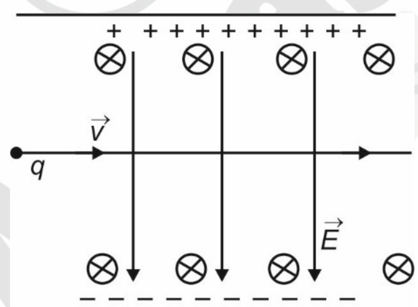
$R' = R + 1$

$\Rightarrow R=\frac{6}{5}+1 \Rightarrow R=\frac{11}{5}\Omega$ **[1]**

(The required value of equivalent resistance).

21. In the presence of electric field and magnetic field, the net force on a moving charged particle is called Lorentz force given by $\vec{F}=q\vec{E}+q(\vec{v}\times\vec{B})$. **[1]**

If a charged particle passes through a region of uniform mutually perpendicular electric and magnetic fields undeflected, then



Force due to magnetic field = force due to electric field

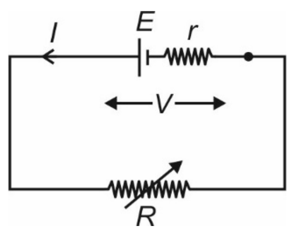
or $qvB = qE$ or $v=\frac{E}{B}$ **[1]**

that gives the velocity of charged particle.

SECTION-C

22. (a) Given situation is shown in figure

$I=\frac{E}{r+R}$

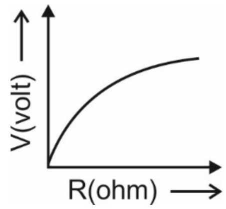


(i) V versus R,

Terminal voltage,

$V = E - Ir$

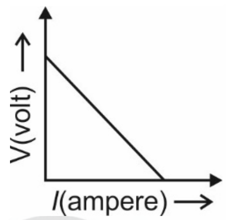
$$V = E - Ir = E - \frac{E}{r+R}r = \frac{ER}{r+R}$$



[1]

(ii) V versus I,

$V = E - Ir$



[1]

(b) When $R = 4\ \Omega$, then $I_1 = 1$ A

$$\therefore\ 1 = \frac{E}{r+4};\ r+4 = E \qquad \text{...(i)}$$

When $R = 9\ \Omega$, then $I = 0.5\ \text{A} = \frac{1}{2}$ A

$$\therefore\ \frac{1}{2} = \frac{E}{r+9} = \frac{r+4}{r+9}$$

$r + 9 = 2r + 8$, $r = 1\ \Omega$ **[1]**

From eqn. (i)

emf, $E = 1 + 4 = 5$ V

23. (a) Initial electric field between the plates of parallel plate capacitor $E_0 = \frac{\sigma}{\varepsilon_0} = \frac{q/A}{\varepsilon_0} = \frac{q}{A\varepsilon_0}$

After introduction of dielectric; the permittivity of medium becomes $K\varepsilon_0$.

So, final electric field between the plates of parallel plate capacitor $E = \frac{q}{AK\varepsilon_0} = \frac{E_0}{K}$

i.e., electric field reduces to $\frac{1}{K}$ times. **[1]**

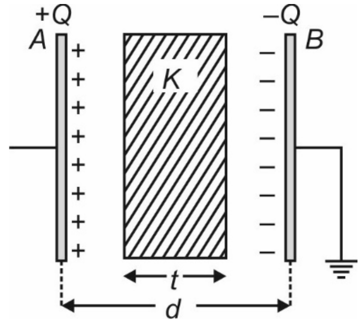
(b) Consider a parallel plate capacitor, area of each plate being A, the separation between the plates being d. Let a dielectric slab of dielectric constant K and thickness $t < d$ be placed between the plates. The thickness of air between the plates is $(d - t)$. If charges on plates are $+Q$ and $-Q$ then surface charge density

$$\sigma = \frac{Q}{A}$$

The electric field between the plates in air,

$$E = \frac{\sigma}{\varepsilon_0} = \frac{Q}{\varepsilon_0 A}$$ **[½]**

The electric field between the plates in the slab,



$$E_2 = \frac{\sigma}{K\varepsilon_0} = \frac{Q}{K\varepsilon_0 A}$$

$\therefore$ The potential difference between the plates V_{AB} = work done in carrying unit positive charge from one plate to another

$= \sum Ex$ (as field between the plates is not constant).

$$= E_1(d-t) + E_2 t = \frac{Q}{\varepsilon_0 A}(d-t) + \frac{Q}{K\varepsilon_0 A}t$$

$$\therefore \quad V_{AB} = \frac{Q}{\varepsilon_0 A}\left[d - t + \frac{t}{K}\right]$$ **[½]**

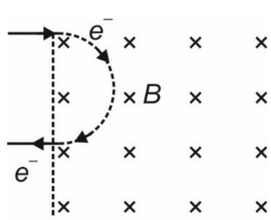
$\therefore$ Capacitance of capacitor,

$$C = \frac{Q}{V_{AB}} = \frac{Q}{\frac{Q}{\varepsilon_0 A}\left(d - t + \frac{t}{K}\right)}$$

or, $$C = \frac{\varepsilon_0 A}{d - t + \frac{t}{K}} = \frac{\varepsilon_0 A}{d - t\left(1 - \frac{1}{K}\right)}$$

Here, $t = \frac{d}{2}$

$$\therefore \quad C = \frac{\varepsilon_0 A}{d - \frac{d}{2}\left(1 - \frac{1}{K}\right)} = \frac{\varepsilon_0 A}{\frac{d}{2}\left(1 + \frac{1}{K}\right)}$$ **[1]**

24. 

Trajectory of electron **[1]**

Let the time taken by the electron to come out of the region of magnetic field be t.

Velocity of the electron, $v = 4 \times 10^4$ m/s

Magnetic field, $B = 10^{-5}$ T

Mass of the electron, $m = 9 \times 10^{-31}$ kg **[½]**

We know

$t = \frac{\pi r}{v}$ where $r = \frac{mv}{qB}$ **[½]**

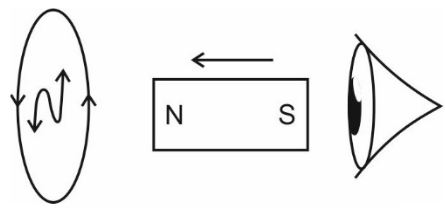
Now, $t = \frac{\pi m}{Bq} = \frac{3.14 \times 9 \times 10^{-31}}{10^{-5} \times 1.6 \times 10^{-19}}$

$\Rightarrow$ $t = 17.66 \times 10^{-7}$ s = 1.77 μs

Thus, the time taken by the electron to come out of the region of magnetic field is 1.77 μs. **[1]**

OR

Lenz's law states that the direction of the induced emf and the direction of induced current are such that they oppose the cause which produces them.



[1]

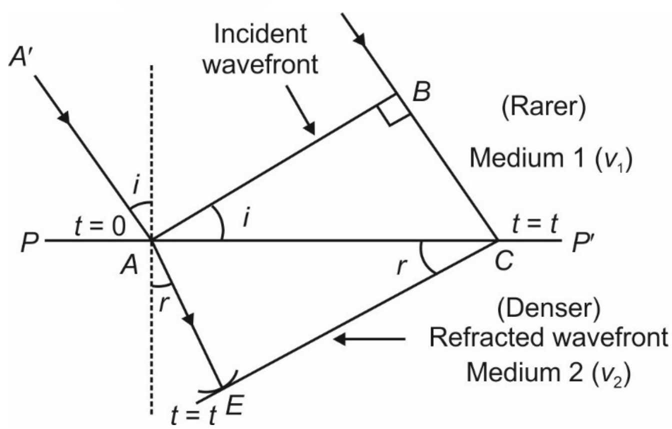
When the *N* pole of a magnet is moved towards a coil, the induced current in the coil flows in anticlockwise direction on the side of magnet, so as to acquire north polarity and oppose the motion of the magnet towards the coil, by applying repulsive force on it.

In order to continue the change in magnetic flux linked with the circuit, some work is to be done or some energy is to be spent against the opposition offered by induced EMF. This energy spent by the external source ultimately appears in the circuit in the form of electrical energy. **[1]**

Suppose that the Lenz's law is not valid. Then the induced current flows through the coil in a direction opposite to one directed by Lenz's law. The resulting force on the magnet makes it move faster and faster, i.e., the magnet gains speed and hence kinetic energy without expanding an equivalent amount of energy. This sets up a perpetual motion machine, violating the law of conservation of energy. Thus Lenz's law is valid and is a consequence of the law of conservation of energy. **[1]**

25. (a) **Wavefront:** The continuous locus of the particles of a medium, which are vibrating in the same phase is called a wavefront. **[½]**

(b) **Snell's law of refraction:** Let *PP′* represents the surface separating medium 1 and medium 2 as shown in figure.



[½]

Let v_1 and v_2 represents the speed of light in medium 1 and medium 2 respectively. We assume a plane wavefront *AB* propagating in the direction *A′A* incident on the interface at an angle *i* at *t* = 0. Let *t* be the time taken by the wavefront to travel the distance *BC*.

$\therefore$ $BC = v_1 t$ [$\because$ distance = speed × time]

In order to determine the shape of the refracted wavefront, we draw a sphere of radius $v_2 t$ from the point A in the second medium (the speed of the wave in second medium is v_2).

Let CE represents a tangent plane drawn from the point C. Then

$AE = v_2 t$

$\therefore$ CE would represent the refracted wavefront. In ΔABC and ΔAEC, we have

$$\sin i = \frac{BC}{AC} = \frac{v_1 t}{AC} \text{ and } \sin r = \frac{AE}{AC} = \frac{v_2 t}{AC}$$

Where i and r are the angles of incident and refraction respectively.

$$\therefore \quad \frac{\sin i}{\sin r} = \frac{v_1 t}{AC} \cdot \frac{AC}{v_2 t}$$

$$\frac{\sin i}{\sin r} = \frac{v_1}{v_2}$$ **[1]**

If c represents the speed of light in vacuum, then

$$\mu_1 = \frac{c}{v_1} \text{ and } \mu_2 = \frac{c}{v_2}$$

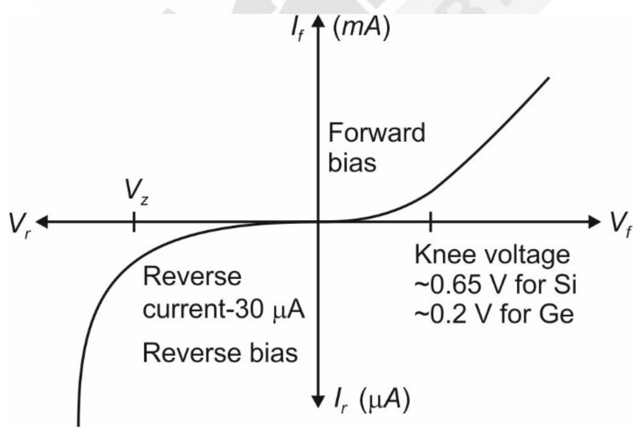
$$\Rightarrow \quad v_1 = \frac{c}{\mu_1} \text{ and } v_2 = \frac{c}{\mu_2}$$

Where μ_1 and μ_2 are the refractive indices of medium 1 and medium 2.

$$\therefore \quad \frac{\sin i}{\sin r} = \frac{c/\mu_1}{c/\mu_2} \Rightarrow \frac{\sin i}{\sin r} = \frac{\mu_2}{\mu_1} \Rightarrow \mu_1 \sin i = \mu_2 \sin r$$ **[1]**

This is the Snell's law of refraction.

26. **[1]**



The reverse current is due to minority charge carriers and even a small voltage is sufficient to sweep the minority carriers from one side of the junction to the other side of the junction. Here the current is not limited by the magnitude of the applied voltage but is limited due to the concentration of the minority carrier on either side of the junction. **[2]**

27. Given: wavelength in air, λ_a = 589 nm = 5.89×10^{-7} m

Refractive index of water, $\mu_w = 1.33$

$\because$ Speed of light in vacuum, $c = 3 \times 10^8$ m/s

$\therefore$ Frequency, $\upsilon = \dfrac{c}{\lambda_a}$

$= \dfrac{3 \times 10^8 \text{ m/s}}{5.89 \times 10^{-7} \text{ m}} = 5.093 \times 10^{14}$ Hz ($\because$ speed in air $\approx c$) **[1]**

Now, speed of light in water, $v = \dfrac{c}{\mu_w}$

$= \dfrac{3 \times 10^8 \text{ m/s}}{1.33} \approx 2.2605 \times 10^8$ m/s **[1]**

$\therefore$ Wavelength in water, $\lambda_w = \dfrac{v}{\nu}$

$= \dfrac{\frac{c}{\mu_w}}{\frac{c}{\lambda_a}} = \dfrac{\lambda_a}{\mu_w} = \dfrac{5.89 \times 10^{-7} \text{ m}}{1.33} \approx 4.43 \times 10^{-7}$ m **[1]**

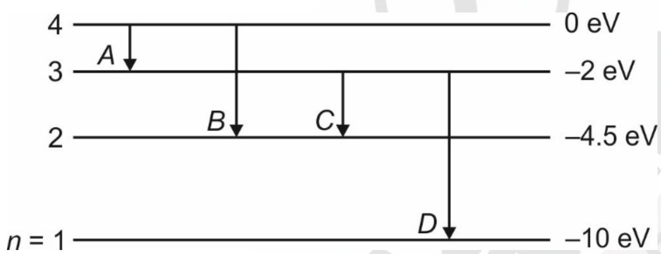
Thus, for the refracted light

Wavelength, $\lambda_w \approx 4.43 \times 10^{-7}$ m

Frequency, $\upsilon = 5.09 \times 10^{14}$ Hz and

Speed, $v \approx 2 \times 10^8$ m/s

28. (a)



The wavelength of emitted radiation from state (n = 4) to the state (n = 2) is

$\lambda = \dfrac{hc}{(E_4 - E_2)} = \dfrac{6.6 \times 10^{-34} \times 3 \times 10^8}{[0 - (-4.5)] \times 1.6 \times 10^{-19}}$ **[1]**

= 2.75×10^{-7} m = 275×10^{-9} m = 275 nm

Hence, transition shown by arrow *B* corresponds to emission of wavelength = 275 nm.

(b) (i) The maximum wavelength of emitted radiation from state n = 4 to n = 3 is

$\lambda = \dfrac{hc}{[0 - (-2)] \text{ eV}} \Rightarrow \lambda = \dfrac{6.6 \times 10^{-34} \times 3 \times 10^8}{2 \times 1.6 \times 10^{-19}}$

= 6.18×10^{-7} m = 618×10^{-9} m = 618 nm **[1]**

Hence transition *A* corresponds to maximum wavelength.

(ii) The minimum wavelength of emitted radiation from state n = 3 to n = 1 is

$\lambda = \dfrac{6.6 \times 10^{-34} \times 3 \times 10^8}{[-2 \text{ eV} - (-10 \text{ eV})]} = \dfrac{6.6 \times 10^{-34} \times 3 \times 10^8}{8 \times 1.6 \times 10^{-19}}$

$\lambda = 1.55 \times 10^{-7}$ m = 155 nm

Hence transition *D* corresponds to minimum wavelength. **[1]**

SECTION-D

29. (i) Answer (2)

$V = E - Ir$ **[1]**

(ii) Answer (2)

$E = 0.5\ (r + 12)$

$E = 0.25(r + 25)$

$$1 = \frac{2(r+12)}{(r+25)}$$

$r = 1\Omega$ **[1]**

(iii) Answer (1)

Potential difference across terminal may be less or more than emf. **[1]**

(iv) Answer (1)

For maximum current $r = R$ **[1]**

30. (i) Answer (3)

Law of reflection state the angle of incidence equals the angle of reflection. **[1]**

(ii) Answer (2)

Law of refraction state the angle of incidence and the angle of refraction. **[1]**

(iii) Answer (3)

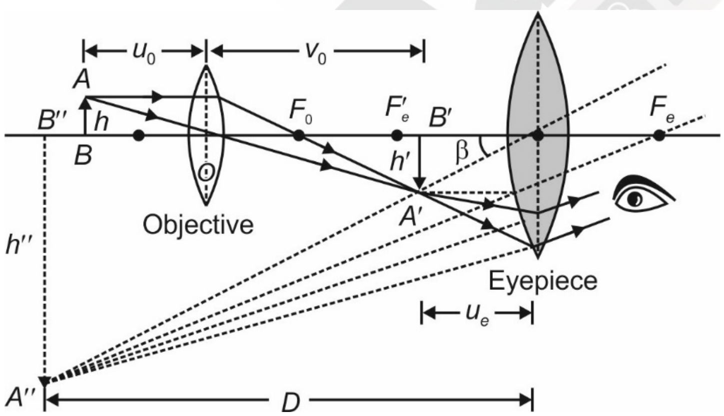
When light travel from one medium to another medium it may bends. **[1]**

(iv) Answer (2)

$1/f = 1/v - 1/u$ **[1]**

SECTION-E

31. (a) **[1]**



Limit of resolution: The minimum distance between two objects at which they can be seen separately by an optical instrument is known as limit of resolution of the instrument.

Limit of resolution depends upon the wavelength of the light used and the cone angle of light rays entering the microscope from the object.

$$d = \frac{1}{\text{RP of the microscope}}$$

where, RP is the resolving power and d is the limit of resolution. **[1]**

(b) Resolving power of a microscope can be increased by

(i) Decreasing the wavelength of light used

(ii) Increasing the diameter of objective lens of the microscope. **[1]**

(c) Through telescope, we see the objects that are at, large distance from the observer. These objects are already far apart from each other, but due to large distance from the observer, they do not appear distinctly. Thus, the telescope resolves these distant objects, so that we can see them distinctly. On the other hand, a microscope magnifies extremely small objects. Thus, one can say that “a telescope resolves whereas a microscope magnifies”. **[2]**

OR

Telescope	Microscope	
1. Resolving power should be higher for certain magnification.	1. Resolving power is not so large but the magnification should be higher.	[½]
2. Focal length of objective should be kept larger while eyepiece focal length should be small for better magnification.	2. Both objective and eyepiece should have less focal length for better magnification.	[½]
3. Objective should be of large aperture.	3. Eyepiece should be of large aperture.	[½]
4. Distance between objective and eyepiece is adjusted to focus the object at infinity.	4. Distance between objective and eyepiece is almost fixed. For focusing an object distance of objective is changed.	[½]

Here, f_0 = 1.25 cm, f_e = 5 cm, m = 30

In normal adjustment, image is formed at least distance of distinct vision, D = 25 cm.

Angular magnification of eyepiece.

$$m_e = \left(1+\frac{D}{f_e}\right) = \left(1+\frac{25}{5}\right) = 6$$ **[1]**

Total angular magnification, $m = m_0 m_e$

$\therefore$ Angular magnification of the objective is

$$m_0 = \frac{m}{m_e} = \frac{30}{6} = 5$$

As the objective forms the real image

$$\therefore \quad m_0 = \frac{v_0}{u_0} = -5 \quad \text{or} \quad v_0 = -5u_0$$ **[1]**

$$\text{As } \frac{1}{v_0} - \frac{1}{u_0} = \frac{1}{f_0} \quad \text{or} \quad \frac{1}{-5u_0} - \frac{1}{u_0} = \frac{1}{1.25}$$

$$\text{or } \frac{-6}{5u_0} = \frac{1}{1.25}$$

$$u_0 = -\frac{1.25 \times 6}{5} = -1.5 \text{ cm}$$ **[1]**

Therefore, the object should be held at 1.5 cm in front of the objective lens.

32. (a) For first line of Lyman series n_i = 2 **[½]**

$$\frac{1}{\lambda_{max}} = R\left(\frac{1}{1^2} - \frac{1}{2^2}\right) = \frac{3R}{4}$$ **[1]**

$$\lambda_{max} = \frac{4}{3R} = \frac{4}{3 \times 1.097 \times 10^7} = 1.215 \times 10^{-7} \text{ m}$$

λ_{max} = 1215 Å **[1]**

The lines of the Lyman series are found in ultraviolet region.

(b) For first line of Balmer series $n_i = 3$ **[½]**

$$\frac{1}{\lambda_{max}} = R\left(\frac{1}{2^2} - \frac{1}{3^2}\right) = \frac{5}{36}R$$ **[1]**

$$\lambda_{max} = \frac{36}{5R} = \frac{36}{5 \times 1.097 \times 10^7} = 6.563 \times 10^{-7} \text{ m}$$

= 6563 Å

Balmer series lie in the visible region of electromagnetic spectrum. **[1]**

OR

According to Bohr's postulates, in a hydrogen atom, as single electron revolves around a nucleus of charge +e. For an electron moving with a uniform speed in a circular orbit of a given radius, the centripetal force is provided by coulomb force of attraction between the electron and the nucleus. The gravitational attraction may be neglected as the masses of electron and proton are very small.

So, $\frac{mv^2}{r} = \frac{ke^2}{r^2}$ $\left(\text{Where, } k = \frac{1}{4\pi\varepsilon_0}\right)$

or $mv^2 = \frac{ke^2}{r}$ ...(i)

Where, m = mass of electron

r = radius of electronic orbit

v = speed of electron **[1]**

Again, by Bohr's second postulates

$$mvr = \frac{nh}{2\pi}$$

Where, n = 1, 2, 3...... or $v = \frac{nh}{2\pi mr}$

Putting the value of v in eq. (i)

$$m\left(\frac{nh}{2\pi mr}\right)^2 = \frac{ke^2}{r} \Rightarrow r = \frac{n^2h^2}{4\pi^2kme^2} \quad ...(ii)$$ **[1]**

Kinetic energy of electron,

$$E_K = \frac{1}{2}mv^2 = \frac{ke^2}{2r} \quad \left(\because \frac{mv^2}{r} = \frac{ke^2}{r^2}\right)$$

Using eq. (ii) we get

$$E_K = \frac{ke^2}{2}\frac{4\pi^2kme^2}{n^2h^2} = \frac{2\pi^2k^2me^4}{n^2h^2}$$ **[1]**

Potential energy of electron,

$$E_p = \frac{k(e)\times(e)}{r} = -\frac{ke^2}{r}$$

Using eq. (ii), we get

$$E_p = -ke^2 \times \frac{4\pi^2 kme^2}{n^2h^2} = -\frac{4\pi k^2 me^4}{n^2h^2}$$ **[1]**

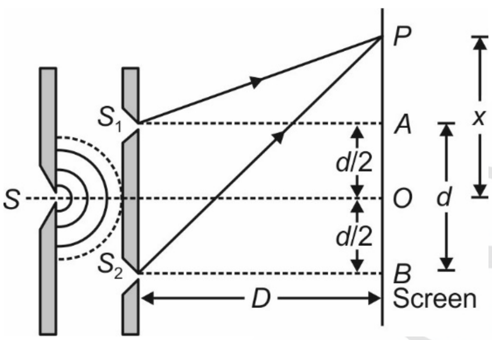
Hence, total energy of the electron in the n^{th} orbit

$E = E_p + E_k$

$$= -\frac{4\pi^2 k^2 me^4}{n^2h^2} + \frac{2\pi^2 k^2 me^4}{n^2h^2}$$

$$= -\frac{2\pi^2 k^2 me^4}{n^2h^2} = -\frac{13.6}{n^2}\text{ eV}$$ **[1]**

33. (a) Two independent monochromatic sources cannot produce sustained interference pattern, because the phase difference between the light waves reaching at a point from two independent sources keeps on changing continuously. **[1]**

(b) 

[1]

Consider a point P on the screen at distance x from the centre O. The nature of the interference at the point P depends on path difference,

Path difference $\Delta x = S_2P - S_1P$

From right-angled ΔS_2BP and ΔS_1AP,

$(S_2P)^2 - (S_1P)^2 = [S_2B^2 + PB^2] - [S_1A^2 + PA^2]$

$$= \left[D^2 + \left(x + \frac{d}{2}\right)^2\right] - \left[D^2 + \left(x - \frac{d}{2}\right)^2\right]$$

or $(S_2P - S_1P)(S_2P + S_1P) = 2xd$ **[1]**

or $S_2P - S_1P = \dfrac{2xd}{S_2P + S_1P}$

In practice, the point P lies very close to O, therefore $S_1P \simeq S_2P \simeq D.$ Hence

$$\Delta x = S_2P - S_1P = \frac{2xd}{2D}$$ **[1]**

or $\Delta x = \dfrac{xd}{D}$

Positions of bright fringes : For constructive interference,

$$\Delta x = \frac{xd}{D} = n\lambda$$

or $x = \dfrac{nD\lambda}{d}$ where $n = 0, 1, 2, 3, ...$

Positions of dark fringes: For destructive interference,

$$\Delta x = \frac{xd}{D} = (2n-1)\frac{\lambda}{2}$$

or $x = (2n-1)\frac{D\lambda}{2d}$ where $n = 1, 2, 3$

Width of a fringe = Separation between two consecutive bright or dark fringes

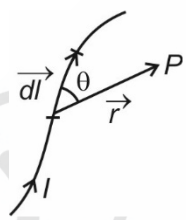
$$= x_n - x_{n-1} = \frac{nD\lambda}{d} - \frac{(n-1)D\lambda}{d} = \frac{D\lambda}{d}$$

$$\beta = \frac{D\lambda}{d}$$ **[1]**

OR

A current carrying wire produces a magnetic field around it. Biot-Savart law states that magnitude of intensity of small magnetic field $d\vec{B}$ due to current *I* carrying element $d\vec{l}$ at any point *P* at distance *r* from it is given by

$$|d\vec{B}| = \frac{\mu_0}{4\pi}\frac{Idl\sin\theta}{r^2}$$



[1]

where θ is the angle between $\vec{r}$ and $\vec{dl}$ and $\mu_0 = 4\pi \times 10^{-7}$ T m A^{-1} is called permittivity of free space.

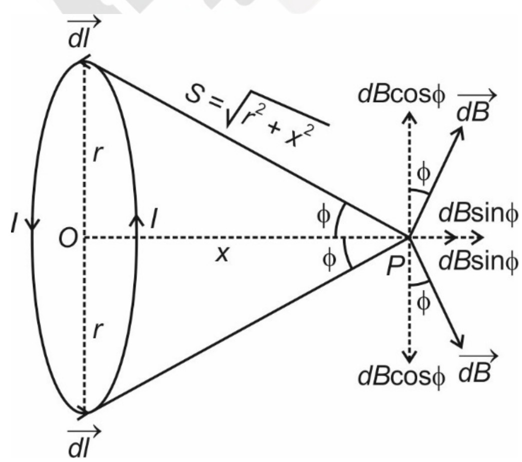
In vectorial form,

$$\vec{dB} = \frac{\mu_0 I}{4\pi}\frac{d\vec{l} \times \vec{r}}{r^3}$$ **[1]**

So, the direction of $d\vec{B}$ is perpendicular to the plane containing $\vec{r}$ and $d\vec{l}$.

S.I. unit of magnetic field strength is tesla denoted by '*T*' and cgs unit is gauss denoted by '*G*', where 1 T = 10^4 G

Magnetic field on the axis of circular coil



[1]

Small magnetic field due to current element of circular coil of radius *r* at point *P* at distance *x* from its centre is

$$dB = \frac{\mu_0}{4\pi}\frac{Idl\sin 90^\circ}{S^2} = \frac{\mu_0}{4\pi}\frac{Idl}{(r^2 + x^2)}$$

Component $dB\cos\phi$ due to current element at point P is cancelled by equal and opposite component $dB\cos\phi$ of another diametrically opposite current element, whereas the sine components $dB\sin\phi$ add up to give net magnetic field along the axis.

So, net magnetic field at point P due to entire loop is

$$B = \oint dB\sin\phi = \int_0^{2\pi r} \frac{\mu_0}{4\pi}\frac{Idl}{(r^2+x^2)}\cdot\frac{r}{(r^2+x^2)^{1/2}}$$ **[1]**

$$B = \frac{\mu_0 Ir}{4\pi(r^2+x^2)^{3/2}}\int_0^{2\pi r} dl \text{ or } B = \frac{\mu_0 Ir}{4\pi(r^2+x^2)^{3/2}}2\pi r$$

or $B = \dfrac{\mu_0 Ir^2}{2(r^2+x^2)^{3/2}}$ directed along the axis,

(a) Towards the coil if current in it is in clockwise direction

(b) Away from the coil if current in it is in anticlockwise direction. **[1]**

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