TOPPER SAMPLE PAPER 2

CLASS XII - PHYSICS

Solutions

1. Since the current does not obey triangular law of vector addition. 1

2. The current induced in the coil will oppose the approach of magnet, so nearer face of coil will act as north pole. Therefore on viewing from the magnet side the current in the coil will be anticlockwise. 1

3. In forward bias the current is represented by

$$i = i_0 \exp(\frac{eV}{2k_B T} - 1)$$

Where i_0 is called reverse saturation current, V is voltage across the diode, k_B is Boltzmann constant. 1

4. All electromagnetic waves travel in vacuum with same speed. $\frac{1}{2}$

$$\text{Ratio} = \frac{c_{\text{infrared}}}{c_{\text{ultraviolet}}} = 1 \qquad \frac{1}{2}$$

5. The size of the object will be magnified by a factor of $(M) = -\frac{f_o}{f_e} = -\frac{60}{5} = -12$

1

6. Nuclear density is independent of mass number so ratio of nuclear densities is 1 : 1.

1

7. As the voltage of a. c. power transmitted from one station to another is very large, the magnitude of the current is very low. Therefore the power loss is reduced in transmission of power as the power loss is given by $P = i^2 R$.

1

8. Because at absolute zero temperature semiconductor behaves as insulator. Therefore **semiconductor devices do not work at absolute zero temperature.**

1

9. Torque $\tau = pE\sin\theta$

$\frac{1}{2}$

$$\because\ p = 4\times10^{-9}\,\text{Cm},\ E = 5\times10^{4}\ \text{NC}^{-1},\ \theta = 30^{o} \qquad \frac{1}{2}$$

$\tau = 4\times10^{-9}\times5\times10^{4}\sin\theta = 30^{o}$ $\frac{1}{2}$

$\tau = 10^{-4}\,\text{Nm}$ $\frac{1}{2}$

10. Resistance $R = \frac{\rho\ell}{A} = \frac{\rho\ell}{\pi r^2}$ $\frac{1}{2}$

New radius $r' = r/2$ $\frac{1}{2}$

New length $\ell' = \ell/4$

$\therefore$ New resistance $R^1 = \frac{\rho\ell^1}{\pi r'^2} = \frac{\rho(\ell/4)}{\pi(r/2)^2} = \frac{\rho\ell}{\pi r^2} = R$ 1

Resistance of the wire will remain unchanged.

11. The fringe width in Young's double slit experiment comes out to be $\beta = \frac{\lambda D}{d}$, where D is the distance between slits and screen, d is slit width and λ is wavelength of light used.
1

If λ is small and d is large then the fringe width of interference pattern becomes so small that interference pattern becomes non-observable.

Therefore Young's double slit experiment the slit size is taken of the order of the wavelength of light used. 1

12. The magnetization of ferromagnetic materials depends both on the applied magnetic field and also on the history of magnetization (i. e., how many cycles of magnetization it has gone through etc.) 1
In other words, the value of magnetization is a record or memory of its cycles of magnetization. Since information bits can be made to correspond to these cycles. Therefore ferromagnetic materials which show hysteresis loop are used in memory devices. 1

2

13.

Wavelength $\lambda = \frac{c}{\nu} = \frac{3\times10^{8}}{6\times10^{12}} = 5\times10^{-5}\,\text{m}$ $\frac{1}{2}$

This wavelength corresponds to infrared waves. $\frac{1}{2}$

Applications of infrared waves:

(i) They are used in green houses to warm the plants. $\frac{1}{2}$

(ii) They are used in taking photographs during fogs. $\frac{1}{2}$

14. Given that

Refractive index of lens material with respect to air n_l = 1.5

Focal length of lens in air f_{air} = 18 cm

Refractive index of water n_w = 4 / 3

Since

$$\frac{1}{f} = ({}_1n_2 - 1)(\frac{1}{R_1} - \frac{1}{R_2}) \qquad \frac{1}{2}$$

For air medium

$$\frac{1}{18} = (1.5 - 1)(\frac{1}{R_1} - \frac{1}{R_2}) \qquad \text{............(1)} \qquad \frac{1}{2}$$

For water medium

$$\frac{1}{f_m} = (\frac{1.5}{4/3} - 1)(\frac{1}{R_1} - \frac{1}{R_2}) \qquad \text{............(2)} \qquad \frac{1}{2}$$

Dividing (1) by (2) and simplifying, we get

f_m = + 72 cm

Therefore change in focal length = 72 - 18 = 54 cm. $\frac{1}{2}$

15. Capacitance of parallel plate capacitor $C = \frac{\varepsilon_o A}{d} \propto A$ $\frac{1}{2}$

Plate area of C_2 is double to that of C_1, i.e., $C_2 = 2C_1$.

Slope of $q - V$ graph $= \frac{q}{V} = C$ $\frac{1}{2}$

As slope of A is greater than slope of *B*, so *A* corresponds to larger capacitance, i.e., C_2 and B to smaller capacitance, i.e., C_1. 1

16. According to Einstein, when a photon of incident light strikes on a bound electron of metal, its energy is used in two ways. $\frac{1}{2}$

(i)in overcoming work function of metal to free metallic electron.

(ii) In imparting kinetic energy to this freed electron.

i.e., $h\nu = w + E_k$ $\frac{1}{2}$

When $E_k = 0$, $\nu = \nu_0$ (threshold frequency), then

$$h\nu_0 = w + 0$$
$$w = h\nu_0 \qquad \frac{1}{2}$$

Therefore $\quad h\nu = h\nu_0 + E_k$

$$E_k = h(\nu - \nu_0)$$

so as the frequency of incident radiation ν increases the max. KE of photoelectrons also increases. $\frac{1}{2}$

OR

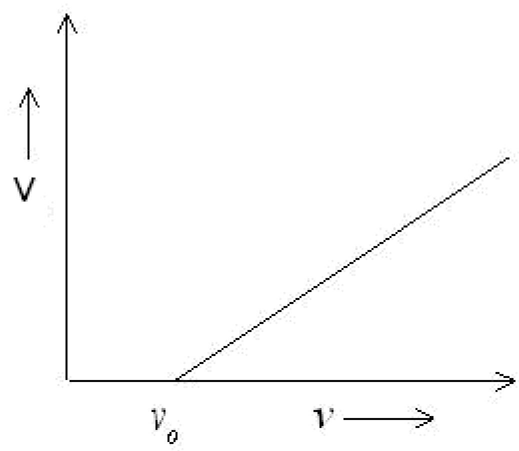
From Einstein's photoelectric equation

$$E_k = h\nu - h\nu_0$$

$$eV = h\nu - h\nu_0 \qquad (V = \text{stopping potential})$$

$$V = \frac{h}{e}\nu - \frac{h}{e}\nu_0 \qquad 1$$

Thus, V vs ν graph is a straight line of form $y = mx + c$ and the slope of graph is $m = \frac{h}{e}$.



1

17. The half-life of $^{14}_{6}C$ is 5700 years. It means that one half of the present number of radioactive nuclei of $^{14}_{6}C$ will remain undecayed after 5700 years. 1

Number of nuclei x after 2 hours, $N_X = N_o\left(\frac{1}{2}\right)^2 = \frac{N_o}{4}$

Number of nuclei y after 2 hours, $N_y = N_o\left(\frac{1}{2}\right)^1 = \frac{N_o}{2}$ $\frac{1}{2}$

$\therefore$ Ratio of disintegration $= = \frac{N_o/4}{N_o/2} = \frac{1}{2}$ $\frac{1}{2}$

18. In amplitude modulation (AM), the amplitude of modulated (carrier) wave varies in accordance with amplitude of information (signal) wave. When amplitude of information increases, the amplitude of modulated wave increases and vice – versa. 1

In frequency modulation (FM), the frequency of modulated wave varies in accordance with the frequency of the signal wave. In this case the amplitude of modulated wave is fixed. 1

19. (i)According to Gauss's law electric flux through S_1 1/2

$$\phi_1 = \frac{1}{\varepsilon_0}Q$$

and $$\phi_2 = \frac{1}{\varepsilon_0}(Q+2Q) = \frac{1}{\varepsilon_0}.3Q$$ 1/2

$$\frac{\phi_1}{\phi_2} = \frac{1}{3}$$

1/2

(ii)When a medium of dielectric constant K = 5 is introduced in the space inside S_1 in place of air, flux through S_1 will be modified to

$$\phi_1' = \frac{1}{\varepsilon}Q = \frac{1}{k\varepsilon_0}Q = \frac{\phi_1}{k} = \frac{\phi_1}{5}$$ 1

That means flux will be reduced to (1/5) of its previous value. 1/2

20. The described arrangement is equivalent to two capacitors joined in parallel where area of plates of either capacitor is $\frac{A}{2}$. Thus, $\frac{1}{2}$

$$C_1 = \frac{k_1\varepsilon_0(\frac{A}{2})}{d} = \frac{k_1\varepsilon_0 A}{2d}$$ $\frac{1}{2}$

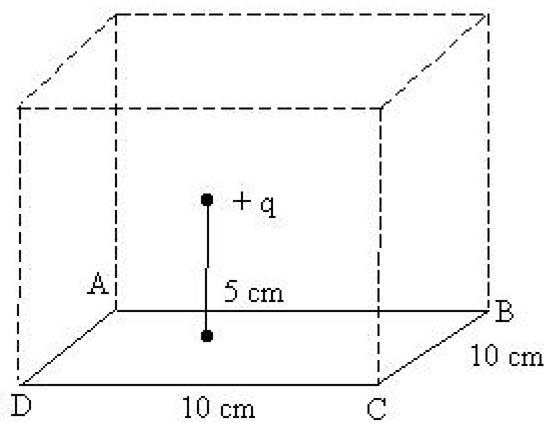
and $$C_2 = \frac{k_2\varepsilon_0(\frac{A}{2})}{d} = \frac{k_2\varepsilon_0 A}{2d}$$ $\frac{1}{2}$

Therefore net capacitance of the capacitor

$$C = C_1 + C_2 = \frac{k_1\varepsilon_0 A}{2d} + \frac{k_2\varepsilon_0 A}{2d}$$

$= \frac{\varepsilon_0 A}{d}\left(\frac{k_1+k_2}{2}\right)$ $\frac{1}{2}$

21. The given square ABCD of side 10 cm is one face of a cube of side 10 cm. At the center of this cube a charge + q = +10 μC is placed.



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According to Gauss's theorem, total electric through the six faces of cube

$= q/\varepsilon_0$ 1

$\therefore$ Total electric flux through square face ABCD of the cube $= \frac{1}{6}\frac{q}{\varepsilon_0}$

$$= \frac{1}{6} \times \frac{10 \times 10^{-6}}{8.85 \times 10^{-12}} = 1.88 \times 10^5 \; Nm^2C^{-1}.$$ 1

OR

Since the air is replaced by another dielectric medium of dielectric constant 10 without disconnecting the capacitor from d. c. source. Hence, potential difference between the plates of capacitor remains unchanged. Consequently, electric field between the plates ($E = \frac{V}{d}$) remains unchanged.

$1\frac{1}{2}$

Now capacitance of capacitor with dielectric $C_m = kC = 10C$

$\frac{1}{2}$

Therefore new energy stored in capacitor

$$U_m = \frac{1}{2}C_m V^2 = \frac{1}{2}(10C)V^2 = 10(\frac{1}{2}CV^2) = 10U$$ 1

Thus, energy stored becomes 10 times the value with air as dielectric.

22. (a) The are many benefits of true friendship.
(i) You are not alone at any circumstances that come across your life. A friend is there to help you out at the worst situations and share you happiness to spread it all around.
(ii) You can openly share your feelings with your friends so that they may guide you of what is wrong or right without misguiding. 1
(b) Given, far point, v = -0.1 m =
u = ∞

$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u} = \frac{1}{-10} - \frac{1}{\infty} = -\frac{1}{10}$$

$f = -10\,\text{cm}$ 2

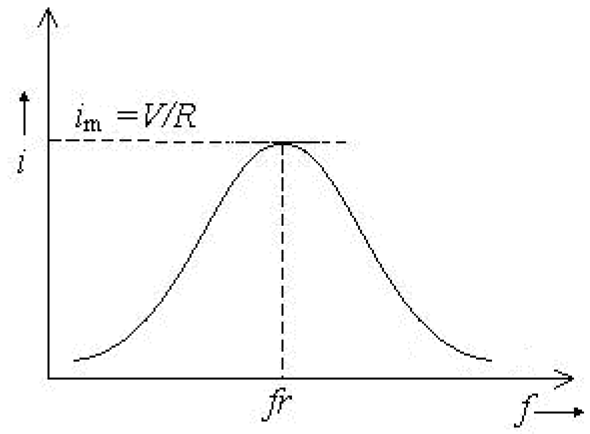
$$P = \frac{100}{f} = \frac{100}{-10} = -10\,D$$

23. The resonance in series LCR circuit occurs when inductive reactance is equal to capacitive reactance, i.e., $X_L = X_c$ 1

$$\omega L = \frac{1}{\omega C} \Rightarrow \omega^2 = \frac{1}{LC}$$ 1/2

$$\omega = \frac{1}{\sqrt{LC}} \Rightarrow f_r = \frac{1}{2\pi}\frac{1}{\sqrt{LC}}$$ 1/2

Graph is shown in given figure.



1

24. $\because$ Intensity $\propto$ (amplitude)^2

$$I \propto A^2$$ 1

$$\frac{I_1}{I_2} = \frac{A_1^{\ 2}}{A_2^2} = \frac{81}{1}.$$

$$\Rightarrow \quad \frac{A_1}{A_2} = \frac{9}{1}$$

1

$$\because \quad \frac{I\max}{I\min} = \frac{(A_1 + A_2)^2}{(A_1 - A_2)^2} = \frac{\left(\frac{A_1}{A_2}\right)^2\left[\left(\frac{A_1}{A_2}\right)+1\right]^2}{\left(\frac{A_1}{A_2}\right)^2\left[\left(\frac{A_1}{A_2}\right)-1\right]^2}$$

$$= \frac{(9+1)^2}{(9-1)^2} = \frac{100}{64}$$

$I\max : I\min = 100:64$ 1

25. Mutual inductance of solenoid coil system

$$M = \frac{\mu_0 N_1 N_2 A_2}{\ell}$$ 1/2

Here, $N_1 = 15,\ N_2 = 1,\ \ \ell = 1cm = 0.01m$

$$A_2 = 2cm^2 = 2\times10^{-4}m^2$$

$$\therefore \quad M = \frac{4\pi\times10^{-7}\times15\times1\times2\times10^{-4}}{10^{-2}}$$ 1/2

$$M = 120\pi\times10^{-9}\,H$$

1/2

Induced emf in the loop

$$\varepsilon_2 = M\frac{\Delta I}{\Delta t}$$ 1/2

$$= \frac{120\pi\times10^{-9}(4-2)}{0.1}$$ 1/2

$$\varepsilon_2 = 7.5\,\mu V$$ 1/2

26. The radius (size) R of nucleus is related to its mass number (A)

as $R = R_0 A^{1/3}$, where $R_0 = 1.1\times10^{-15}\,m$ 1

If *m* is the average mass of a nucleon, then

Mass of nucleus = mA, where A = mass number

Volume of nucleus $= \frac{4}{3}\pi R^3 = \frac{4}{3}\pi R_0^{\,3} A$ 1/2

$\therefore$ Density of nucleus $\rho_N = \frac{\text{mass}}{\text{volume}} = \frac{mA}{\frac{4}{3}\pi R_0^3 A}$ 1/2

$$\rho_N = \frac{3m}{4\pi R_0^{\,3}}$$ 1/2

Thus, nuclear density ρ_N is independent of mass number A. 1/2

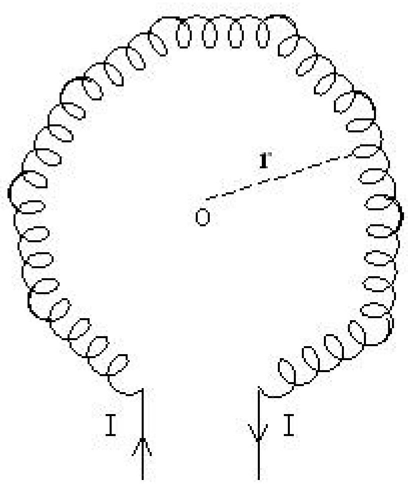
27. i) High frequency band : $3\text{MHz} - 30\,\text{MHz}$ 1

ii) Ultra – high frequency band : $300\text{MHz} - 3000\,\text{MHz}$ 1

iii) Super –high frequency band : $3000\,\text{MHz} - 30,000\text{MHz}$ 1

28. Magnetic field due to a torodial solenoid : A long solenoid shaped in the form of closed ring is called a torodial solenoid. 1

Let *n* be the number of turns per unit length of toroid and I the current through it. The current causes the magnetic field inside the turns of the solenoid. The magnetic lines of force inside the toroid are in the form of concentric circles. By symmetry the magnetic field has same magnitude at each point of circle and is along the tangent at every point on the circle.1/2



1/2

For points inside the core of toroid –

Considering a circle of radius r in the region enclosed by turns of toroid. Now we apply Ampere's circuital law to this circular path, i.e.,

$$\oint \vec{B} \cdot d\vec{l} = \mu_o I$$ 1/2

$$\oint B\,dl\cos 0^\circ = \mu I$$ 1/2

$$B\ 2\pi r = \mu_o I$$ 1/2

$\because$ Current enclosed by circular path $= (n2\pi r).I$ 1/2

$$B2\pi r = \mu_o\ n2\pi r\, I$$ 1/2

$$B = \mu_o n\, I$$ 1/2

OR

Torque on a current carrying loop: - considering a rectangular loop PQRS of length l, breadth *b*, suspended in a uniform magnetic field $\vec{B}$. The length of loop $= \mathrm{PQ} = \mathrm{RS} = \ell$ and breadth $\mathrm{QR} = \mathrm{SP} = \mathrm{b}$.

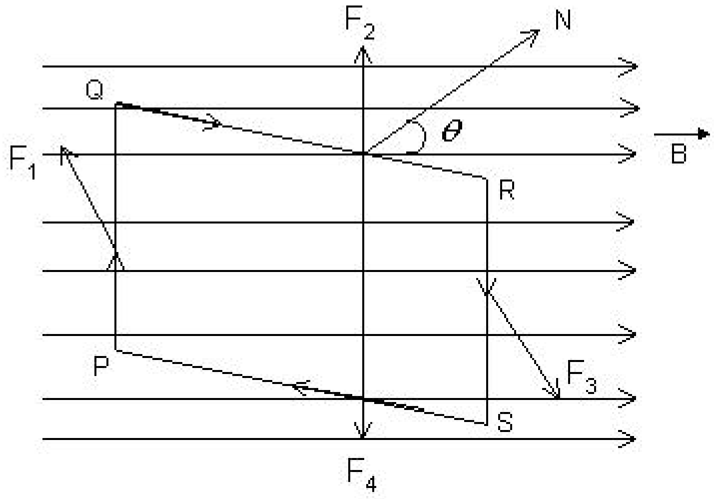
Let at any instant the normal to the plane of, loop make an angle θ with direction of magnetic field $\vec{B}$ and I is the current in the loop. 1/2

We know that a force acts on a current carrying wire placed in a magnetic field. Therefore, each side will experience a force. The net force and torque acting on the loop will be determined by the forces acting on all sides of loop. Suppose that the forces on side PQ, QR, RS and SP are $\vec{F_1}, \vec{F_2}, \vec{F_3}$ and $\vec{F_4}$ respectively. The sides QR and SP make angle $(90^\circ - \theta)$ with the direction of $\vec{B}$. Therefore each of the forces $\vec{F_2}$ and $\vec{F_4}$ acting on these sides has same magnitude

$$F^1 = Blb\sin(90^\circ - \theta) = Blb\cos\theta$$ 1/2

According to Fleming's left hand rule the forces $\vec{F_2}$ and $\vec{F_4}$ are equal and opposite but their line of action is same. Therefore these forces cancel each other, i.e., the resultant of $\vec{F_2}$ and $\vec{F_4}$ is zero. 1/2

Axis of loop or normal to loop



1/2

The side PQ and RS of current loop are perpendicular to $\vec{B}$, therefore the magnitude of each of forces $\vec{F_1}$ and $\vec{F_3}$ is

$$F = IlB \sin 90^{\circ} = I\,lB$$ 1/2

According to Fleming's left hand rule the forces $\vec{F_1}$ and $\vec{F_3}$ acting on sides PQ and RS are equal and opposite, but their lines of action are different. Therefore the resultant force of $\vec{F_1}$ and $\vec{F_3}$ is zero, but they form a couple called the deflecting couple.

Moment of couple or Torque

$\tau = \text{force} \times$ perpendicular distance 1/2

$\tau = (BIl)b \sin\theta = I(lb)B\sin\theta$ 1/2

$\because \quad lb = \text{area of loop}\,(A)$

½

$\therefore \quad \tau = IAB\sin\theta$

1/2

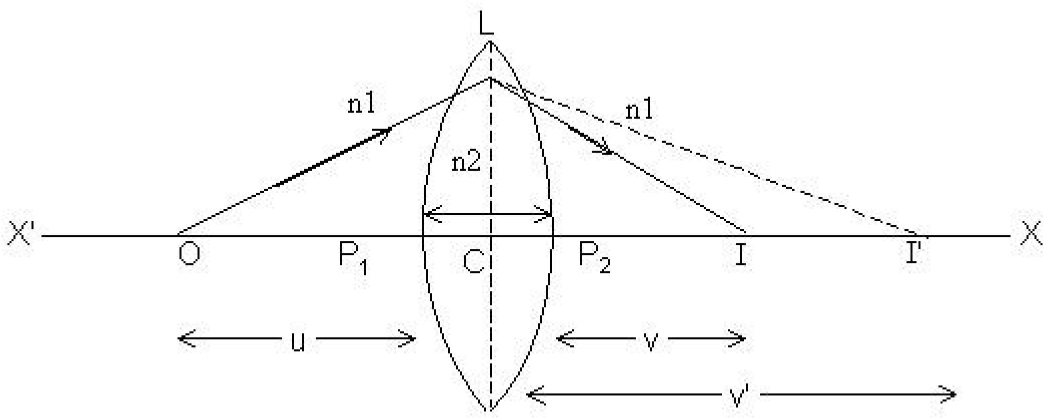
If the loop contains N – turns, then

$$\tau = NIAB\sin\theta$$ 1/2

29. Len's Maker's Formula: Suppose L is a thin lens. The refractive index of material of lens is n_2 and it is placed in a medium of refractive index n_1. The optical center of lens is *c* and x' x is principal axis. The radii of the curvatures of the surfaces of the lens are R_1 and R_2 and their poles are P_1 and P_2. The thickness of the lens is t, which is very small. O is a point object on the principal axis of the lens. The distance of object from pole P_1 is u. The first refracting surface from an image of O at I' at a distance v' from P_1

$$\frac{1}{2}$$

From the refraction formula at spherical surface, we have,



$\frac{1}{2}$

$$\because \qquad \frac{n_2}{u} - \frac{n_1}{u} = \frac{n_2 - n_1}{R_1} - \qquad (1)$$ $\frac{1}{2}$

The image I' acts as a virtual object for second surface and after refraction at second surface the final image is formed at I. The distance of I from pole P_2 of the second surface is v. The distance of virtual object (I') from pole P_2 is $(v' - t)$.

For refraction at a second surface, the ray is going from second medium (refractive index n_2) to first medium (refractive index n_1), therefore from refraction formula at spherical surface, we have

$$\frac{n_1}{v} - \frac{n_2}{(v' - t)} = \frac{n_1 - n_2}{R_2} - \qquad (2)$$ $\frac{1}{2}$

For a thin lens, t is negligible as compared to v', from (2)

$$\frac{n_1}{v} - \frac{n_2}{(v')} = -\frac{n_2 - n_1}{R_2} \qquad -(3)$$

adding equation (1) and (3), we get

$$\frac{n_1}{v} - \frac{n_1}{u} = (n_2 - n_1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$$ $\frac{1}{2}$

$$\frac{1}{v}-\frac{1}{u}=\left[\frac{n_2}{n_1}-1\right]\left[\frac{1}{R_1}-\frac{1}{R_2}\right]$$

$\frac{1}{2}$

$$\frac{1}{v}-\frac{1}{u}=\left({}_1n_2-1\right)\left[{}^{-}\frac{1}{R_1}-\frac{1}{R_2}\right] \qquad -(4) \qquad \frac{1}{2}$$

where ${}_1n_2=\frac{n_2}{n_1}$ is refractive index of second medium with respect to first medium.

If the object O is at infinity, the image will be formed at second focus i.e.

$u=\infty,\quad v=f_2=F$

Therefore from equation (4)

$$\frac{1}{F}-\frac{1}{\infty}=\left({}_1n_2-1\right)\left[\left|\frac{1}{R_1}-\frac{1}{R_2}\right.\right]$$

$\frac{1}{2}$

$$\frac{1}{F}=\left({}_1n_2-1\right)\left[\frac{1}{R_1}-\frac{1}{R_2}\right] \qquad -(5) \qquad \frac{1}{2}$$

This is the formula of refraction for a thin lens. The formula is called Lens Maker’s formula

If the first medium is air and refractive index of material of lens be n, then ${}_1n_2=n$ therefore eq – (5) may be written as

$$\frac{1}{F}=(n-1)\left[\frac{1}{R_1}-\frac{1}{R_2}\right] \qquad \frac{1}{2}$$

OR

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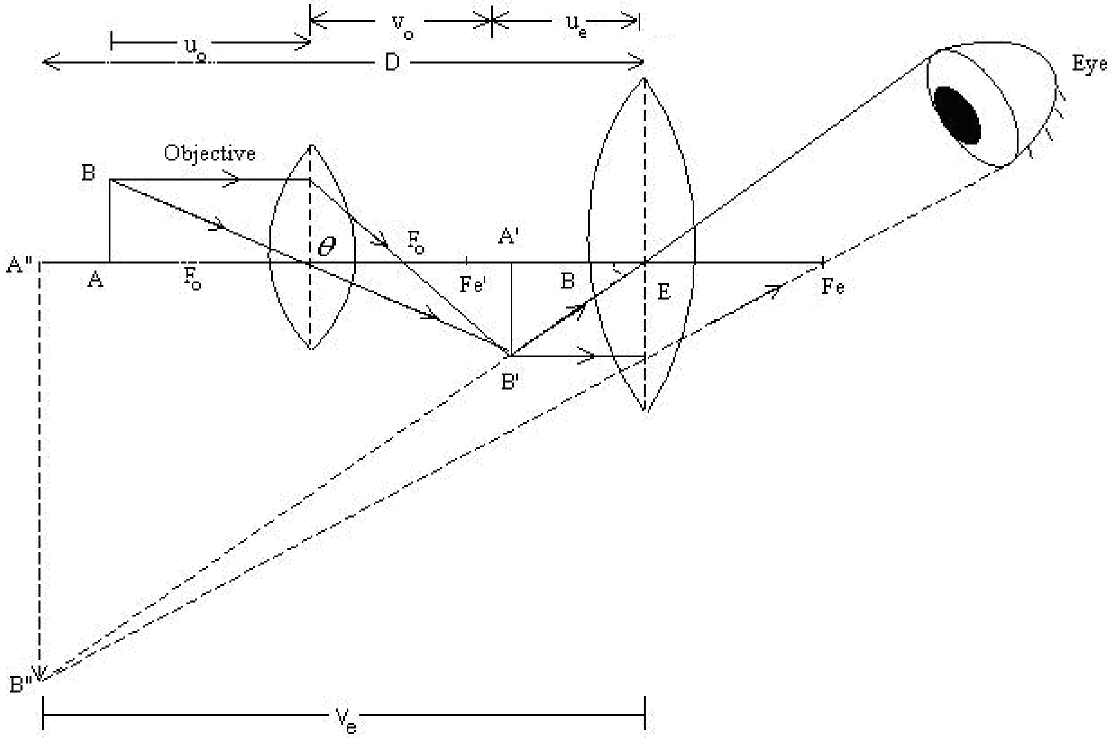

$1\frac{1}{2}$

Working Principle:- Suppose a small object AB is placed slightly away from the focus Fo' of the objective lens. The objective lens forms the real, inverted and magnified image A'B', which acts as an object for eye – piece. The eye-piece is so adjusted that the image A'B' lies between the first focus Fe' and the eye-piece E. The eye-piece forms image $A''B''$ which is virtual, erect and magnified.

Thus the final image A" B" formed by the microscope is inverted and magnified and its position is outside the objective and eye-piece towards objective lens. $\frac{1}{2}$

Magnifying Power of a Microscope:- It is defined as the ratio of angle (β) subtended by final image on the eye to the angle (α) subtended by the object on eye, when object is placed at the least distance of distinct vision, i.e,

Magnifying Power $M = \beta/\alpha \qquad \text{eqn}(1)$

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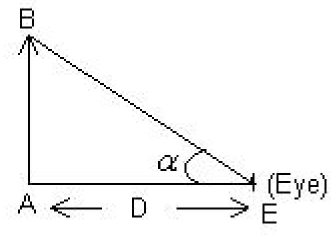

As the object is very small angle α and **β** are very small and so $\tan\alpha \approx \alpha$ and $\tan\beta \approx \beta.$

By definition the object is placed AB is placed at least distance of distinct vision.

$$\alpha \approx \tan\alpha = \frac{AB}{EA}$$

By sign convention $EA = -D,$ $\quad\therefore \alpha = \dfrac{AB}{-D}$

And from figure $\beta = \tan\beta = \dfrac{A'B'}{EA'}$ 1

If u_e is distance at image A'B' from eye-piece E, than by sign convention, EA' = - u_e and So,

$$\beta = \frac{A'B'}{(-u_e)}$$

Hence magnifying Power

$$M = \frac{\beta}{\alpha} = \frac{A'B'/(-u_e)}{AB/(-D)}$$

$$= \frac{A'B'}{AB}.\frac{D}{u_e}$$

By sign convention, magnification of objective lens

$$\frac{A'B}{AB} = \frac{v_o}{-u_o}$$

1

$$M = -\frac{v_o}{u_o}\cdot\frac{D}{u_e} \qquad -(2)$$

using lens formula $\dfrac{1}{F} = \dfrac{1}{v} - \dfrac{1}{u}$ for eye-lens

i.e., using

$F = f_e,\ v = -v_e,\ \ u = -u_e$

we get

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$$\frac{1}{f_e} = \frac{1}{-v_e} - \left[\frac{1}{-u_e}\right]$$

or $$\frac{1}{u_e} = \frac{1}{f_e} + \frac{1}{v_e}$$

Magnifying Power

$$M = -\frac{v_o}{u_o} D\left[\frac{-1}{f_e} + \frac{1}{v_e}\right]$$

$$M = -\frac{v_o D}{u_o}\left[\frac{1}{f_e} + \frac{1}{v_e}\right]$$

30. (i) The logic gate shown is OR gate 1

(ii)Truth table of OR gate is

A	B	Y
0	0	0
1	0	1
0	1	1
1	1	1

1

(ii) The input wave forms A &B are discrete square waves.
For convenience the components of wave fronts A& B are shown by vertical dotted lines.

Between $a \,\&\, b, \quad A = 1, \quad B = 1 \rightarrow y = 1$

Between $b \,\&\, c, \quad A = 0, \quad B = 0, \rightarrow y = 0$

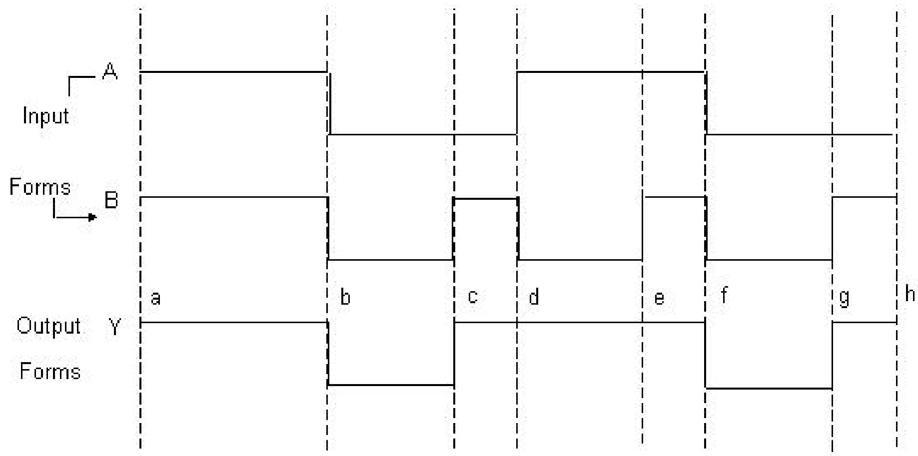
Between $c \,\&\, d, \quad A = 0, \quad B = 1, \rightarrow y = 1$

Between $d \,\&\, e, \quad A = 1, \quad B = 0 \rightarrow y = 1$ 2

Between $e \,\&\, f, \quad A = 1, \quad B = 1 \rightarrow y = 1$

Between $f \,\&\, g, \quad A = 0, \quad B = 0 \rightarrow y = 0$

Between $g \,\&\, n, \quad A = 0, \quad B = 1 \rightarrow y = 1$



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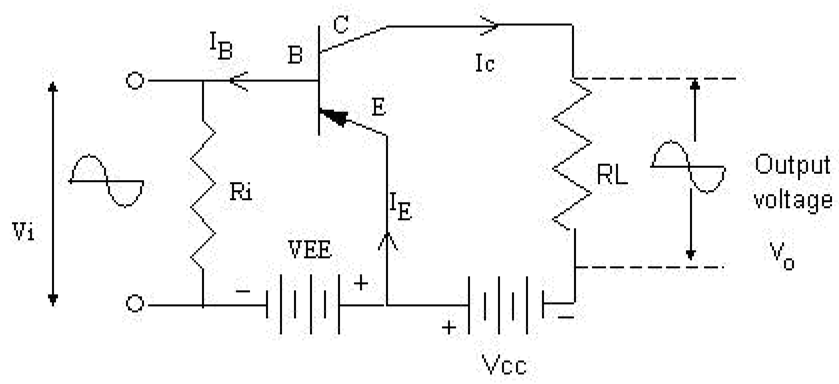
OR

<u>Common – Emitter Transistor Amplifier</u> – Common emitter transistor gives the highest gain & hence it is the most commonly employed circuit. Fig depicts the circuit for a PNP transistor.

In this circuit, the emitter is common to both the input (emitter base) & output (collector – emitter) circuits and is grounded. The emitter – base circuit is forward biased & the base - collector circuit reverse biased.

1



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Working principle: In a common – emitter circuit, the collector – current is controlled by the base - current rather than the emitter current. Since in a transistor, a large collector-current corresponds to a very small base – current, therefore, when input signal is applied to base, a very small change in base – current provides a much larger change in collector current & thus extremely large currents gains are possible.

1

<u>Current gain</u> – The ratio of change in collector current to the change in base current is defined as the alternating current gain denoted by β. Thus.

$$\beta(ac) = \frac{\Delta I_c}{\Delta I_b}$$ 1

β has positive values & is generally greater than 20

Voltage gain :
The voltage gain of common - emitter transistor amplifier is given by.

$$A_v = \frac{\Delta V_{out}}{\Delta V_{in}} = \frac{R_L \, \Delta I_c}{R_i \, \Delta I_b} = \frac{\Delta I_c}{\Delta I_b} \cdot \frac{R_L}{R_i}$$

$$\Rightarrow A_v = \beta \frac{R_L}{R_i}$$

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