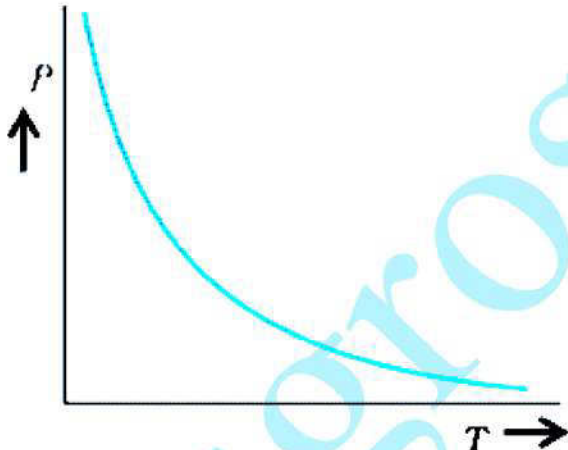
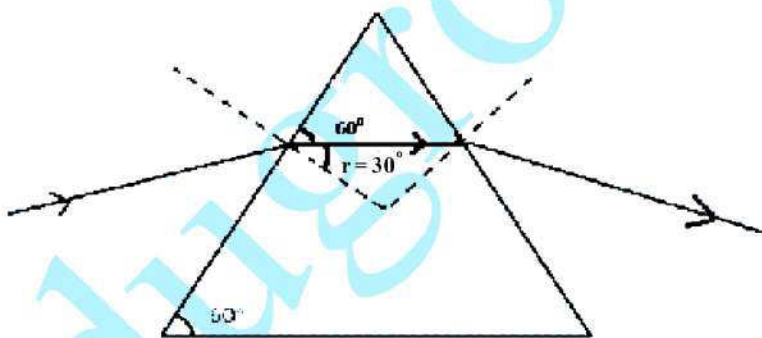


# CBSE Class 12 Physics Question Paper Solution 2012

QUESTION PAPER CODE 55/1/1

Q. No.	Expected Answer/value Points	Marks	Total Marks
1.	No	1	1
2.	Zero (If the student writes $B_v = B \sin \delta$ , award $\frac{1}{2}$ mark) [Also, if the student calculates the value of vertical component at that place as $B_v = B \sin 60^\circ$ , or $B_v = B_H \tan 60^\circ$ , award $\frac{1}{2}$ mark.]	1	1
3.	 <p>[If the graph is correct but the axis of the graph are not labelled, or labelled in an incorrect manner, award <math>\frac{1}{2}</math> mark.]</p>	$\frac{1}{2}$	
4.	<p>In the static situation, there is no current inside, or on the surface, of the conductor. Hence the electric field is zero everywhere inside the conductor</p> <p>Alternatively:</p> <p>i. since the charge inside the conductor is zero, the electric field is also zero.</p> <p>or</p> <p>Alternatively,</p> <p>ii. since the conductor is uncharged so the electric field inside it is zero. (or any other logically valid answer.)</p>	1	1

- |                              |  |                                |               |                              |                 |  |  |
|------------------------------|--|--------------------------------|---------------|------------------------------|-----------------|--|--|
| 5.                           | Speed (or velocity)  | 1                              | 1             |                              |                 |  |  |
| 6.                           | When the refractive index of glass is equal to the refractive index of the liquid.<br>(Alternatively, when $\mu_L = \mu_g$ )   | 1                              | 1             |                              |                 |  |  |
| 7.                           | i. Clockwise in 1<br>ii. Anticlockwise in 2<br><br>(Alternatively, if the student correctly depicts the direction of flow of current diagrammatically, award full credit.)   | $\frac{1}{2}$<br>$\frac{1}{2}$ | 1             |                              |                 |  |  |
| 8.                           | De-Broglie hypothesis states that atomic particles of matter moving with a given velocity, (or momentum) can display wave like properties.<br><br>[Award full 1 mark even if the student just writes $\lambda = \frac{h}{p}$ ] | 1                              | 1             |                              |                 |  |  |
| 9.                           | <table border="1"> <tr> <td>Formula</td> <td><math>\frac{1}{2}</math></td> </tr> <tr> <td>Substitution and calculation</td> <td><math>1 \frac{1}{2}</math></td> </tr> </table>   | Formula                        | $\frac{1}{2}$ | Substitution and calculation | $1 \frac{1}{2}$ |  |  |
| Formula                      | $\frac{1}{2}$  |                                |               |                              |                 |  |  |
| Substitution and calculation | $1 \frac{1}{2}$  |                                |               |                              |                 |  |  |



From the diagram,  $r = 30^\circ$

Also  $n_{21} = \frac{\sin i}{\sin r}$

$$\Rightarrow \sqrt{3} = \frac{\sin i}{\sin 30}$$

$$\Rightarrow \sin i = \sqrt{3} \times \frac{1}{2}$$

$$\Rightarrow i = 60^\circ$$

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

2

10. Difference between Analog  
and Digital signals

2

Analog signals are continuous variations of voltage or current.

1

Digital signals are those which can take only discrete (stepwise) values.

1

(Give full credit even if the student depicts the above difference with the help of suitable diagrams.)

2

OR

Function of transducer/ repeater/

Transmitter/ bandpass filter(Any Two) 1+1

Any two of the following

1+1

- i. **Transducer:** — A device which converts energy from one form to another form.
- ii. **Repeater:** — A repeater is a combination of a receiver and a transmitter.
- iii. **Transmitter:** — A transmitter processes the incoming message signal so as to make it suitable for transmission through a channel and for its subsequent reception.  
[Alternatively: A transmitter is a device used for sending the information in a communication system.]
- iv. **Bandpass filter:** — A bandpass filter blocks lower and higher frequencies and allows only a band of frequencies to pass through.

2

11. Correct Identification

 $\frac{1}{2} \times 4 = 2$ 

i)  $i = 4.2 \text{ A}$

 $\frac{1}{2}$ 

ii)  $i = 1.05 \text{ A}$

 $\frac{1}{2}$ 

iii)  $i = 0.42 \text{ A}$

 $\frac{1}{2}$ 

iv)  $i = 1.4 \text{ A}$

 $\frac{1}{2}$ 

[If a student only writes the correct formulae in all four cases as given below but does not identify the values of current, award 1 mark only.  
For any two correct formulae, award  $\frac{1}{2}$  mark only.]

$$i) i = \frac{\varepsilon}{r} \quad ii) i = \frac{\varepsilon}{r+R_1} \quad iii) i = \frac{\varepsilon}{r+R_1+R_2} \quad iv) i = \frac{\varepsilon}{r+\frac{R_1 R_2}{R_1+R_2}}$$

Award  $\frac{1}{2}$  mark if the student only writes that current is inversely proportional to the resistance.]

2

12.	Correct Identification	1
	Two Properties	1

Diamagnetic Material

1

Properties (any two)

- They have the tendency to move from stronger to weaker part of the external magnetic field.
- They expel magnetic field lines.
- Such substances are repelled by a magnet.
- When placed in an external magnetic field, a net magnetic dipole moment is developed inside it which is in a direction opposite to that of the applied magnetic field.

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

(Give full credit for any other correct property)

[If the student identifies the substance as paramagnetic or ferromagnetic, but gives the properties of the same correctly, award 1 mark only.]

2

13.	Magnitude of net magnetic field	$1\frac{1}{2}$
	Direction	$\frac{1}{2}$

We have:  $B_p = B_Q = \frac{\mu_0 I}{2R}$

 $\frac{1}{2}$ 

$B_p$  is directed in the vertically upward direction while  $B_Q$  is directed along the horizontal direction.

 $\frac{1}{2}$ 

$$\therefore B = \sqrt{B_p^2 + B_Q^2}$$

$$= \sqrt{2} B_p$$

 $\frac{1}{2}$ 

(If the student directly writes  $B = \sqrt{2} B_p$ , award this  $\frac{1}{2}$  mark)

$$\Rightarrow B = \sqrt{2} \frac{\mu_0 I}{2R} = \left( \frac{\mu_0 I}{\sqrt{2} R} \right)$$

The net magnetic field is directed at an angle of  $45^\circ$  with either of the fields.

[Award this  $\frac{1}{2}$  mark, even if the student takes  $B_Q$  along the vertically downward direction and writes that  $\theta = 135^\circ$ ]  $\frac{1}{2}$

2

14. Explanation

2

When an ideal capacitor is charged by dc battery, charge flows (momentarily) till the capacitor gets fully charged. When an ac source is connected then

conduction current  $i_c = \frac{dq}{dt}$  keep on flowing in the connecting wires.  $\frac{1}{2}$

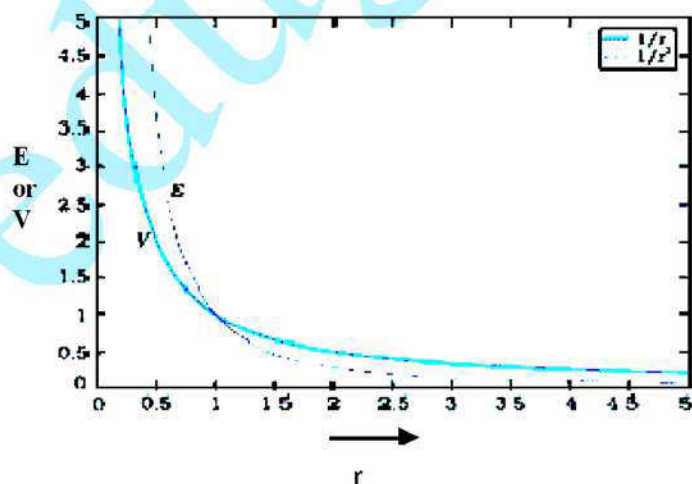
Due to changing current, charge deposited on the plates of the capacitor changes with time. This causes change in electric field between the plates of the capacitor which causes the electric flux to change and gives rise to a displacement current in the region between the plates of the capacitor.  $\frac{1}{2}$

Displacement current  $i_d$  is given by  $i_d = \epsilon_0 \frac{dq_E}{dt}$   $\frac{1}{2}$

and is equal to the conduction current at all instants.  $\frac{1}{2}$

[Alternatively: If the student explains the continuous flow of current, for a capacitor connected to an AC source, on the basis of capacitive reactance, or the charging and discharging of a capacitor, award 1 mark only.] 2

15.



1+1

[If the graphs are not labelled, deduct  $\frac{1}{2}$  mark. Please award these marks even if the student draws two separate graphs, one each for E and V] 2

16.	Definition	1
	Derivation	1

Self Inductance is the property by which an opposing induced emf is produced in a coil due to a change in current, or magnetic flux, linked with the coil.

or Self inductance of a coil is numerically equal to the flux linked with the coil when the current through the coil is 1A.

or, self inductance of a coil is equal to the induced emf developed in the coil when the rate of change of current is the coil is one ampere per second.

1

Energy stored in an inductor:

Consider a source of emf connected to an inductor L. As the current starts growing, the opposing induced emf is given by

$$e = -L \frac{di}{dt} \quad \frac{1}{2}$$

If the source of emf sends a current  $i$  through the inductor for a small time  $dt$ , then the amount of work, done by the source, is given by

$$\begin{aligned} dW &= |e| i dt \\ &= Li \frac{di}{dt} dt \\ &= Lidi \end{aligned}$$

Hence the total amount of work done (by the source of emf) will the current increases from its initial value ( $i = 0$ ) to its final value ( $I$ ) is given by

$$W = \int_0^i Lidi = L \int_0^i idi = L \left[ \frac{i^2}{2} \right]_0^i = \frac{1}{2} Li^2 \quad \frac{1}{2}$$

This work done gets stored in the inductor in the form of energy.

$$\therefore U = \frac{1}{2} LI^2$$

2

17. Explanation 2

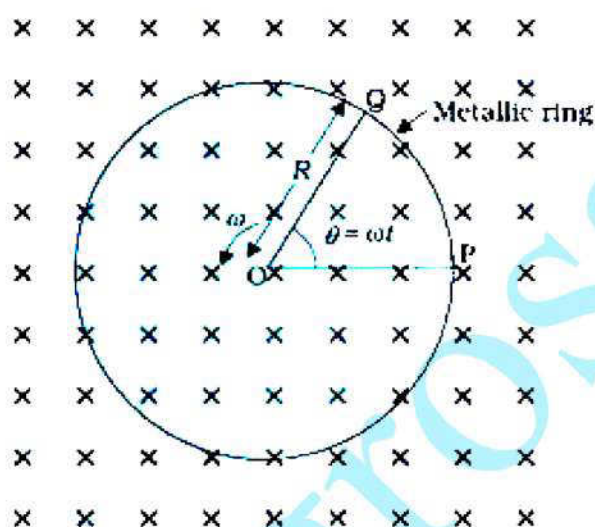
Even though the current in forward bias has a larger magnitude, the change, due to changes in light intensity, in the minority carrier dominated reverse bias current, is more and is, therefore, more easily detectable.

2

Alternatively, any other logically valid explanation(including /based on the characteristic curves) to be given full credit. (Even if the student does not explicitly write that forward current is more, award full marks.)

2

18. Derivation 2



The magnitude of the emf, generated across a length  $dr$  of the rod, as it moves at right angles to the magnetic field, is given by

$$d\varepsilon = B\omega r dr. \quad 1$$

Therefore,

$$\varepsilon = \int d\varepsilon = \int_0^R B\omega r dr = \int_0^R B\omega r dr = \frac{B\omega R^2}{2} \quad 1$$

Alternatively, the potential difference across the resistor is equal to the induced emf and equals  $B \times$  (rate of change of area of loop). If  $\theta$  is the angle between the rod and the radius of the circle at P at time t, the area of the sector OPQ(as shown in the figure) is given by

$$\pi R^2 \times \frac{\theta}{2\pi} = \frac{1}{2} R^2 \theta \quad \frac{1}{2}$$

where  $R$  is the radius of the circle. Hence, the induced emf is

$$\varepsilon = B \times \frac{d}{dt} \left[ \frac{1}{2} R^2 \theta \right] = \frac{1}{2} BR^2 \frac{d\theta}{dt} = \frac{B\omega R^2}{2} \quad \frac{1}{2}+1 \quad 2$$

19.	Calculations of angular frequency	1
	Calculation of current	1
	Calculation of rms voltage across capacitor	1

$$(i) \quad \omega = \frac{1}{\sqrt{LC}} \quad \frac{1}{2}$$

$$= \frac{1}{\sqrt{5 \times 80 \times 10^{-6}}} = 50 \text{ radian / s} \quad \frac{1}{2}$$

(ii) Current at resonance

$$I_{rms} = \frac{V_{rms}}{R} = \frac{240}{40} \text{ A} = 6 \text{ A} \quad \frac{1}{2}+\frac{1}{2}$$

(iii)  $V_{rms}$  across capacitor

$$V_{rms} = I_{rms} X_c \quad \frac{1}{2}$$

$$= 6 \times \frac{1}{50 \times 80 \times 10^{-6}} \text{ V}$$

$$= \frac{6 \times 10^6}{4 \times 10^3} \text{ V} = \frac{6000}{4} \text{ V} = 1500 \text{ V} \quad \frac{1}{2} \quad 3$$

20.	Calculations of torque	1
	Calculation of force	2

(i) Torque on the loop  $\frac{1}{2}$

$$\tau = MB \sin \theta$$

As  $M$  and  $B$  are parallel,  $\theta = 0$

Therefore,  $\tau = 0$

$\frac{1}{2}$

(Award this one mark, if student writes torque  $\tau = 0$  directly)

(ii) Force acting on the loop

$$|F| = \frac{\mu_0 I_1 I_2}{2\pi} \ell \left( \frac{1}{r_1} - \frac{1}{r_2} \right)$$

$$= 2 \times 10^{-7} \times 2 \times 2 \times 10^{-1} \left( \frac{1}{10^{-2}} - \frac{1}{5 \times 10^{-2}} \right) \text{ N}$$

$\frac{1}{2}$

$$= \frac{8 \times 10^{-8}}{10^{-2}} \left( 1 - \frac{1}{5} \right) \text{ N}$$

$$= 8 \times 10^{-6} \left( \frac{4}{5} \right) \text{ N}$$

$$= 6.4 \times 10^{-6} \text{ N}$$

$\frac{1}{2}$

Direction : Towards conductor / Attractive

$\frac{1}{2}$

[Alternatively, If a student calculates the force by the following method, award the allotted 2 marks(for force calculation) as follows

$$\text{Magnetic field } B = \frac{\mu_0 I}{2\pi r}$$

$$|F_1| = I\ell B_1 \text{ (towards the conductor)} \quad \frac{1}{2} \text{ mark}$$

$$|F_2| = I\ell B_2 \text{ (away from the conductor)} \quad \frac{1}{2} \text{ mark}$$

$$|F| = I\ell (B_1 - B_2)$$

$$= I\ell \left( \frac{\mu_0 i}{2\pi r_1} - \frac{\mu_0 i}{2\pi r_2} \right) = \frac{\mu_0 i}{2\pi} \ell \left( \frac{1}{r_1} - \frac{1}{r_2} \right)$$

$$|F| = \frac{2 \times 10^{-7} \times (2)^2 \times 10^{-1}}{10^{-2}} \left( 1 - \frac{1}{5} \right) \text{ N}$$

$$= 6.4 \times 10^{-6} \text{ N}$$

$\frac{1}{2}$  mark

Direction : Towards the conductor / attractive  $\frac{1}{2}$  mark ]

3

21.	(i) Justifying of the result	2
	(ii) Maximum number of spectral lines	1

(i) According to Bohr's second postulate

$$mvr_n = \frac{nh}{2\pi} \quad 1$$

$$\Rightarrow 2\pi r_n = \frac{nh}{mv}$$

$$\text{But } \frac{h}{mv} = \frac{h}{p} = \lambda$$

$$\therefore 2\pi r_n = n\lambda \quad \frac{1}{2}$$

[Note: If the student just writes  $mvr_n = \frac{nh}{2\pi}$  and writes  $\lambda = \frac{h}{p}$  award 2 marks)  $\frac{1}{2}$

ii) For third excited state  $n = 4$

for ground state  $n = 1$

Hence possible transitions are

$n_1 = 4$  to  $n_1 = 3, 2, 1$

$n_1 = 3$  to  $n_1 = 2, 1$

$n_1 = 2$  to  $n_1 = 1$

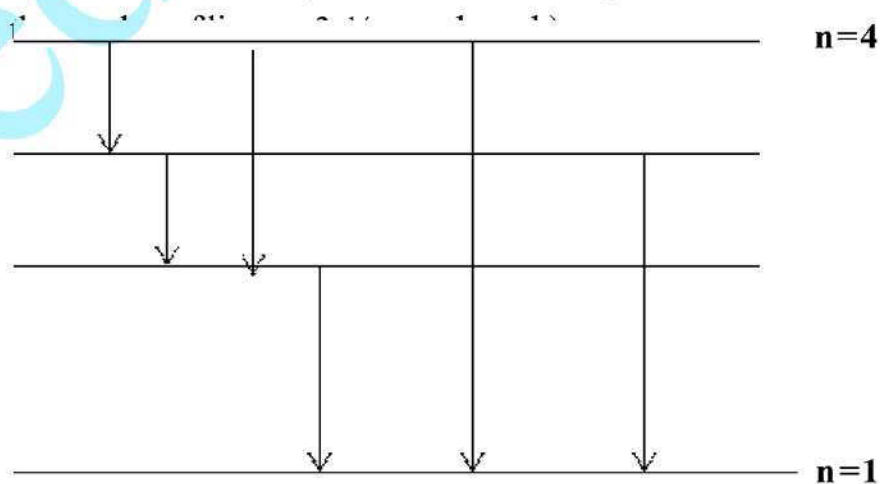
Total number of transitions = 6

1

Alternatively:

i. The student may show the transitions on the energy level diagram and count the total number as 6 award this 1 mark in such a case also

ii. If the student takes only the transitions to the ground state and writes



22.	(i) Finding $\frac{\epsilon_1}{\epsilon_2}$	2
	(ii) Position of null point for cell $\epsilon_1$	$\frac{1}{2}$
	(iii) Increase of sensitivity	$\frac{1}{2}$

(1)  $\epsilon_1 + \epsilon_2 = 300k$  ( $k$  is potential gradient in volt/cm)

 $\frac{1}{2}$ 

$$\epsilon_1 - \epsilon_2 = 120k$$

 $\frac{1}{2}$ 

$$\Rightarrow \frac{\epsilon_1}{\epsilon_2} = \frac{7}{3}$$

1

(ii)  $\epsilon_1 + \epsilon_2 = 300k$

$$\therefore \epsilon_1 + \frac{3}{7} \epsilon_1 = 300k$$

$$\Rightarrow \epsilon_1 = 210k$$

Therefore, balancing length for cell  $\epsilon_1$  is 210 cm

 $\frac{1}{2}$ 

(Award this  $\frac{1}{2}$  mark even if the student writes  $\epsilon_1 = 210k$ )

(Award full marks for any other correct method)

(iii) By decreasing potential gradient.

[Or through Increasing length, reducing potential drop across wire, increasing resistance put in series with the main cell etc.]

 $\frac{1}{2}$ 

3

**OR**

Calculation of unknown resistance (R)	1
Calculation of potential difference between A & D	2

Applying Kirchhoff's Voltage rule

for loop ABEFA

$$-9 + 6 + 4 \times 0 + 2I = 0$$

 $\frac{1}{2}$ 

$$2I - 3 = 0$$

$$I = \frac{3}{2} \text{ A} = 1.5 \text{ A}$$

 $\frac{1}{2}$

For loop BCDEB

$$3 + IR + 4 \times 0 - 6 = 0 \quad \frac{1}{2}$$

$$\therefore IR = 3$$

Substituting the value of current I,

$$\frac{3}{2} \times R = 3$$

$$\therefore R = 2 \Omega \quad \frac{1}{2}$$

Potential difference between A & D

Through path ABCD

$$+9V - 3V - IR = V_{AD}$$

$$+9 - 3 - \frac{3}{2} \times 2 = V_{AD}$$

$$\Rightarrow V_{AD} = 3V$$

[Alternatively through path AFD] 1

$$\frac{3}{2} \times 2 = V_{AD}$$

$$\Rightarrow V_{AD} = 3V \quad 3$$

(Note: Also accept any other logically valid approach leading to correct answer)

23.	(i) Naming the characteristic property	1
	(ii) Showing density of nucleus is independent of mass number	2

(i) Saturation / short range nature of nuclear forces. 1

(ii) We have

$$R = R_0 A^{1/3} \quad \frac{1}{2}$$

$$\therefore \text{Density } \rho = \frac{mA}{\frac{4}{3}\pi (R_0 A^{1/3})^3} \quad \frac{1}{2}$$

$$= \frac{m}{\frac{4}{3}\pi R_0^3} \quad \frac{1}{2}$$

Hence  $\rho$  is independent of A

(Here  $m$  is the mass of the nucleus.)  $\frac{1}{2}$

3

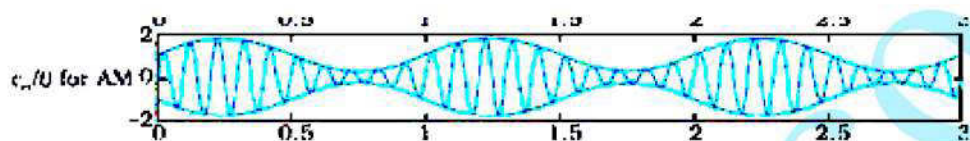
24. Two factors justifying the need for modulation 1 + 1

Diagram of amplitude modulated wave 1

Writing any two of the following factors:

1+1

- (i) Practical size of antenna / aerial
- (ii) Effective power radiated by an antenna
- (iii) To avoid mixing up of signals from different transmitters.



3

25. Photoelectric equation  $\frac{1}{2}$

Obtaining this equation from photon picture 1

Three salient features  $\frac{1}{2} + \frac{1}{2} + \frac{1}{2}$

$$h\nu = \phi_0 + K_{\max}$$

$\frac{1}{2}$

Energy ( $h\nu$ ), carried by a photon of frequency  $\nu$ , is absorbed (by the electrons on the surface.) to:

- (1) overcome the work function of metal ( $\phi_0$ )  $\frac{1}{2}$
- (2) Impart maximum kinetic energy to the emitted electron ( $K_{\max}$ )  $\frac{1}{2}$

$$\therefore h\nu = \phi_0 + K_{\max}$$

[Note: Award only one mark for writing the photoelectric equation, when a student also explains the symbols used in the equation]

Three salient features (Any three):

- (i) Cut-off potential of the emitted electrons is proportional to  $\nu$
- (ii) maximum kinetic energy is independent of the intensity of incident radiations.
- (iii) Photoelectric emission of electrons is possible only when  $\nu > \nu_0 = \frac{\phi_0}{h}$   $\frac{1}{2} + \frac{1}{2}$
- (iv) Emission of electrons is instantaneous  $\frac{1}{2}$

26.	a) Need for coherent sources (to produce sustained interference)	1
	b) Calculation of intensity	2

- (a) Coherent sources are needed to ensure that the positions of maxima and minima do not change with time.

Alternatively,

Coherent sources have constant phase difference and, therefore, produce a sustained interference pattern.

(b)

$$I = 4 I_0 \cos^2 \frac{\theta}{2}$$

$$[\text{Alternatively, } I = I_1 + I_2 + 2 \sqrt{I_1 I_2} \cos \theta] \quad \frac{1}{2}$$

For path difference  $\lambda$ , phase difference

$$\phi = 2\pi$$

$$\text{Hence, } K = 4 I_0 \cos^2 \pi = 4 I_0$$

$$\text{For path difference } \frac{\lambda}{3} \quad \frac{1}{2}$$

$$\text{Phase difference } \phi = \frac{2\pi}{3}$$

Intensity

$$I' = 4 I_0 \cos^2 \frac{\pi}{3} \quad \frac{1}{2}$$

$$= 4 I_0 \left( \frac{1}{2} \right)^2 = I_0$$

$$\text{Therefore, } I' = \frac{K}{4} \quad \frac{1}{2} \quad 3$$

27.	Explanation of the formation of diffraction pattern using Huygens's principle	2
	Effect of width of slit on the size and intensity of central maxima	$\frac{1}{2} + \frac{1}{2}$

Explanation :

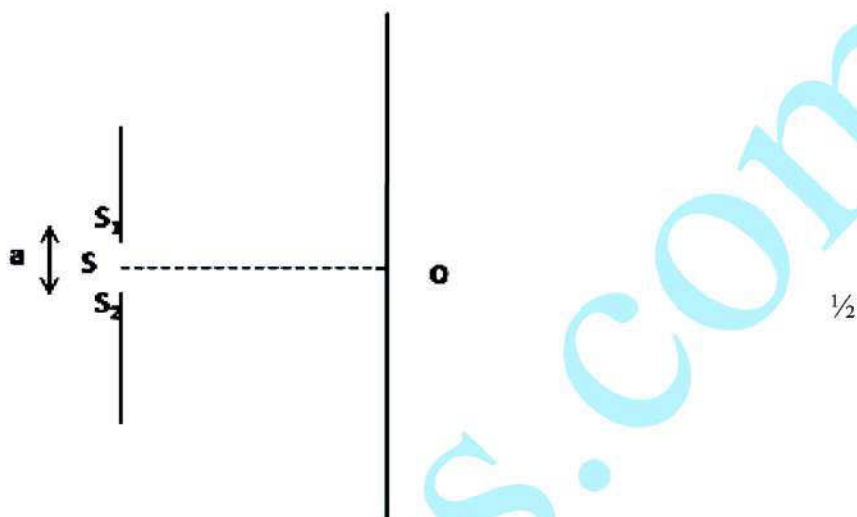
As per Huygen's Principle

Net effect at any point

= sum total of contribution of all wavelets with proper phase difference  $\frac{1}{2}$

At the central Point (O)

Contribution from each half in  $SS_1$  is in phase with that from the corresponding part in  $SS_2$ . Hence, O is a maxima  $\frac{1}{2}$



At the point M where  $SM - SM_1 = \lambda/2$

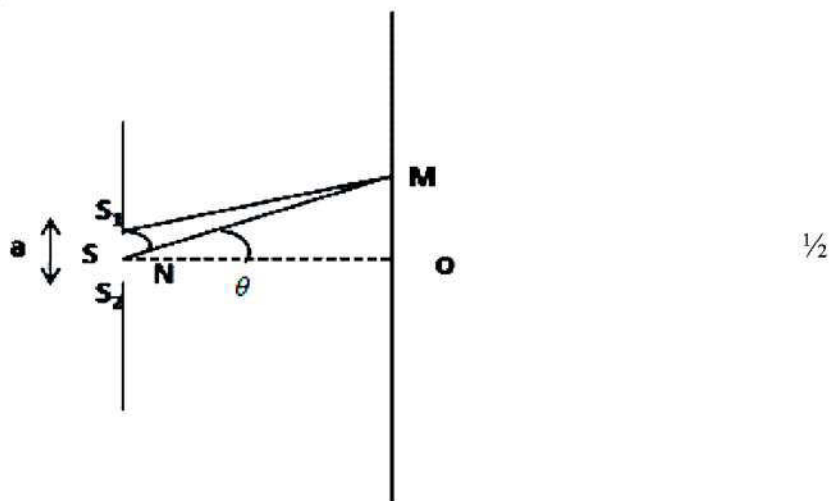
Phase difference between each wavelet from  $SS_1$  and corresponding wavelet from  $SS_2 = \lambda/2$

Hence, M would be a minima.

All such points (path difference =  $n\lambda/2$ ) are also minima.

Similarly, all points, for which path difference =  $(2n+1)\lambda/2$ , are maxima but with decreasing intensity.  $\frac{1}{2}$

From the figure



Half angular width of central maxima  $= \lambda/a$

$\therefore$ , Size of central maxima will be reduced to half

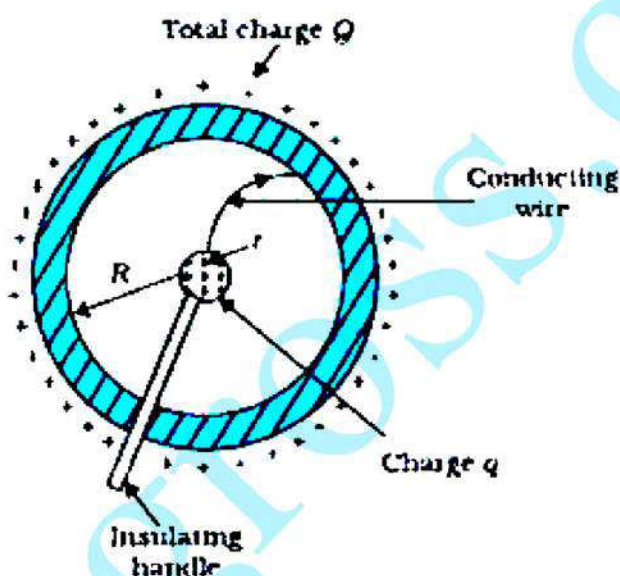
and intensity of central maxima will be four times

[Note: award this last one mark even when the student writes the 'effect on size' only.]

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

3

28.	Principle of device	1
	Diagram and explanation of working	2 + 1
	Restriction	1

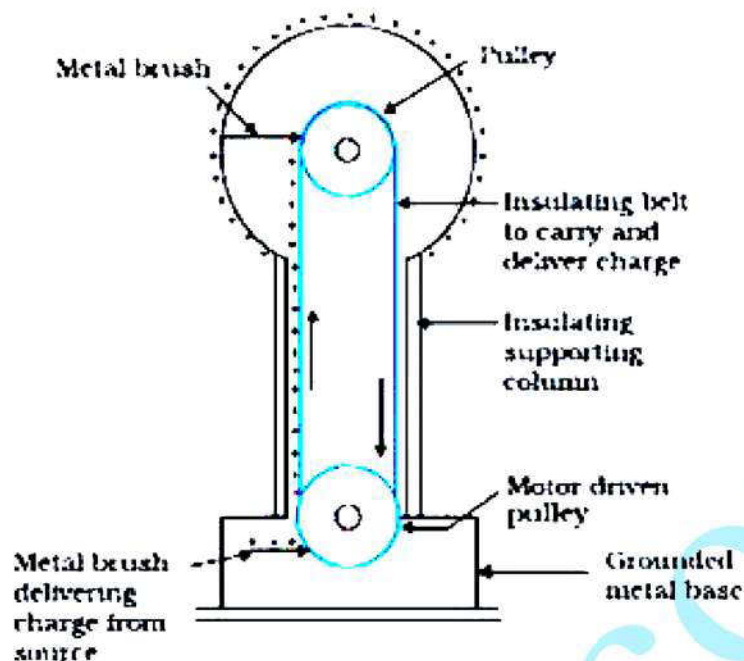


Principle: The inner smaller sphere is at a higher potential than the larger outer sphere. Hence even a small positive charge, on the small sphere, flows immediately to the larger sphere when both are connected by a conducting wire, even when the charge on the larger sphere is quite large.

[Alternatively:

- i. Surface charge density of sharp points of a conductor is extremely high and hence charge is continuously being sprayed out from sharp points.
- ii. Charge given to inner surface of a hollow conductor is transferred to its outer surface and is uniformly distributed over it.]

1



**Working:** The belt continuously carries positive charge, sprayed on to it by a brush at ground level, to the top. There it transfers its positive charge to another conducting brush connected to the large shell. Thus positive charge is transferred to the shell, where it spreads out uniformly on the outer surface. In this way voltage difference is built up.

Yes, high voltages can be built up only upto the breakdown field of the surrounding medium.

(Award marks if student describes any other correct device.)

OR

a)	Definition of Electric flux	1
	SI unit	$\frac{1}{2}$
b)	Derivation	$2\frac{1}{2}$
c)	Direction of field	$\frac{1}{2} + \frac{1}{2}$

- a) Electric flux is defined as the number of electric field lines passing through an area normal to them.

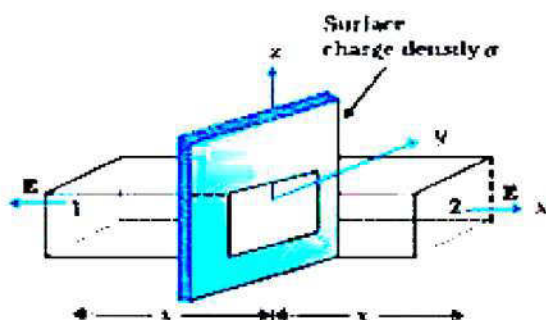
Alternatively

Surface integral of the electric field is defined as the electric flux through a closed surface

$$\varphi = \oint \vec{E} \cdot d\vec{S} \quad \frac{1}{2}$$

$$\text{SI unit: } \frac{N \cdot m^2}{C} \text{ or volt. metre}$$

(a)



Outward flux through the gaussian surface, is

$$2EA = \sigma A / \epsilon_0 \quad \frac{1}{2}$$

$$\therefore E = \sigma / 2\epsilon_0 \quad \frac{1}{2}$$

Vectorically,

$$\vec{E} = \frac{\sigma}{2\epsilon_0} \hat{n},$$

where  $\hat{n}$  is a unit vector normal to the plane, away from it.  $\frac{1}{2}$

Hence, Electric field is independent of the distance from sheet.

(i) for positively charged sheet

$\rightarrow$  away from the sheet  $\frac{1}{2}$

for negatively charged sheet

$\rightarrow$  towards the plane sheet  $\frac{1}{2}$

5

29.	Definition of Magnifying power	1
	Expression	1
	Calculation of height of final image	3

a) Magnifying power is the ratio of the angle subtended at the eye by the image to the angle subtended at the unaided eye by the object.

1

Expression

$$m = \beta/\alpha = f_o/f_e$$

$$\text{or } m = f_o/f_e \left(1 + \frac{f_e}{D}\right) \quad 1$$

[Award 1 mark if student writes expression with -ve sign]

b) Using, the lens equation for objective lens,:

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

$$\frac{1}{150} = \frac{1}{v_o} - \frac{1}{-3 \times 10^5}$$

$$\Rightarrow \frac{1}{v_o} = \frac{1}{150} - \frac{1}{-3 \times 10^5} = \frac{2000-1}{3 \times 10^5} \quad \frac{1}{2}$$

$$\Rightarrow v_o = \frac{-3 \times 10^5}{1999} \text{ cm}$$

$$\approx 150 \text{ cm}$$

Hence, magnification due to the objective lens

$$m_o = \frac{v_o}{u_o} = \frac{150 \times 10^{-2} \text{ m}}{3000 \text{ m}} \quad \frac{1}{2}$$

$$\approx \frac{10^{-2}}{20} = .05 \times 10^{-2}$$

Using lens formula for eyepiece

$$\Rightarrow \frac{1}{f_e} = \frac{1}{v_e} - \frac{1}{u_e}$$

$$\Rightarrow \frac{1}{5} = \frac{1}{-25} - \frac{1}{u_e}$$

$$\Rightarrow \frac{1}{u_e} = \frac{1}{-25} - \frac{1}{5} = \frac{-1-5}{25}$$

$$\Rightarrow u_e = \frac{-25}{6} \text{ cm}$$

$$\therefore \text{Magnification due to eyepiece } m_e = \frac{-25}{-\frac{25}{6}} = 6 \quad \frac{1}{2}$$

Hence, total magnification  $\Rightarrow m = m_e \times m_o$

$$m = 6 \times 5 \times 10^{-4} = 30 \times 10^{-4}$$

Hence, size of final image

$$= 30 \times 10^{-4} \times 100 \text{ m}$$

$$= 30 \text{ cm}$$

(Award full marks for alternative method)

OR

Difference in working of telescope and microscope	2
Finding position of object	3

Working differences:

1. Objective of a telescope forms the image of a very far off object at, or within, the focus of its eyepiece. The microscope does the same for a small object kept just beyond the focus of its objective.
2. The final image formed by a telescope is magnified relative to its size as seen by the unaided eye while the final image formed by a microscope is magnified relative to its absolute size.
3. The objective of a telescope has large focal length & large aperture while the corresponding for a microscope have very small values.

Give full credit if any two differences are written.

Telescope	Microscope
1. Resolving power should be higher for certain magnification.	1. Resolving power is not so large but the magnification should be higher.
2. Focal length of objective should be kept larger while eyepiece focal length should be small for better magnification.	2. Both objective and eye piece should have less focal length for better magnification.
3. Objective should be of large aperture.	3. Eye piece should be of large aperture.

4. Distance between objective and eye piece is adjusted to focus the object at infinity.

4. Distance between objective and eye piece is fixed, for focusing an object the distance of the objective is changed.

$\frac{1}{2}$

[Alternatively: Award these two marks if the student writes any two of the following differences.]

Given :  $f_o = 1.25\text{cm}$

$$f_e = 5\text{cm}$$

Angular magnification  $m = 30$

$$\text{Now, } m = m_e \times m_o$$

In normal adjustment, angular magnification of eyepiece

$$m_e = \frac{d}{f_e} = + \frac{25}{5} = 5$$

Hence,  $m_o = 6$

$$\text{But } m_o = \frac{v_o}{u_o} \Rightarrow -6 = \frac{v_o}{u_o}$$

$\frac{1}{2}$

$$\Rightarrow v_o = -6 u_o$$

Applying lens equation to the objective lens :

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

$\frac{1}{2}$

$$\frac{1}{1.25} = \frac{1}{-6u_o} - \frac{1}{u_o}$$

$\frac{1}{2}$

$$\frac{1}{1.25} = \frac{-1-6}{6u_o}$$

$$6 u_o = 1.25 \times (-7)$$

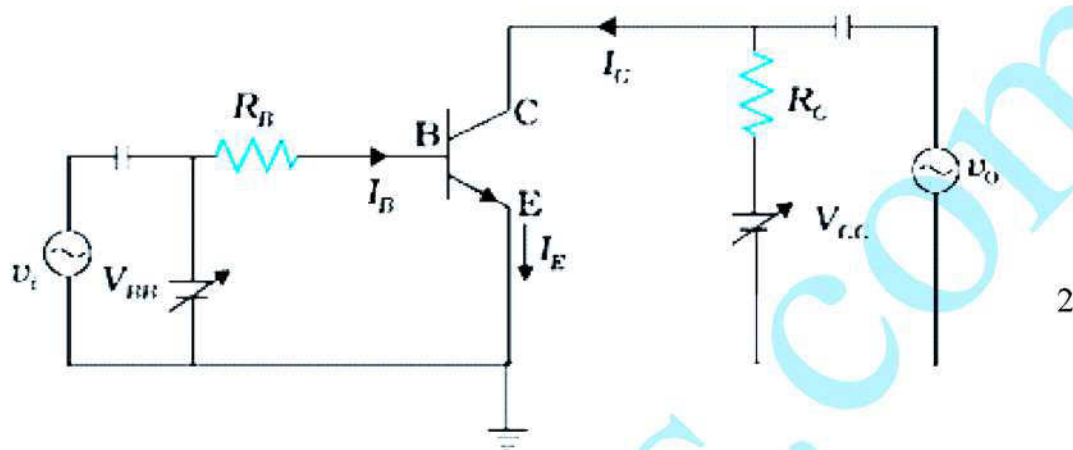
$$u_o = \frac{-1.25 \times 7}{6} \text{ cm}$$

$$= -1.46 \text{ cm}$$

$\frac{1}{2}$

5

30.	Circuit of CE transistor amplifier	2
	Working	1
	Derivation of voltage gain expression	1½
	Significance of negative sign	½



When an ac input signal  $v_i$  is superimposed on the bias  $v_{BB}$ , the output, which is measured between collector and ground, increases.

$$v_{CC} = v_{CE} + I_C R_L$$

$$v_{BB} = v_{BE} + I_B R_B$$

When  $v_i$  is not zero, we have

$$v_{BE} + v_i = v_{BE} + I_B R_B + \Delta I_B (R_B + R_i)$$

$$\Rightarrow v_i = \Delta I_B (R_B + R_i)$$

$$v_i = r \Delta I_B$$

Change in  $I_B$  causes a change in  $I_C$ .

$$\text{Hence, } \beta_{ac} = \frac{\Delta I_C}{\Delta I_B} = \frac{I_C}{I_B}$$

$$\text{As } \Delta V_{CC} = \Delta V_{CE} + R_L \Delta I_C = 0$$

$$\Rightarrow \Delta V_{CE} = -R_L \Delta I_C$$

$$\Rightarrow V_o = -R_L \Delta I_C$$

$$= \beta_{ac} \Delta I_B R_L$$

$\Rightarrow$  voltage gain of the amplifier

$$A_v = \frac{V_o}{v_i} = \frac{\Delta V_{CE}}{r \Delta I_B} = \frac{-\beta_{ac} \Delta I_B R_L}{r \Delta I_B}$$

$$= -\beta_{ac} \frac{R_L}{r}$$

Negative sign in the expression shows that output voltage and input voltage have phase difference of  $\pi$ .

$\frac{1}{2}$

[Alternatively

(Also accept this derivation for voltage gain expression)

$$A_v = \frac{\Delta V_{CE}}{\Delta V_{BE}} = \frac{-\Delta I_C R_L}{\Delta I_B R_i}$$

$\frac{1}{2}$

But current gain

$$\beta_{ac} = \frac{-\Delta I_C}{\Delta I_B}$$

$\frac{1}{2}$

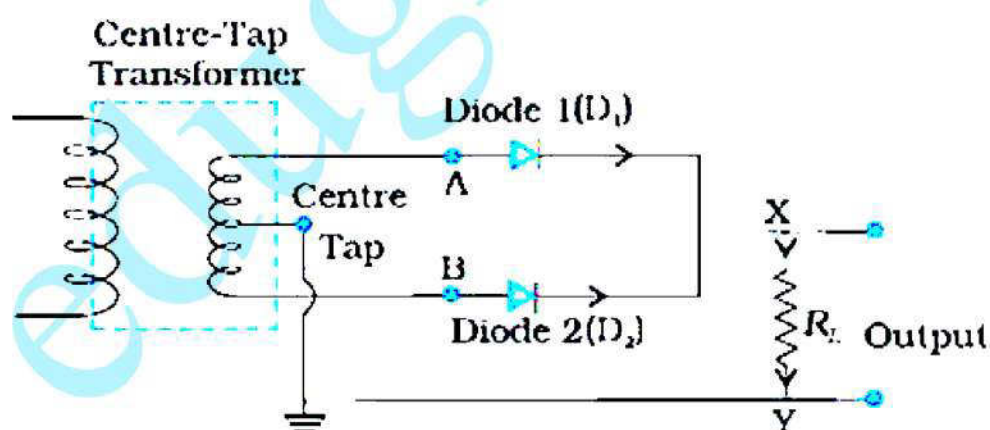
$$\Rightarrow A_v = -\beta_{ac} \times \frac{R_L}{R_i}$$

$\frac{1}{2}$

5

OR

(a)	Circuit diagram	1
	Working	1
	Output and input waveform	$\frac{1}{2} + \frac{1}{2}$
(b)	Output waveforms of OR and NAND gates	1 + 1



1

During first half cycle:

A is positive w.r.t centre tap but B is negative, hence only diode  $D_1$  conducts and current flows through the load in the sense X to Y.

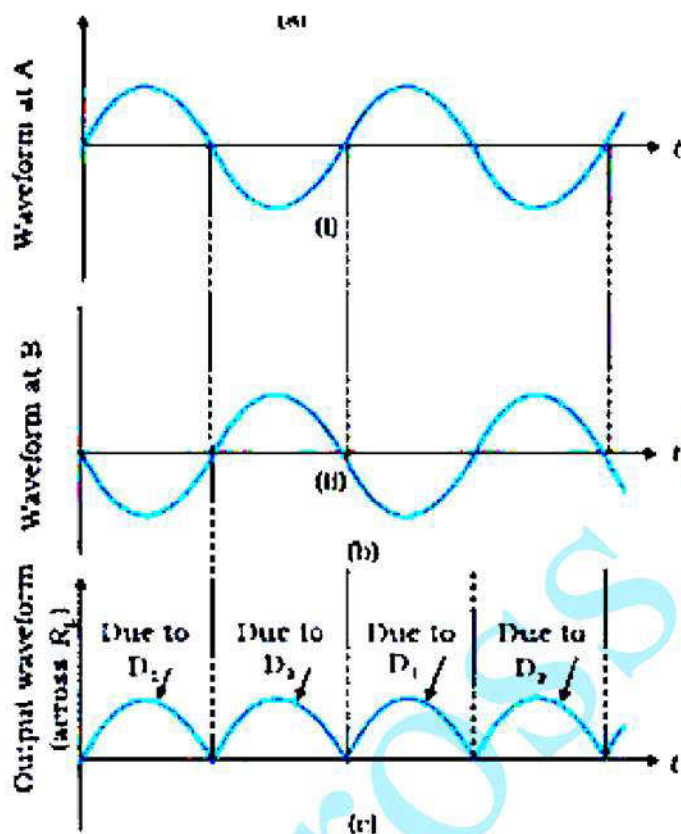
$\frac{1}{2}$

During the second half cycle:

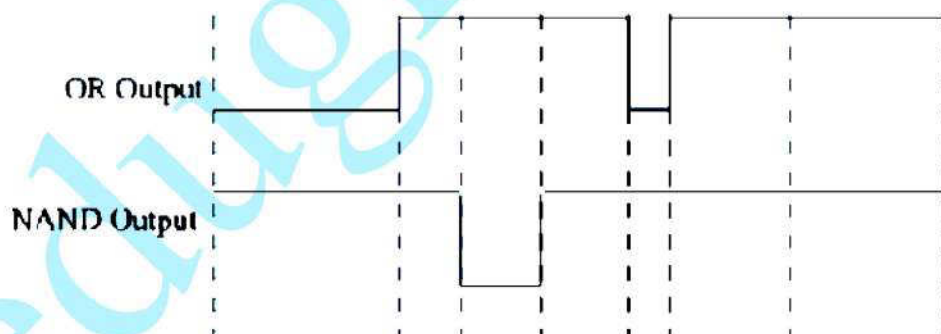
B is positive w.r.t centre tap but A is negative hence only diode  $D_2$  conducts and again send currents through load from X and Y.

 $\frac{1}{2}$ 

$\therefore$  Current through the load, in both the halves of input, is unidirectional.


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

(b)



1

1

5