Tripura Board
Class XII
Physics
Sample Paper Solution- 1

SECTION- A

1. The mass of electron is small and a small increase in energy of the electron makes the electrons move with a very high speed. As a result of it, the electrons go quickly out of step with oscillating electric field.

2. Foucault currents also called Eddy currents are the induced currents when the magnetic flux linked with a conductor changes with time.

$$i = \frac{\text{induced emf}}{\text{resistance}}$$

$$i = \frac{(-d\phi / dt)}{R}$$

3. Overlapping interference pattern of different colours will form and the central bright fringe will be white.

4. When the impact parameter is minimum, the alpha particles rebound back.

5. No. We cannot have resonance in RL or RC circuit as presence of L and C in the circuit is necessary for resonance.

6. Long distance radio broadcast use short wave bands as ionosphere layer of the atmosphere reflects the waves in these bands hence making the long distance broadcast feasible.

7. I_b would increase, so I_c decreases.
Hence, current gain also decreases.

8. The frequency of output of half wave rectifier will be 50 Hz.

SECTION- B

9. Area vector $\vec{S}$ in y-z plane points along outward along positive x-direction.

$\vec{S} = 20\,\hat{i}$

Hence the flux is:

$\phi_E = \vec{E}.\vec{S} = (6\hat{i} + 3\hat{j} + 4\hat{k}).20\,\hat{i}$

= 120 units.

10. Let R_1 and R_2 be the resistances of the coils.

$R_1 + R_2 = 18$ (i) series connection

$R_1 R_2 / (R_1 + R_2) = 4$ (ii) parallel connection

Multiplying (i) and (ii) we have $R_1 R_2 = 18 \times 4 = 72$

Now $(R_1 - R_2)^2 = (R_1 + R_2)^2 - 4 R1 R2 = 18^2 - 4 (72) = 36$

$R_1 - R_2 = \pm 6$ (iii)

Solving equations (i) and (iii), we get

$R_1 = 12\,\Omega$ or $6\,\Omega$; $R_2 = 6\,\Omega$ or $12\,\Omega$.

11.

$\tau = MB\sin\theta$

$M = \frac{\tau}{B\sin\theta}$

$M = \frac{0.055}{0.35 \times 0.5}$

$M = 0.31\,JT^{-1}$

12.

$T = \frac{1}{\nu} = \frac{\lambda}{c}$

$T = \frac{5550 \times 10^{-10}}{3 \times 10^{8}}$

$T = 1.85 \times 10^{-15}$ seconds

13. A potentiometer is sensitive if it is capable of measuring the small potential differences and it shows significant change in balancing length for a small change in the potential difference being measured.

Sensitivity of potentiometer means the smallest potential difference that can be measured by using it. This can be achieved by decreasing the potential gradient by increasing the length of the wire or reducing the current in the potentiometer using rheostat.

14. If a lens has different radii of curvature, it forms an image of an object placed on its axis. If we reverse the lens the position of the image of the object will not change.
We can deduce this using the lens makers' formula which is as follows:

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

OR

The images formed by total internal reflection are brighter than those formed by mirrors or lenses because, in total internal reflection 100% of incident light is reflected back into the same medium without any loss of intensity, while in reflection from mirrors and lenses there is always some loss of intensity.

15. According to Einstein's photoelectric equation,
$(1/2)\ mv^2_{max} = h\ f - h\ f_0$

Where, m = mass of the electron
f = frequency of incident radiation
f_0 = threshold frequency

If the frequency of incident radiation is less than the threshold value ($f < f_0$), the K.E. of emitted electron is negative i.e. photoelectric emission will not takes place, no matter how large is the intensity of the incident radiation.

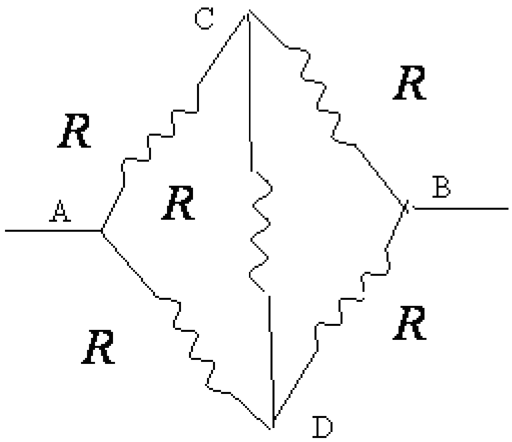
16. Ratio of electrons orbit radius to nuclear radius
$= (10^{-10} / 10^{-15}) = 10^5$ m
The radius of sun is R = 7×10^8 m
If we consider radius of earth orbits in same ratio the expected radius of earth orbit would be $7 \times 10^8 \times 10^5 = 7 \times 10^{13}$ m.
It means the expected radius of earth's orbit is about 500 times the actual radius which is 1.5×10^{11} m.

17. Here, m = 3.2g = 3.2×10^{-3} kg
$E = 10^{10}\ NC^{-1}$
Let n be the number of electrons removed from the coin. Then the charge on the coin is,
q = +n e

When the coin just floats,
Upward force of electric field = weight of the coin
n q E = mg

$$n = \frac{mg}{qE} = \frac{3.2\times10^{-3}\times9.8}{1.6\times10^{-19}\times10^{10}} = 1.96\times10^{7} \text{ electrons}$$

18. The network shown in the figure can be redrawn as shown in the figure below.



It is a balanced Wheatstone bridge. Therefore, point C and D are at the same potential. Since no current flows in the branch CD, this branch is ineffective in determining the equivalent resistance between terminal A and B and can be removed.

The branch ABC (= R+R= 2R) is in parallel with the branch ADB (= R+R= 2R)

$$R_{AB} = \frac{2R \times 2R}{2R + 2R} = R$$

SECTION- C

19. We know when inductances are connected in parallel, then

$$\frac{1}{L_p} = \frac{1}{L_1} + \frac{1}{L_2}$$

$$\frac{1}{L_p} = \frac{1}{3} + \frac{1}{7}$$

$1 / L_p = 10 / 21$

$L_p = 2.1$ H

$L_{total} = 6 + 5 + 2.1 = 13.1$ H

OR

$\phi = (4t^2 + t + 5) \times 10^{-3}$

$e = -(d\phi / dt)$

$e = d((4t^2 + t + 5) \times 10^{-3}) / dt$

$e = (8t + 1) \times 10^{-3}$

At t = 3 s

$e = 25 \times 10^{-3}$ volts

$e = 0.025$ volts

20.

$$E = -\frac{dv}{dr} = -\frac{10\,V}{10\,cm}$$

$$= \frac{10\,V}{10^{-1}m} = 100\,V\,m^{-1}$$

(i) Magnitude of electric field between Y and Z is 100 Vm^{-1}
The direction of the electric is from plate A to plate B.

(ii) Zero. This is because the points X and Y are at the same potential.

21. In a pure inductive circuit

$I = I_0 \sin\omega t$

$V = V_0 \sin(\omega t + 90^0)$

$V = V_0 \cos\omega t$

V leads by $\pi/2$

Hence,

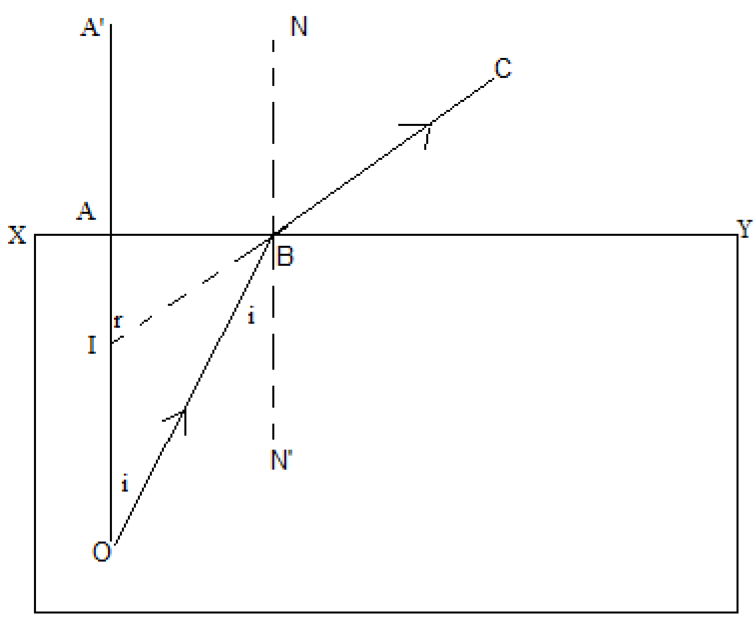
$$\text{Power}, P = \frac{1}{T}\int_0^T VIdt$$

$$P = \frac{1}{T}\int_0^T V_0 I_0 \sin\omega t \cos\omega t\, dt$$

$$P = \frac{V_0 I_0}{2T}\int_0^T \sin 2\omega t\ dt$$

P = 0

22.



In figure, OA passes straight along OAA′. Another ray of light from O incident at angle i on XY along OB deviates away from normal. It gets refracted at angle r along BC. When we produce back BC meets OA at I. Hence it's the virtual image of O. Hence AI is the apparent depth and AO is the real depth.

$\angle$ AOB = $\angle$ OBN′ = i

$\angle$ AIB = $\angle$ NBC = r

In Δ OAB, sin i = AB / OB

In Δ IAB, sin r = AB / IB

Light is travelling from denser to rarer medium, so

μ_w^a = Sin r / sin i = (AB / IB) x (OB / AB) = OB / IB

μ_w^a = OA / IA = real depth / apparent depth = x / y

y = x / μ_w^a = x / 4/3 = (¾) x

Hence apparent depth is ¾ of the real depth.

23.

(a) In Young's double slit experiment, the distance of the nth fringe from the central fringe is given by;

$X_n = (2n - 1)\,\lambda D/2d$

Where n= 1,2,3…..

For second dark fringe, n=2

$X_2 = (2\text{x } 2\text{-}1)\,(\lambda D/2d) = 3(\lambda D/d)$

Here $\lambda = 6000\text{x } 10^{-10}$m; D = 0.800m; d=0.200x 10^{-3}m

$$X = \frac{3 \times 6000 \times 10^{-10} \times 0.800}{2 \times 0.200 \times 10^{-3}} = 0.360 \times 10^{-2}\text{m}$$

(b) The distance of nth bright fringe from the central fringe is given by;

$x_n = n(\lambda D/d)$

For second bright fringe, n=2

Therefore

$$x_2 = 2(\lambda D/d) = \frac{2 \times 6000 \times 10^{-10} \times 0.800}{0.200 \times 10^{-3}} = 0.480 \times 10^{-2}\text{m}$$

24. The information or message signal is called "base band signal". In general, it spreads over a range of frequencies called the signal 'bandwidth'.

(i) The frequency range of voice of human speech is from 300 Hz to 3100Hz at the maximum end. Hence the bandwidth of 3100-300= 2800 Hz is considered adequate for speech transmission.

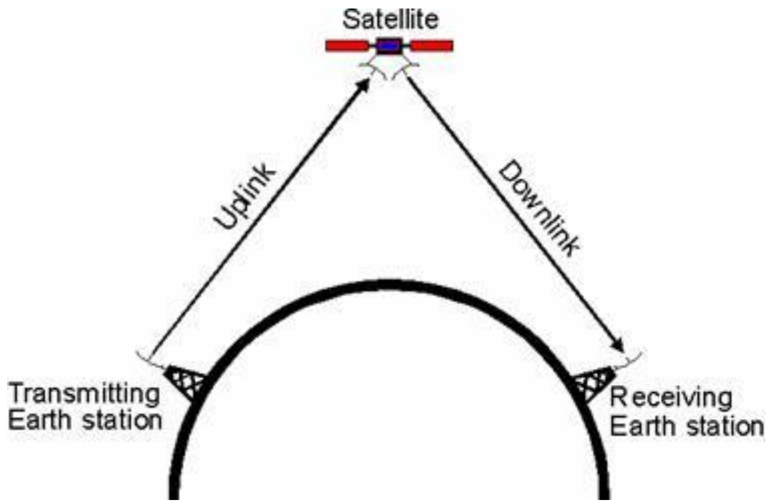
(ii) Different musical instruments produce high frequencies covering the entire range of audible frequencies from 20 Hz to 20 KHz. Hence, a bandwidth of about 20 KHz is required.

(iii) Video signals require about 4.2 MHz of bandwidth. As TV signals contain both video as well as voice, hence a signal band width of 4.5 MHz is required. But to avoid interference among telecast by different TV stations, a TV channel is usually allotted 6 MHz of bandwidth for transmission.

25. The communication of signal between transmitter and receiver with the help of satellite is called satellite communication.

Working: A satellite receives the signals from earth (which is beamed by transmitter), processes the signals and transmits them back to earth. The signal beamed by the satellite is received back on a distant location on earth, from which the original information signal is extracted by the process called demodulation.

The frequency at which satellite receives the signal is called uplink frequency while the frequency at which satellite returns the signal towards earth is called as downlink frequency. The downlink frequency and uplink frequencies are different so that there is no interference between these two signals.



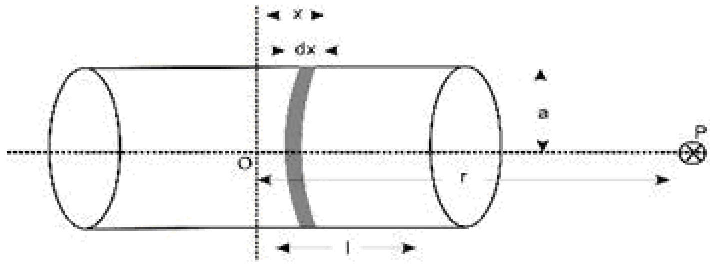
26.

(i) Awareness, critical thinking, decision making and persuasive power.

(ii) The radiations from a radioactive element are α, β and $\gamma-$rays. In the order of increasing ionising power, they are $\gamma-$rays, β-particle and α-particle.

27. The magnetic field lines for a bar magnet and a solenoid resembles each other. Thus a bar magnet may be considered as a large number of circulating circuits in analogy with a solenoid.

Consider the figure shown below:



The magnitude of the field at point P due to the circular element is,

$$dB = \frac{\mu_0 ndxIa^2}{2[(r-x)^2 + a^2]^{3/2}}$$

The magnitude of total field is obtained by integrating from x = - l to x = +l, thus,

$$B = \frac{\mu_0 nIa^2}{2}\int_{-l}^{+l}\frac{dx}{[(r-x)^2 + a^2]^{3/2}}$$

Considering the far axial field of solenoid i.e. r>> a and >> l, then

$$[(r-x)^2 + a^2]^{3/2} \approx r^3$$

$$\therefore B = \frac{\mu_0 nIa^2}{2r^2}\int_{-l}^{+l}dx$$

$$= \frac{\mu_0 nIa^2 2l}{2r^3}$$

Since magnetic moment of solenoid = n (2l) I (πa^2)

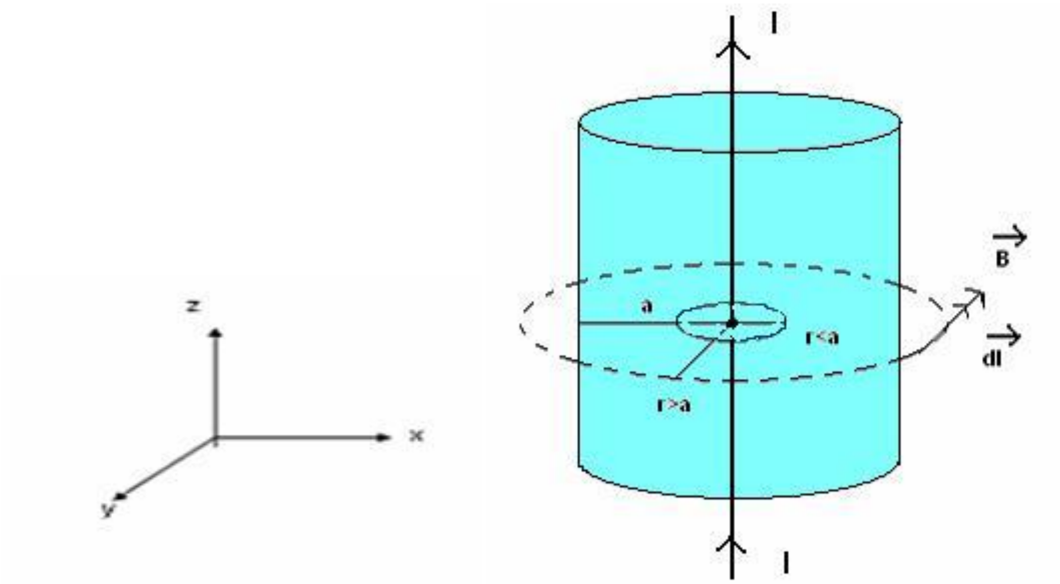
$$\therefore B = \frac{\mu_0 2m}{2\pi r^3}$$

This is also the far axial magnetic field of a bar magnet. Thus, a bar magnet and a solenoid produce similar magnetic field.

OR

Since the current distribution possesses cylindrical symmetry, therefore the magnetic field it generates also possesses cylindrical symmetry. The magnetic field circulates in the x-y plane in an anti-clockwise direction.

Let us first calculate the magnitude of magnetic field outside the wire and apply Ampere's circuital law to a circular Amperian loop in the x-y plane where the loop is centered at the centre of the wire, and is of radius r>a, where "a" is the radius of the cylindrical wire.



As the magnetic field lines form closed circle, so the magnetic field is tangential to the loop everywhere, and is in the same direction as dl taken in the counter clock wise direction. Thus, the angle between the magnetic field and dl is zero everywhere on the loop.

Also, the magnitude of magnetic field is constant. So the situation is same as that for an infinitely thin wire.
From Ampere's law,

$$\oint \vec{B}.d\vec{l} = \oint \frac{\mu_0}{2\pi r} dl = \frac{\mu_0}{2\pi r} \oint dl$$

We have, $B = \frac{\mu_0 I}{2\pi r}$ for r>a.

(Since $\oint dl = 2\pi r$, is the circumference of the circle)

That is, $B \alpha \frac{1}{r}$

Let us now apply Ampere's circuital law to a circular Amperian loop which is of radius r < a. The current I_e enclosed by the loop of radius r < a is

$$I_e = \frac{I}{\pi a^2} \pi r^2 = \frac{Ir^2}{a^2}$$

From Ampere's law,

$$\oint \vec{B}.d\vec{l} = \mu_0 \mu_r I_e$$

$$2\pi r B = \mu_0 \mu_r I_e = \mu_0 \mu_r \frac{Ir^2}{a^2}$$

$$B = \frac{\mu_0 \mu_r Ir}{2\pi a^2}, \text{that is} B \alpha r$$

SECTION- D

28. Interference is the phenomena in which the redistribution of light energy in a medium takes place due to superposition of light waves from two coherent sources.

The interference may be of two types:-

1. Constructive interference
2. Destructive interference

We are given with the values,

ΔD = - 5 x 10^{-2} m.

$\Delta \beta$ = - 3 x 10^{-5} m

d = 10^{-3}m

To find out, wavelength (λ) =?

We have the relation,

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

Hence wavelength (λ) can be given by

$\lambda = d. \Delta \beta / \Delta D$ = 10^{-3} x (- 3 x 10^{-5}) / (-5 x 10^{-2})

λ = 6 x 10^{-7} m.

OR

Assumptions:

(i) The lens is a thin lens.

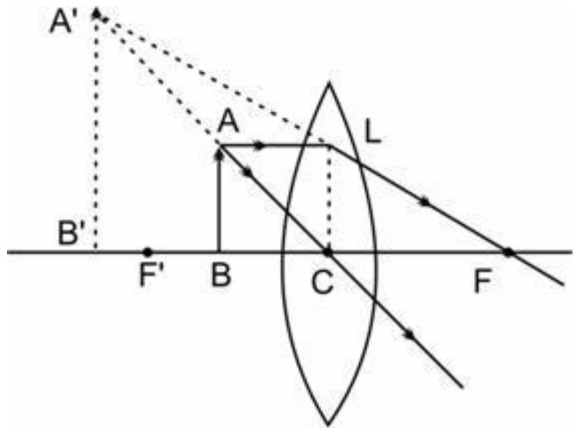
(ii) The aperture of the lens is small.

Sign Conventions:

(i) All the distance are measured from the optical centre of the lens.

(ii) Distances measured in the direction of incidence of light are taken as positive and in the opposite direction negative.

(iii) Distances perpendicular and above the principle axis are taken positive but below the principle axis as negative.



The image formation of an object AB placed between the optical centre C and principal focus F′ of a convex lens has been shown in fig. The image A′B′ is virtual, erect and magnified.

As Δ A′B′C and Δ ABC are similar, hence

$$\frac{A'B'}{AB} = \frac{CB'}{CB} \qquad \text{(i)}$$

Again as Δ A′B′F and Δ LCF are similar, hence

$$\frac{A'B'}{LC} = \frac{B'F}{CF} \text{ or } \frac{A'B'}{AB} = \frac{B'F}{CF} \qquad \text{(ii) } [\because LC = AB]$$

Comparing (i) and (ii), we get

$$\frac{CB'}{CB} = \frac{B'F}{CF} = \frac{CB' + CF}{CF}$$

As per sign convention being followed, let

CB = -u, CB′ = -v and CF = +*f*

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

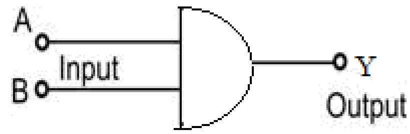
$$\therefore -v f = uv - uf$$

Dividing both sides by *uvf*, we get

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

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

29. The logic symbol of AND is shown in fig.

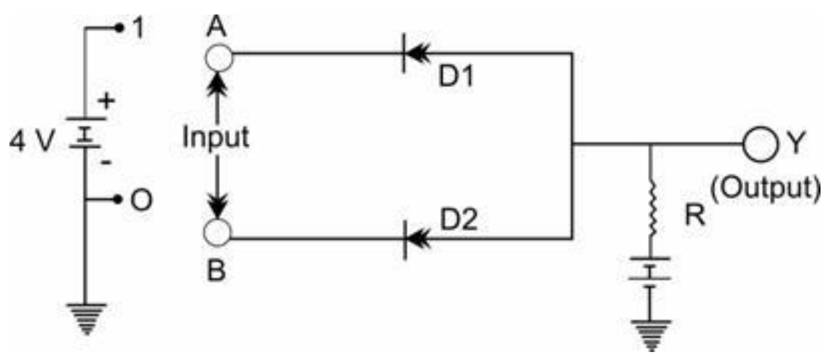


The truth table of AND gate is given below:-

A	B	Output
0	0	0
0	1	0
1	0	0
1	1	1

Realization of an AND gate:

To realize an AND gate having two inputs A and B, we complete the electrical circuit as shown below in fig. using two diodes D_1 and D_2.



Operation:

(i) When A = 0, B = 0, both diodes conduct and offer low (almost zero) resistance. Hence, whole voltage drop is across the resistor R and the net output voltage level at Y will be zero.

(ii) When A = 1, B = 0, diode D_1 does not conduct but D_2 conducts and provides a low resistive path. As a result, output voltage level at Y is still zero.

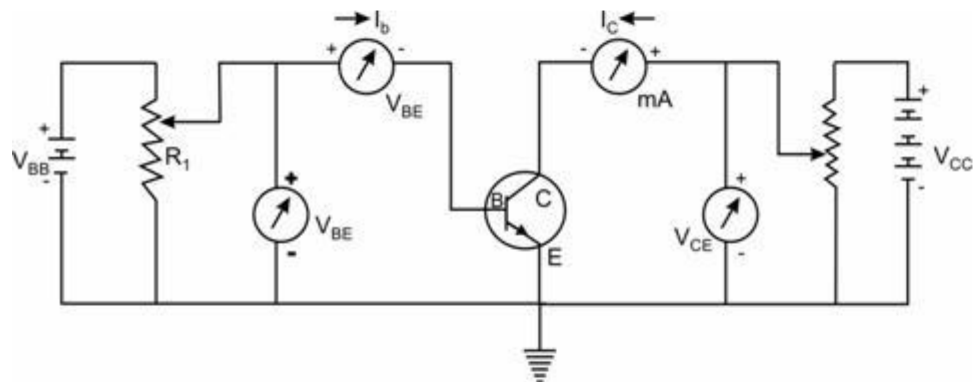
(iii) When A = 0, B = 1, diode D_1 conducts and provides a low resistance path but D_2 does not conduct. Output voltage level at Y is even now zero.

(iv) When A = B = 1, none of the two diodes conduct and there would be no drop in voltage across resistance R. Hence, voltage of Y will be 4V i.e., Y will be at voltage level 1.

Thus, output level is 1 only when both inputs A and B are at 1 level, which is the condition of AND gate.

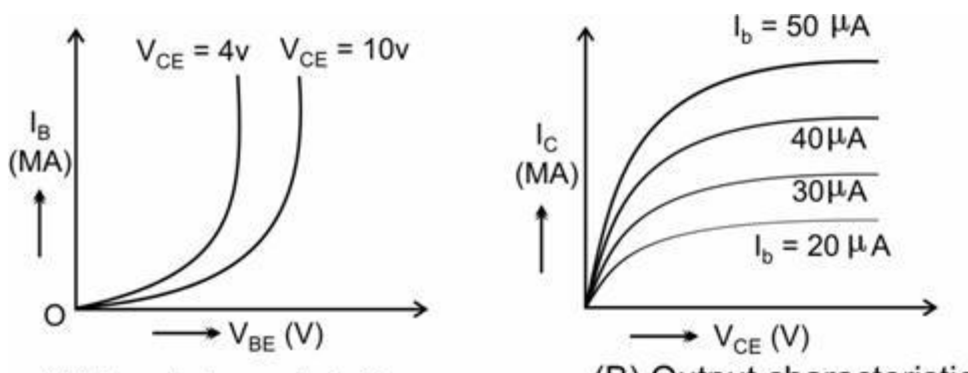
OR

The circuit arrangement to obtain the characteristics of an n-p-n transistor is shown in fig. In common emitter configuration, we proceed as follows to obtain input and output characteristics.



Input Characteristics: Adjust collector-emitter voltage V_{CE} with the help of rheostat R_2 and set it at a fixed value V_{CE}. Now with the help of rheostat R_1 gradually increase the value of base-emitter voltage V_{BE} in small steps and note the corresponding values of base current I_b.

Plot graph between I_b and V_{BE} to get the input characteristics. Repeat the process for different constant values of V_{CE}. The characteristics are shown in fig (a).



(A) Input characteristic (B) Output characteristic

Output Characteristics: Keep value of base current I_b fixed with the help of V_{BE}. Now gradually change the value of V_{CE} and note the values of collector current I_C. Plot I_C – V_{CE} graph. Repeat the process for different constant values of I_b. The output characteristics are shown in fig (b).

30. Let μ_1 be refracting index of rarer medium and μ_2 be the refracting index of spherical convex refracting surface XY of small aperture.

From A draw AM such that $AM \perp OI$

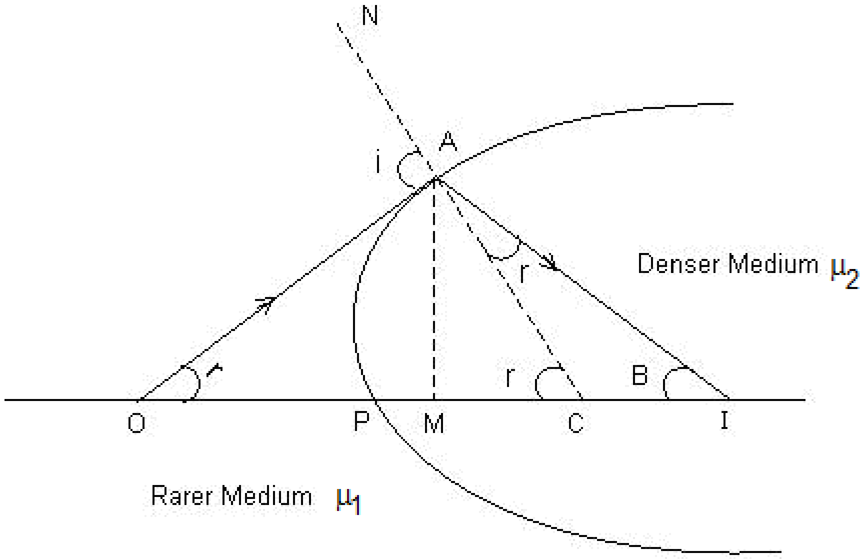
In ΔIAC

$$\text{r} + B = \gamma \left(\text{Ext. angle property}\right)$$

$$\therefore \quad r = \gamma - \beta$$

Similarly in $\Delta\, OAC$

$$i = \alpha + \gamma$$



According to Snell's law

$$\frac{\mu_2}{\mu_1} = \frac{\sin i}{\sin r} \approx \frac{i}{r} \Rightarrow \mu_2 r = \mu_1 i$$

So, $\mu_1(\alpha + \gamma) = \mu_2(\gamma - \beta)$ (i)

Let

$$\alpha \approx \tan\alpha = \frac{AM}{OM} = \frac{AM}{PO}$$

$$\beta = \tan\beta = \frac{AM}{MI} = \frac{AM}{PC}$$

As spherical surface has small aperture, so we have

$$y = \tan\beta = \frac{AM}{MC} = \frac{AM}{PC}$$

Substituting the value in eq. (i), we get

$$\frac{\mu_1}{PO} + \frac{\mu_2}{PI} = \frac{\mu_2 - \mu_1}{PC}$$

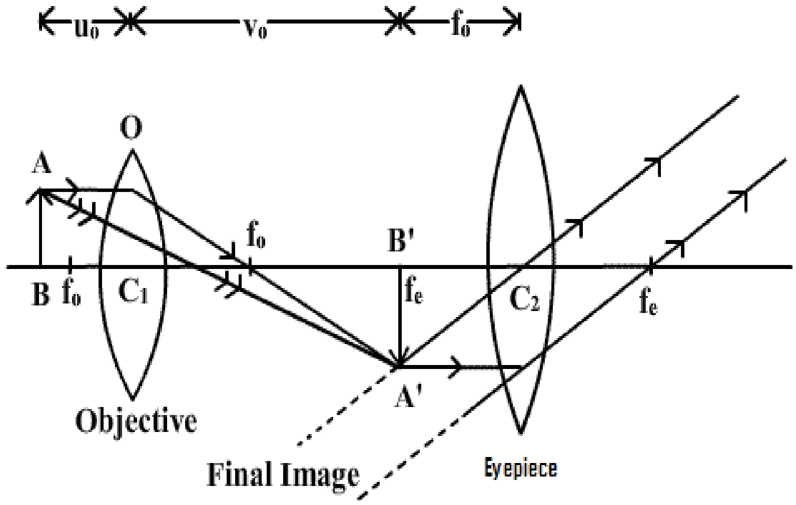
By sign convention put $PO = -u,\ PI = +v,\ PC = +R$

We get

$$\frac{\mu_1}{-u} + \frac{\mu_2}{v} = \frac{\mu_2 - \mu_1}{R}$$

OR

A labelled diagram of a compound microscope, when the final image is formed at infinity:



If m_o and m_e be the magnification produced by the objective lens and eye lens respectively, then the total magnifying power of microscope is $m = m_o \times m_e$.

If u_o be the distance of the object AB from objective lens and v_o be the distance of image $A'B'$ formed by objective, then magnifying power of objective is

$$m_o = \frac{v_o}{u_o}$$

The magnifying power of eyepiece when the final image is formed at infinity is

$$m_e = \frac{D}{f_e}$$

Here, object distance, $u_e = f_e$

D = Least distance of distinct vision

Now, the magnifying power of microscope is

$$m = \frac{v_o}{u_o}.\frac{D}{f_e}$$

As a first approximation $u_o \approx f_o$ and $v_o = L$ (distance between objective and eyepiece), then after substituting the values from above equation, we get

$$m = (\frac{L}{f_o}).(\frac{D}{f_e})$$