

# PHYSICS

Time allowed : 3 hours

Maximum marks: 70

## General Instructions:

- (i) All questions are compulsory.
- (ii) There is no overall choice. However, an internal choice has been provided in one question of two marks, one question of three marks and all three questions of five marks. You have to attempt only one of the choice in such questions.
- (iii) Question numbers 1 to 5 are very short answer type questions, carrying one mark each.
- (iv) Question numbers 6 to 12 are short answer type questions, carrying two marks each.
- (v) Question numbers 13 to 24 are also short answer type questions, carrying three marks each.
- (vi) Questions numbers 25 to 27 are long answer type questions, carrying five marks each.
- (vii) Use of calculators is not permitted. However, you may use log tables, if necessary.
- (viii) You may use the following values of physical constants wherever necessary:

$$c = 3 \times 10^8 \text{ ms}^{-1}$$

$$h = 6.6 \times 10^{-34} \text{ Js}$$

$$e = 1.6 \times 10^{-19} \text{ C}$$

$$\mu_0 = 4\pi \times 10^{-7} \text{ T m A}^{-1}$$

$$\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2 \text{ N}^{-1} \text{ m}^{-2}$$

$$\frac{1}{4\pi\epsilon_0} = 9 \times 10^9 \text{ Nm}^2 \text{ C}^{-2}$$

$$\text{Mass of neutron } m_n \cong 1.6 \times 10^{-27} \text{ kg}$$

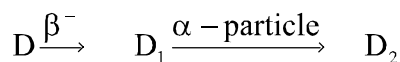
$$\text{Boltzmann's constant } k = 1.38 \times 10^{-23} \text{ JK}^{-1}$$

$$\text{Avogadro's number } N_A = 6.023 \times 10^{23} / \text{mole}$$

## QUESTION PAPER CODE 55/1/1

1. An electron, an alpha-particle and a proton have the same kinetic energy. Which one of these particles has the largest de-Broglie wavelength ? 1
2. Why should the material used for making permanent magnets have high coercivity ? 1

3. The radioactive isotope D decays according to the sequence



If the mass number and atomic number of  $D_1$  are 176 and 71 respectively, what is (i) the mass number (ii) atomic number of D ?

4. What will be the values of input A and B for the Boolean expression  $\overline{(A+B)} \cdot \overline{(A \cdot B)} = 1$  ?
5. Why is frequency modulation preferred over amplitude modulation for transmission of music ?
6. The output of an OR gate is connected to both the inputs of a NAND gate. Draw the logic circuit of this combination of gates and write its truth table.
7. Draw a plot of potential energy of a pair of nucleons as a function of their separation. What is the significance of negative potential energy in the graph drawn ?
8. A convex lens of refractive index 1.5 has a focal length of 18 cm in air. Calculate the change in its focal length when it is immersed in water of refractive index  $\frac{4}{3}$ .
9. Distinguish between the terms 'average value' and 'rms value' of an alternating current. The instantaneous current from an a.c. source is  $I = 5 \sin(314t)$  ampere. What are the average and rms values of the current ?
10. Write the relation for the force  $\vec{F}$  acting on a charge carrier  $q$  moving with a velocity  $\vec{v}$  through a magnetic field  $\vec{B}$  in vector notation. Using this relation, deduce the conditions under which this force will be (i) maximum (ii) minimum.
11. A cylindrical metallic wire is stretched to increase its length by 5%. Calculate the percentage change in its resistance.
12. The electric field  $E$  due to a point charge at any point near it is defined as  $E = \lim_{q \rightarrow 0} \frac{F}{q}$  where  $q$  is the test charge and  $F$  is the force acting on it. What is the physical significance of  $\lim_{q \rightarrow 0}$  in this expression ? Draw the electric field lines of a point charge  $Q$  when (i)  $Q > 0$  and (ii)  $Q < 0$ .

**OR**

Define electric flux. Write its S.I. units. A spherical rubber balloon carries a charge that is uniformly distributed over its surface. As the balloon is blown up and increases in size, how does the total electric flux coming out of the surface change ? Give reason.

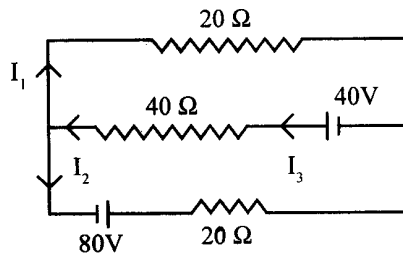
13. Deduce an expression for the electric potential due to an electric dipole at any point on its axis. Mention one contrasting feature of electric potential of a dipole at a point as compared to that due to a single charge. 3

14. A parallel plate capacitor, each with plate area  $A$  and separation  $d$ , is charged to a potential difference  $V$ . The battery used to charge it is then disconnected. A dielectric slab of thickness  $d$  and dielectric constant  $K$  is now placed between the plates. What change, if any, will take place in

- (i) charge on the plates
- (ii) electric field intensity between the plates
- (iii) capacitance of the capacitor.

Justify your answer in each case. 3

15. State Kirchhoff's rules of current distribution in an electrical network. Using these rules determine the value of the current  $I_1$  in the electric circuit given below. 3



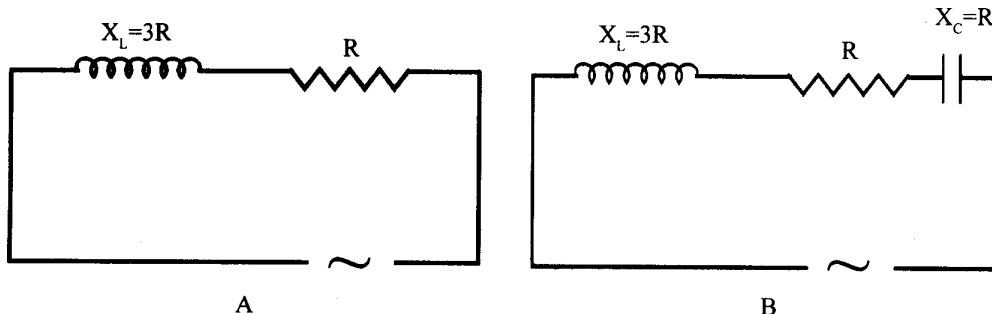
16. Write the mathematical relation for the resistivity of a material in terms of relaxation time, number density and mass and charge of charge carriers in it. Explain, using this relation, why the resistivity of a metal increases and that of a semi-conductor decreases with rise in temperature. 3

17. Explain with the help of a labelled diagram the underlying principle and working of a step-up transformer. Why cannot such a device be used to step-up d.c. voltage? 3

**OR**

Draw a labelled diagram of an a.c. generator. Explain briefly its principle and working. 3

18. Given below are two electric circuits A and B



Calculate the ratio of power factor of the circuit B to the power factor of circuit A. 3

19. Define the term 'resolving power' of an astronomical telescope. How does it get affected on  
 (i) increasing the aperture of the objective lens ?  
 (ii) increasing the wavelength of the light used ?  
 Justify your answer in each case. 3
20. Write any four characteristics of electromagnetic waves. Give two uses each of  
 (i) Radio-waves (ii) Micro-waves. 3
21. In a plot of photoelectric current versus anode potential, how does  
 (i) the saturation current vary with anode potential for incident radiations of different frequencies but same intensity ?  
 (ii) the stopping potential vary for incident radiations of different intensities but same frequency ?  
 (iii) photoelectric current vary for different intensities but same frequency of incident radiations ?  
 Justify your answer in each case. 3
22. Calculate the amount of energy released during the  $\alpha$  – decay of  

$${}_{92}^{238}\text{U} \rightarrow {}_{90}^{234}\text{Th} + {}_2^4\text{He}$$
 Given: 1. atomic mass of  ${}_{92}^{238}\text{U} = 238.05079 \text{ u}$   
 2. atomic mass of  ${}_{90}^{234}\text{Th} = 234.04363 \text{ u}$   
 3. atomic mass of  ${}_2^4\text{He} = 4.00260 \text{ u}$   
 $1 \text{ u} = 931.5 \text{ MeV} / c^2$   
 Is this decay spontaneous ? Give reason. 3
23. What is a digital signal ? Explain the function of modem in data communication. Write two advantages of digital communication. 3
24. Explain, with the help of a schematic diagram, the principle and working of a Light Emitting Diode. What criterion is kept in mind while choosing the semiconductor material for such a device ? Write any two advantages of Light Emitting Diode over conventional incandescent lamps. 3
25. Draw a labelled diagram of a moving coil galvanometer. State the principle on which it works.  
 Deduce an expression for the torque acting on a rectangular current carrying loop kept in a uniform magnetic field. Write two factors on which the current sensitivity of a moving coil galvanometer depend. 5

**OR**

State Biot-Savart law. Use it to derive an expression for the magnetic field at the centre of a circular loop of radius  $R$  carrying a steady current  $I$ . Sketch the magnetic field lines for such a current carrying loop.

5

26. What are coherent sources ? Why are coherent sources required to produce interference of light ? Give an example of interference of light in everyday life.

In Young's double slit experiment, the two slits are 0.03 cm apart and the screen is placed at a distance of 1.5 m away from the slits. The distance between the central bright fringe and fourth bright fringe is 1 cm. Calculate the wavelength of light used.

5

**OR**

State the condition under which the phenomenon of diffraction of light takes place. Derive an expression for the width of the central maximum due to diffraction of light at a single slit.

A slit of width ' $a$ ' is illuminated by a monochromatic light of wavelength 700 nm at normal incidence. Calculate the value of ' $a$ ' for position of

- (i) first minimum at an angle of diffraction of  $30^\circ$ .
- (ii) first maximum at an angle of diffraction of  $30^\circ$ .

5

27. State the principle of working of p-n diode as a rectifier. Explain, with the help of a circuit diagram, the use of p-n diode as a full wave rectifier. Draw a sketch of the input and output waveforms.

5

**OR**

Draw the symbolic representation of a (i) p-n-p, (ii) n-p-n transistor. Why is the base region of transistor thin and lightly doped ? With proper circuit diagram, show the biasing of a p-n-p transistor in common base configuration. Explain the movement of charge carriers through different parts of the transistor in such a configuration and show that  $I_E = I_C + I_B$ .

5

### QUESTION PAPER CODE 55/1

1. In a series LCR circuit, the voltages across an inductor, a capacitor and a resistor are 30 V, 30 V and 60 V respectively. What is the phase difference between the applied voltage and the current in the circuit ?

1

2. Ultraviolet radiations of different frequencies  $\nu_1$  and  $\nu_2$  are incident on two photosensitive materials having work functions  $W_1$  and  $W_2$  ( $W_1 > W_2$ ) respectively. The kinetic energy of the emitted electrons is same in both the cases. Which one of the two radiations will be of higher frequency ?

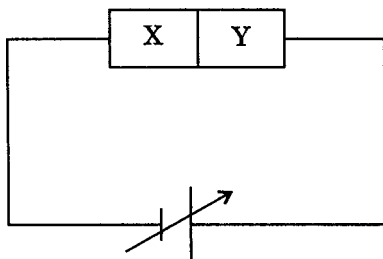
1

3. Define the term 'activity' of radionuclide. Write its SI unit. 1
4. An electron is moving along +ve x-axis in the presence of uniform magnetic field along +ve y-axis. What is the direction of the force acting on it? 1
5. What should be the length of dipole antenna for a carrier wave of frequency  $6 \times 10^8$  Hz? 1
6. Two point charges  $4 \mu\text{C}$  and  $-2 \mu\text{C}$  are separated by a distance of 1 m in air. Calculate at what point on the line joining the two charges is the electric potential zero. 2
7. A voltage of 30 V is applied across a carbon resistor with first, second and third rings of blue, black and yellow colours respectively. Calculate the value of current, in mA, through the resistor. 2
8. A galvanometer has a resistance of  $30 \Omega$ . It gives full scale deflection with a current of 2 mA. Calculate the value of the resistance needed to convert it into an ammeter of range 0-0.3 A. 2
9. Calculate the current drawn by the primary of a transformer which steps down 200 V to 20 V to operate a device of resistance  $20 \Omega$ . Assume the efficiency of the transformer to be 80%. 2

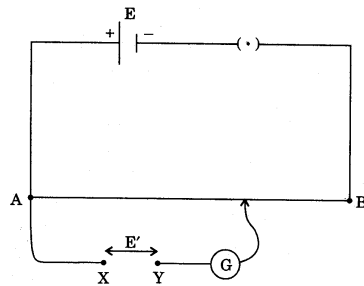
**OR**

An a.c. voltage of 100 V, 50 Hz is connected across a 20 ohm resistor and mH inductor in series. Calculate (i) impedance of the circuit, (ii) rms current in the circuit.

10. Define resolving power of a compound microscope. How does the resolving power of a compound microscope change when
  - (i) refractive index of the medium between the object and objective lens increases?
  - (ii) wavelength of the radiation used is increased? 2
11. Draw a graph showing the variation of potential energy between a pair of nucleons as a function of their separation. Indicate the regions in which the nuclear force is (i) attractive, (ii) repulsive. 2
12. Two semiconductor materials X and Y shown in the given figure, are made by doping germanium crystal with indium and arsenic respectively. The two are joined end to end and connected to a battery as shown. 2



- (i) Will the junction be forward biased or reverse biased ?  
(ii) Sketch a V-I graph for this arrangement. 2
- 13.** State Gauss's theorem in electrostatics. Apply this theorem to derive an expression for electric field intensity at a point near an infinitely long straight charged wire. 3
- 14.** Explain the underlying principle of working of a parallel plate capacitor.  
If two similar plates, each of area  $A$  having surface charge densities  $+\sigma$  and  $-\sigma$  are separated by a distance  $d$  in air, write expressions for  
(i) the electric field at points between the two plates.  
(ii) the potential difference between the plates.  
(iii) the capacitance of the capacitor so formed. 3
- 15.** For the potentiometer circuit shown in the given figure, points  $X$  and  $Y$  represent the two terminals of an unknown emf  $E'$ . A student observed that when the jockey is moved from the end  $A$  to the end  $B$  of the potentiometer wire, the deflection in the galvanometer remains in the same direction.

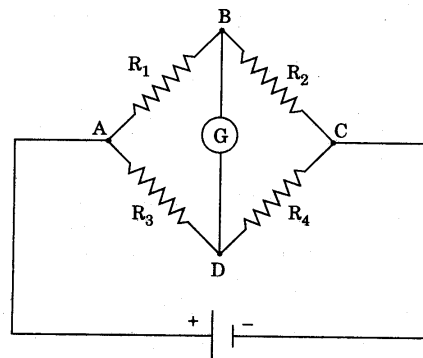


What may be the two possible faults in the circuit that could result in this observation ?

If the galvanometer deflection at the end  $B$  is (i) more, (ii) less, than that at the end  $A$ , which of the two faults, listed above, would be there in the circuit ? Give reasons in support of your answer in each case. 3

**OR**

The given figure shows a network of resistances  $R_1$ ,  $R_2$ ,  $R_3$  and  $R_4$ .



Using Kirchhoff's laws, establish the balance condition for the network.

16. What is Seebeck effect ? Plot a graph showing the variation of thermo emf with temperature of hot junction (keeping cold junction at  $0^{\circ}\text{C}$ ) of a thermocouple. How will the (i) neutral temperature, (ii) inversion temperature of a thermocouple change when the temperature of cold junction is increased ? 3
17. Name the following constituent radiations of electromagnetic spectrum which  
 (i) produce intense heating effect.  
 (ii) is absorbed by the ozone layer in the atmosphere.  
 (iii) is used for studying crystal structure.  
 Write one more application for each of these radiations. 3
18. A double convex lens of glass of refractive index 1.6 has its both surfaces of equal radii of curvature of 30 cm each. An object of height 5 cm is placed at a distance of 12.5 cm from the lens. Calculate the size of the image formed. 3
19. Draw a schematic diagram of the experimental arrangement used by Davisson and Germer to establish the wave nature of electrons. Explain briefly how the de-Broglie relation was experimentally verified in case of electrons. 3
20. Draw the graph to show variation of binding energy per nucleon with mass number of different atomic nuclei. Calculate binding energy/nucleon of  ${}_{20}^{40}\text{Ca}$  nucleus. 3  
 Given :  
 mass of  ${}_{20}^{40}\text{Ca} = 39.962589 \text{ u}$   
 mass of proton = 1.007825 u  
 mass of neutron = 1.008665 u  
 and  $1 \text{ u} = 931 \text{ MeV}/c^2$
21. Draw the circuit diagram of a common emitter amplifier using n-p-n transistor. What is the phase difference between the input signal and output voltage ? State two reasons why a common emitter amplifier is preferred to a common base amplifier. 3
22. Explain the formation of energy band in solids. Draw energy band diagram for (i) a conductor, (ii) an intrinsic semiconductor. 3
23. What is modulation ? Explain the need of modulating a low frequency information signal. With the help of diagrams, differentiate between PAM and PDM. 3
24. Write the acronym LASER in expanded form. State any four reasons for preferring diode lasers as light sources for optical communication links. 3
25. Explain, with the help of a labelled diagram, the principle and construction of a cyclotron.  
 Deduce an expression for the cyclotron frequency and show that it does not depend on the speed of the charged particle. 5



**OR**

Distinguish the magnetic properties of dia, para- and ferro-magnetic substances in terms of (i) susceptibility, (ii) magnetic permeability and (iii) coercivity. Give one example of each of these materials.

Draw the field lines due to an external magnetic field near a (i) diamagnetic, (ii) paramagnetic substance.

- 26.** Explain the term 'inductive reactance'. Show graphically the variation of inductive reactance with frequency of the applied alternating voltage.

An a.c. voltage  $E = E_0 \sin \omega t$  is applied across a pure inductor of inductance  $L$ . Show mathematically that the current flowing through it lags behind the applied voltage by phase angle of  $\pi/2$ .

5

**OR**

Explain the term 'capacitive reactance'. Show graphically the variation of capacitive reactance with frequency of the applied alternating voltage.

An a.c. voltage  $E = E_0 \sin \omega t$  is applied across a pure capacitor of capacitance  $C$ . Show mathematically that the current flowing through it leads the applied voltage by a phase angle of  $\pi/2$ .

- 27.** State the essential condition for diffraction of light to take place.

Use Huygen's principle to explain diffraction of light due to a narrow single slit and the formation of a pattern of fringes obtained on the screen. Sketch the pattern of fringes formed due to diffraction at a single slit showing variation of intensity with angle  $\theta$ .

5

**OR**

What are coherent sources of light ? Why are coherent sources required to obtain sustained interference pattern ?

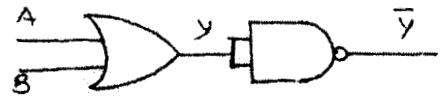
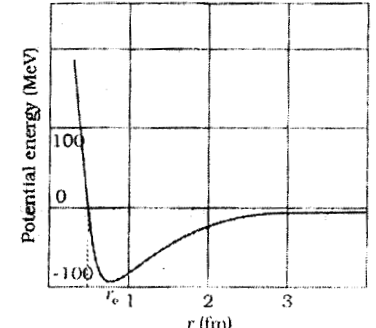
State three characteristic features which distinguish the interference pattern due to two coherently illuminated sources as compared to that observed in a diffraction pattern due to a single slit.

## Marking Scheme — Physics

### *General Instructions :*

1. The Marking Scheme provides general guidelines to reduce subjectivity in the marking. The answers given in the marking scheme are suggested answers. The content is thus indicative. If a student has given any other answer, which is different from the one given in the Marking Scheme, but conveys the meaning correctly, such answers should be given full weightage.
2. Evaluation is to be done as per instructions provided in the marking scheme. It should not be done according to one's own interpretation or any other consideration. Marking Scheme should be strictly adhered to and religiously followed.
3. If a question has parts, please award marks in the right hand side for each part. Marks awarded for different part of the question should then be totalled up and written in the left hand margin and circled.
4. If a question does not have any parts, marks are be awarded in the left hand margin only.
5. If a candidate has attempted an extra question, marks obtained in the question attempted first should be retained and the other answer should be scored out.
6. No marks to be deducted for the cumulative effect of an error. The student should be penalized only once.
7. Deduct  $\frac{1}{2}$  marks for writing wrong units, or missing units, in all numerical problems.
8. Formula can be taken as implied from the calculations even if not explicitly written.
9. In short answer type questions, asking for two features/ characteristics/ properties, if a candidate writes three features/ characteristics/ properties or more, only the first two should be evaluated.
10. Full marks should be awarded to a candidate if his/her answer in a numerical problem is close to the value given in this scheme.
11. Award full marks to the answer of a questions if it deserves.

QUESTION PAPER CODE 55/1/1  
**EXPECTED ANSWERS/VALUE POINTS**

Q.No.		Marks	Total marks																				
1.	Electron	1	1																				
2.	Magnetisation is not easily erased by stray magnetic field/ minor mechanical damage/ temperature variation	1	1																				
3.	(i) Mass number 180 (ii) Atomic number 72 OR $D_{72}^{180}$	½ ½	1																				
4.	A = 0 B = 0	½ ½	1																				
5.	Better quality transmission/ larger band width/ Atmospheric or man made electrical noise signal do little harm.	1	1																				
6.	<table style="width: 100%; border-collapse: collapse;"> <tr> <td style="padding: 2px;">Logic circuit</td> <td style="text-align: center; padding: 2px;">1</td> </tr> <tr> <td style="padding: 2px;">Truth table</td> <td style="text-align: center; padding: 2px;">1</td> </tr> </table>	Logic circuit	1	Truth table	1	1																	
Logic circuit	1																						
Truth table	1																						
																							
	<table border="1" style="border-collapse: collapse; text-align: center;"> <thead> <tr> <th>A</th> <th>B</th> <th>Y</th> <th>Y</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <td>0</td> <td>1</td> </tr> <tr> <td>0</td> <td>1</td> <td>1</td> <td>0</td> </tr> <tr> <td>1</td> <td>0</td> <td>1</td> <td>0</td> </tr> <tr> <td>1</td> <td>1</td> <td>1</td> <td>0</td> </tr> </tbody> </table>	A	B	Y	Y	0	0	0	1	0	1	1	0	1	0	1	0	1	1	1	0	1	2
A	B	Y	Y																				
0	0	0	1																				
0	1	1	0																				
1	0	1	0																				
1	1	1	0																				
7.	<table style="width: 100%; border-collapse: collapse;"> <tr> <td style="padding: 2px;">Plot of potential energy curve</td> <td style="text-align: center; padding: 2px;">1</td> </tr> <tr> <td style="padding: 2px;">Significance</td> <td style="text-align: center; padding: 2px;">1</td> </tr> </table>	Plot of potential energy curve	1	Significance	1																		
Plot of potential energy curve	1																						
Significance	1																						
		1																					
	Nuclear forces are attractive	1	2																				

Q.No.	Marks	Total marks
-------	-------	-------------

8.	Formula	1/2
	Calculation	1
	Result	1/2

$$\frac{1}{f} = (\mu - 1) \left( \frac{1}{R_1} - \frac{1}{R_2} \right) \quad \frac{1}{2}$$

for air

$$\frac{1}{f_a} = ({}^a\mu_g - 1) \left( \frac{1}{R_1} - \frac{1}{R_2} \right) = \left( \frac{1}{2} \right) \left( \frac{1}{R_1} - \frac{1}{R_2} \right) \quad \frac{1}{2}$$

for water

$$\frac{1}{f_w} = ({}^w\mu_g - 1) \left( \frac{1}{R_1} - \frac{1}{R_2} \right) = \left( \frac{1}{8} \right) \left( \frac{1}{R_1} - \frac{1}{R_2} \right) \quad \frac{1}{2}$$

$$f_w = 4f_a$$

Change in focal length =  $3f_a = 54 \text{ cm}$  1/2      2

9.	Average value	1/2
	rms value	1/2
	Calculation of AV value	1/2
	Calculation of rms value	1/2

Average value of an alternating current over a time T is

$$I_{AV} = \frac{1}{T} \int_0^T I(t) dt \quad \frac{1}{2}$$

rms value of an alternating current is that value of steady current which when flowing through a resistance for a certain amount of time produces same amount of heat as the given A.C. does in the same resistance in the same time. 1/2

Average value over half cycle is  $\frac{2}{\pi} I_0 = 3.18A$

or Average value over complete cycle is zero 1/2

rms value is  $\frac{I_0}{\sqrt{2}} = 3.54A$  or  $\frac{5}{\sqrt{2}} A$  1/2      2

Q.No.	Marks	Total marks
-------	-------	-------------

10.	Expression	1
	Condition of maximum	½
	Condition of minimum	½

$$\vec{F} = q(\vec{V} \times \vec{B}) \quad \therefore |\vec{F}| = qVB \sin \theta \quad 1$$

(i) Maximum when

$$\vec{V} \perp \vec{B} \text{ or } \theta = \pi/2 \quad 1/2$$

(ii) Minimum when

$$\vec{V} \parallel \vec{B} \text{ or } \theta = 0 \text{ or } 180^\circ \quad 1/2 \quad 2$$

11.	Formula	½
	Calculation	1
	Result	½

$$R = \rho \frac{l}{A} \quad 1/2$$

$$Al = A' l'$$

$$A = \frac{105}{100} A'$$

$$\frac{R_1}{R_2} = \frac{l A'}{l' A}$$

$$\therefore R_2 = (1.05)^2 R_1 \quad 1$$

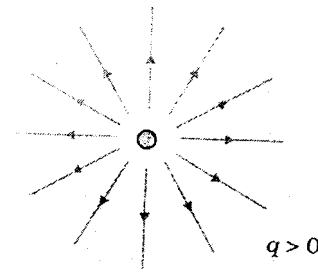
$$\% \text{ change} = \frac{R_2 - R_1}{R_1} \times 100 = 10.25 \quad 1/2$$

(full credit to be given even if % change is given approximately as 10%) 2

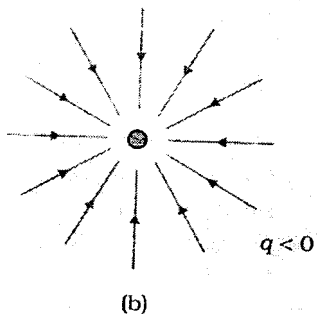
12.	Significance	1
	Field pattern for (i)	½
	Field pattern for (ii)	½

We say so to ensure that the source charge remains (almost) undisturbed in the presence of the test charge.

1



1/2



1/2

2

**OR**

Definition	1/2
Unit	1/2
Effect on flux	1/2
Reason	1/2

Electric flux is the total number of electric field lines passing normally through a given surface.

OR Electric Flux =  $\int_s \vec{E} \cdot d\vec{s}$  1/2

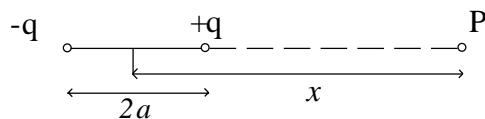
S.I. unit  $Nm^2/C$  OR  $V.m$  1/2

No Change 1/2

As the total charge enclosed remains the same. 1/2 2

**13.**

Derivation	2
Contrasting feature	1



1/2

Q.No.	Marks	Total marks
-------	-------	-------------

Potential at P due to +q

$$V_{+q} = \frac{1}{4\pi\epsilon_0} \frac{q}{x-a} \quad \frac{1}{2}$$

Potential at P due to -q

$$V_{-q} = \frac{1}{4\pi\epsilon_0} \frac{-q}{x+a} \quad \frac{1}{2}$$

∴ potential at P due to the dipole

$$V = \frac{1}{4\pi\epsilon_0} \frac{q(2a)}{(x^2 - a^2)}$$

for  $a \ll x$ , we have

$$\therefore V \cong \frac{1}{4\pi\epsilon_0} \frac{q(2a)}{x^2} \quad \frac{1}{2}$$

For a single charge  $V \propto \frac{1}{x} \quad \frac{1}{2}$

For a dipole  $V \propto \frac{1}{x^2} \quad \frac{1}{2} \quad 3$

14.

(i) Effect on charge with justification	$\frac{1}{2} + \frac{1}{2}$
(ii) Electric field with justification	$\frac{1}{2} + \frac{1}{2}$
(iii) Capacitance with justification	$\frac{1}{2} + \frac{1}{2}$

(i) No change  $\frac{1}{2}$

As the battery is disconnected  $\frac{1}{2}$

(ii) Decreases OR becomes  $\frac{1}{k}$  times  $\frac{1}{2}$

Due to polarization of the dielectric  $\frac{1}{2}$

(iii) Increases OR becomes  $k$  times  $\frac{1}{2}$

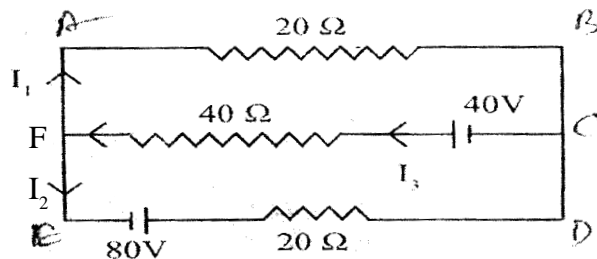
As the electric field, and therefore, the p.d., between the plates decreases  $\frac{1}{2} \quad 3$

15.

Statement	$\frac{1}{2} + \frac{1}{2}$
Calculation of $I_1$	2

**Junction Rule** : At any junction of several circuit elements the sum of currents entering the junction must be equal to the sum of currents leaving it.  $\frac{1}{2}$

**Loop Rule** : Algebraic sum of changes in the potential around any closed loop must be zero.  $\frac{1}{2}$



Loop ABCFA

$I_1 + 2I_3 = 2$  ..... (1) 1/2

Loop FCDEF

$2I_3 + I_2 = 6$  ..... (2) 1/2

At F,  $I_1 + I_2 = I_3$  ..... (3) 1/2

Solving (1), (2) and (3)

$I_1 = -0.8 \text{ A}$  1/2

3

16.

Relation	1
Explanation	1 + 1

$\rho = \frac{m}{ne^2\tau}$  1

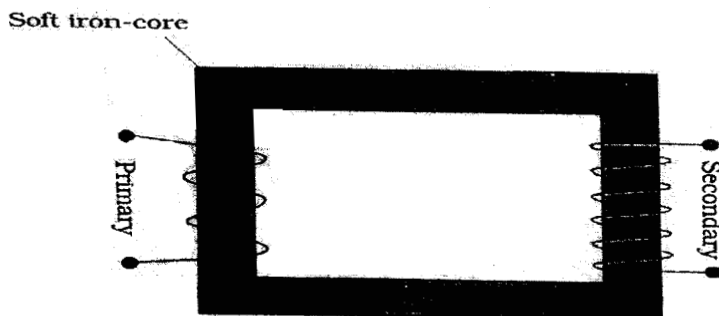
For a metal, as the temperature increases,  $\tau$  decreases. Hence  $\rho$  increases. 1

For a semiconductor, as the temperature increases, number density of electrons in the conduction band increases. Hence  $\rho$  decreases. 1

3

17.

Labelled diagram	1
Principle	1/2
Working	1
Reason	1/2



1



**Principle :** When alternating current flows through the primary, the magnetic flux linked with the secondary changes. As a result, an e.m.f. is induced in it.

OR

It works on the principle of Mutual Induction.

½

**Working:**

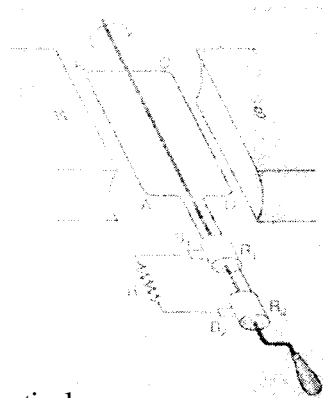
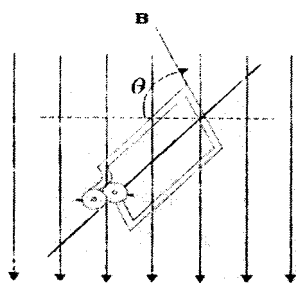
1

Change of flux is zero for d.c.

½

OR

Diagram	1
Principle	1
Working	1



Alternatively

1

**Principle:-**It works on the principle of electromagnetic induction.

1

OR

When a coil is rotated in a magnetic field, magnetic flux linked with it changes. Hence an emf is induced in it.

**Working:**

1

3

18.

Formula	1
Calculation	2

$$\cos\phi = \frac{R}{Z}$$

½

where  $Z = \sqrt{R^2 + (X_L - X_C)^2}$

½

$$\frac{\cos\phi_B}{\cos\phi_A} = \frac{Z_A}{Z_B} = \frac{\sqrt{R_A^2 + X_{L_A}^2}}{\sqrt{R_B^2 + (X_{L_B} - X_{C_B})^2}}$$

1

$$= \frac{R\sqrt{10}}{R\sqrt{5}} = \sqrt{2}$$

1

3

Q.No.	Marks	Total marks
-------	-------	-------------

19.	Definition	1
	Affect of	
	(i) Aperture	½
	(ii) Wavelength	½
	Justification i)	½
	ii)	½

- Resolving power (R.P) is the reciprocal of limit of angular resolution  
OR any other suitable definition. 1
- (i) Increases ½
- Resolving power =  $\frac{d}{1.22\lambda}$  ½
- ∴ R.P is directly proportional to 'd' (For a given λ) ½
- (ii) Decreases ½
- ∴ R.P is inversely proportional to 'λ' (For a given d) ½ 3

20.	Any four characteristics	2
	One use each of (i) and (ii)	½ + ½

Alternatively

	Any two characteristics	1
	2 uses each of (i) & (ii)	1+1

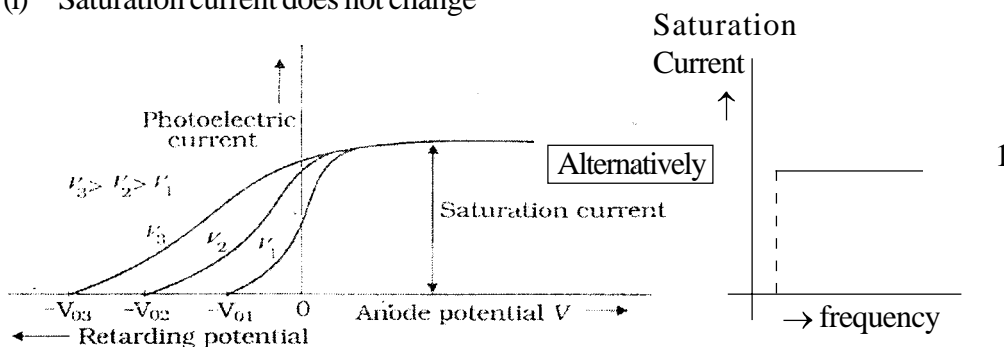
**Characteristics** (Any four)

- (a)  $\vec{E}$  and  $\vec{B}$  are mutually perpendicular and also perpendicular to the direction of propagation.
- (b) Transverse in nature
- (c) Travels with the speed of light in free space for all frequencies.
- (d) Doesn't require a material medium to propagate.
- (e) Energy is equally shared between  $\vec{E}$  and  $\vec{B}$
- (f) Exerts radiation pressure.
- (g) Produced by accelerated/ oscillating charge 2

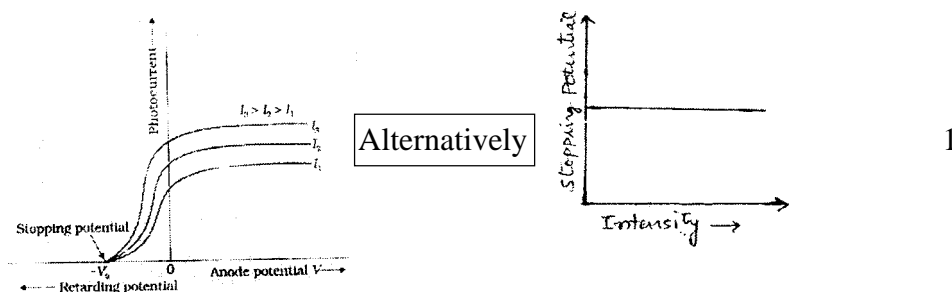
**USES:** (Any two)

- |  |   |   |   |
|--|---|---|---|
| (i) Radio waves: Cellular Phone/ Television / Wireless communication | } | 1 | 3 |
| (ii) Micro waves: Radar/ Micro wave Oven / Satellite Communication   |   |   |   |

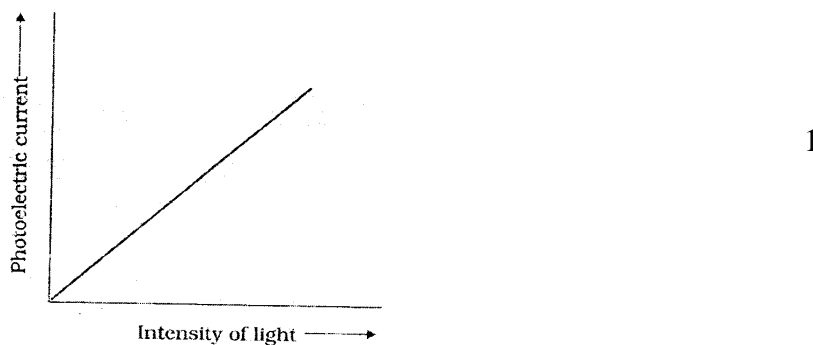
21. (i) Saturation current does not change



(ii) stopping potential does not change



(iii) Photoelectric current increases with increase in intensity



**Note:** Even if the candidate explains without graph, full credit should be given.

3

22.

Calculation of mass defect	1
energy released	1
Conclusion	1/2
Reason	1/2

$$\Delta m = M_U - M_{Th} - M_{He}$$

$$= 0.00456 \text{ u}$$

1/2

1/2

Q.No.	Marks	Total marks
-------	-------	-------------

Energy released $=\Delta mc^2$	$\frac{1}{2}$	
$= 0.00456 \times 931.5$		
$= 4.25 \text{ MeV}$	$\frac{1}{2}$	
Yes	$\frac{1}{2}$	
As $\Delta m$ is positive.	$\frac{1}{2}$	3

23.	Meaning	1
	Function of Modem	1
	Advantages	$\frac{1}{2} + \frac{1}{2}$

A digital signal is one which can have only two discrete values 1

Modem converts digital data to analog at the transmitting end and converts analog to digital at the receiver end.

OR

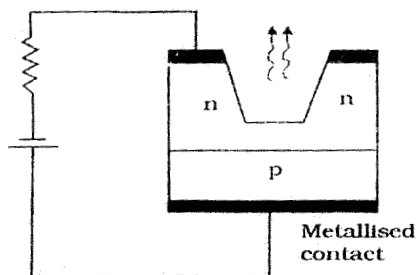
It modulates and demodulates in digital communication 1

**Advantage:**

- (a) It is much easier for receiver to detect pulses.
- (b) Error and noise free communication
- (c) Large number of signals can be sent through a single channel
- (d) Data rate is faster

(Any two)  $\frac{1}{2} + \frac{1}{2}$       3

24.	Diagram	$\frac{1}{2}$
	Principle	$\frac{1}{2}$
	Working	$\frac{1}{2}$
	Criterion	$\frac{1}{2}$
	Advantages	$\frac{1}{2} + \frac{1}{2}$



1

Q.No.	Marks	Total marks
-------	-------	-------------

**Principle:**

When electrons fall from a higher to a lower energy level, containing holes, energy, in the form of light radiation, gets released. 1/2

**Working :**

1/2

**Criterion :**

The semiconductor material used in LED is chosen according to the required wavelength of emitted radiation 1/2

OR

Chosen to have a energy gap matching the energy of a photon of the radiation required to be emitted.

**Advantages:**

- (a) Low operation voltage
- (b) Less power
- (c) No warm up time
- (d) Fast action
- (e) Light emitted is nearly monochromatic
- (f) Long life

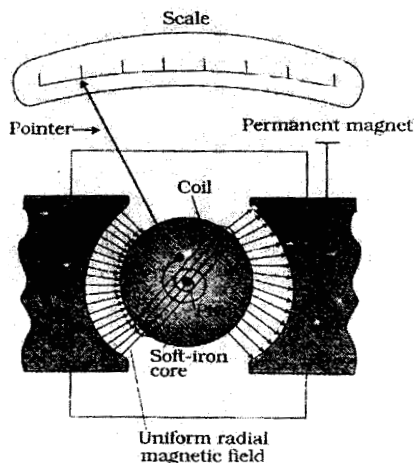
(Any two)

1/2+1/2

3

25.

Labelled Diagram	1
Principle	1
Derivation of expression of torque	2
Two Factors	1/2 + 1/2



1

**Principle :** When a current carrying coil is kept in a uniform magnetic field it experiences a torque.

1

**Derivation :**

$$\begin{aligned}\tau &= NIBA \sin \theta \\ &= MB \sin \theta \quad (M = NIA)\end{aligned}$$

OR

$$\tau = \mathbf{M} \times \mathbf{B}$$

2

Current sensitivity depends on

- number of turns
  - strength of the magnetic field
  - torsional constant of the suspension wire
  - Area of the coil
- (Any two)

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

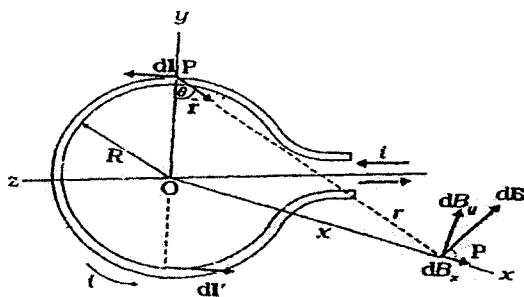
5

OR

Statement	1
Derivation	2
magnetic Field Lines	2

**Statement :** The magnitude of the magnetic field,  $dB$ , at any point, due to a current carrying conductor, is directly proportional to the current,  $I$ , the element length ' $d\ell$ ' and inversely proportional to the square of the distance ' $r$ '. Its direction is perpendicular to the plane containing ' $d\ell$ ' and  $r$  as defined by  $\vec{d\ell} \times \vec{r}$ .

1



**Derivation**

$$dB = \frac{\mu_0}{4\pi} \frac{I \left| d\ell \times \vec{r} \right|}{r^3}$$

 $\frac{1}{2}$ 

$$dB = \frac{\mu_0}{4\pi} \frac{Id\ell}{(x^2 + R^2)^{3/2}}, \quad \cos \theta = \frac{R}{(x^2 + R^2)^{1/2}}$$

 $\frac{1}{2}$

Q.No.	Marks	Total marks
-------	-------	-------------

$$dB_x = \frac{\mu_0 I}{4\pi} \frac{dIR}{(x^2 + R^2)^{3/2}}$$

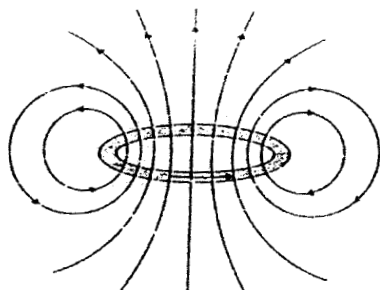
1

$$B = B_x \bar{i} = \frac{\mu_0 IR^2}{2(x^2 + R^2)^{3/2}} \bar{i}$$

1/2

$$\therefore B_0 = \frac{\mu_0 I}{2R} \bar{i}$$

(also accept the direct derivation of the field at the centre of the coil)



1

5

26.

Meaning	1
Need	1
Example	1/2
Formula	1
Calculation	1
Result	1/2

Two sources are said to be coherent when they produce light, of same wavelength, in phase, or with a constant phase difference, continuously.

1

If the sources are not coherent the average intensity at any given point will be same and interference pattern would not be observable.

1

Colours in a soap bubble / colours seen on a thin oil film on water.

1/2

$$x_n = \frac{n\lambda D}{d}$$

1

$$\therefore \lambda = \frac{x_n d}{nD} = \frac{10^{-2} \times 0.03 \times 10^{-2}}{4 \times 1.5}$$

1

$$= 5 \times 10^{-7} \text{ m}$$

1/2

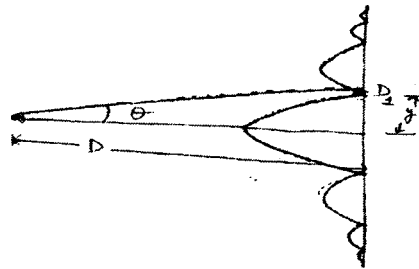
5

OR

Condition	1
Derivation	2
Calculation	
(i) first minimum	1
(ii) first maximum	1

The wavelength of incident light should be comparable to the aperture of the slit / opening or to the size of the obstacle.

1



For first minimum

$$d \sin \theta = \lambda$$

$$\therefore \sin \theta = \frac{\lambda}{d}$$

$\theta$  being small we have

$$\therefore \theta \cong \frac{\lambda}{d} \dots\dots\dots (1)$$

For a central maxima on a screen at distance 'D'

 $\frac{1}{2}$ 

$$\tan \theta = \frac{y}{D}$$

$$\text{or } \theta \cong \frac{y}{D} \dots\dots\dots (2)$$

 $\frac{1}{2}$ 

From (1) & (2)

$$\frac{\lambda}{d} = \frac{y}{D}$$

$$\Rightarrow y = \frac{\lambda D}{d}$$

 $\frac{1}{2}$ 

$$\text{width of central maxima} = \frac{2\lambda D}{d}$$

 $\frac{1}{2}$

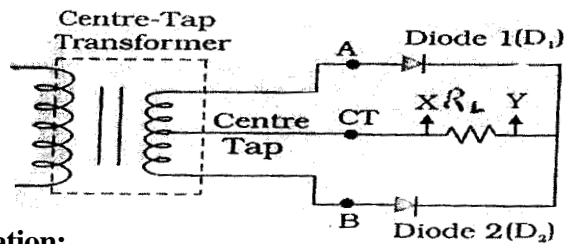


Q.No.	Marks	Total marks
-------	-------	-------------

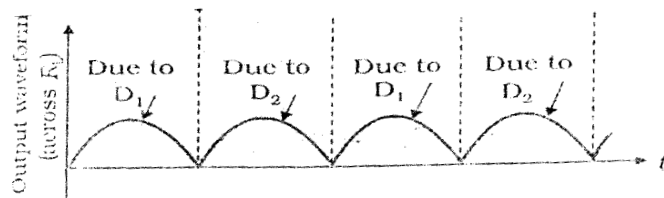
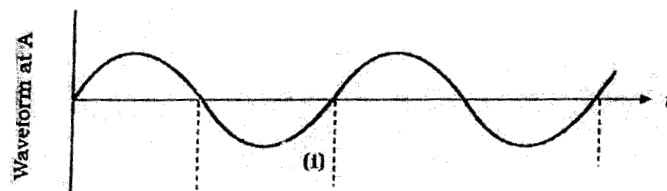
- (i)  $a \sin \theta = \lambda$   
 $a = \frac{\lambda}{\sin \theta} = \frac{700 \times 10^{-9}}{\sin 30^\circ}$  1/2  
 $= 14 \times 10^{-7} \text{ m}$  1/2
- (ii)  $a \sin \theta = \frac{3\lambda}{2}$   
 $a = \frac{3\lambda}{2 \sin \theta} = \frac{3 \times 700 \times 10^{-9} \times 2}{2}$  1/2  
 $= 21 \times 10^{-7} \text{ m}$  1/2

27.	Principle	1
	Circuit Diagram	2
	Explanation	1
	Sketch	1/2 + 1/2

**Principle :** p-n junction diode conducts when it is forward biased and doesn't conduct when it is reverse biased 1



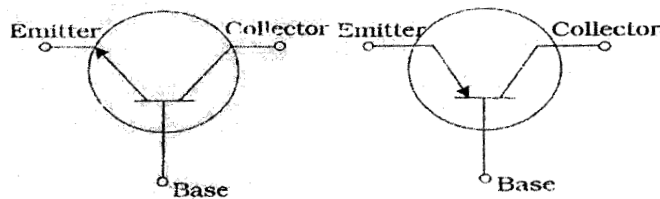
**Explanation:** 1  
**Wave form:**



(Full marks will be awarded if input and output wave form are shown with the circuit diagram.)

OR

Symbols	1/2 + 1/2
Reason	1
Circuit diagram	1
Explanation of movements of charge carriers	1 1/2
$I_E = I_C + I_B$	1/2

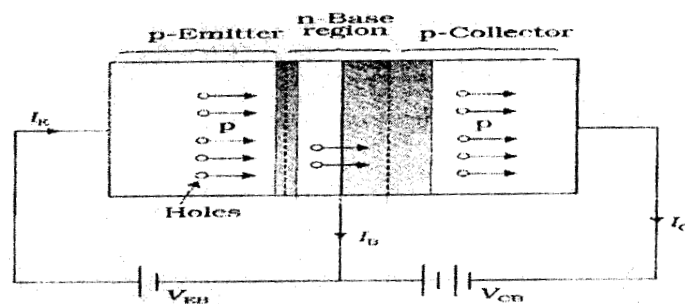


1/2+1/2

(i) n-p-n transistor      (ii) p-n-p transistor

Base region is thin and lightly doped so that the most of the charge carriers from the emitter are able to diffuse through base and go to the collector

1



A large number of holes from p-type emitter region flow towards the base. These constitute the current through the emitter  $I_e$ . These holes have a tendency to combine with the electrons in the 'n' region of the base. Only a few holes (less than 5%) are able to combine with the electrons in the base region constituting base current ' $I_b$ '. Remaining 95% of the holes, due to favorable negative potential at the collector move towards the collector region, and constitute collector current ' $I_c$ '.

1 1/2

$$\therefore I_e = I_b + I_c$$

1/2

5

QUESTION PAPER CODE 55/1  
**EXPECTED ANSWERS/VALUE POINTS**

Q.No.		Marks	Total marks				
1.	<p>Applied Voltage and current are in the same phase</p> <p>OR</p> <p><math>\theta = 0</math> or simply zero</p> <p>OR</p> $\tan \theta = \frac{V_L - V_c}{V_R} = 0$ <p>OR</p> <p><math>\tan \theta = 0</math></p>	1	1				
2.	$v_1 > v_2$	1	1				
3.	<table style="width: 100%; border-collapse: collapse;"> <tr> <td style="padding: 2px 10px;">Definition</td> <td style="text-align: right; padding: 2px 10px;"><math>\frac{1}{2}</math></td> </tr> <tr> <td style="padding: 2px 10px;">Unit</td> <td style="text-align: right; padding: 2px 10px;"><math>\frac{1}{2}</math></td> </tr> </table> <p>The total decay rate of a sample of one or more radionuclide is called activity</p> <p style="text-align: center;"><b>OR</b></p> <p>Radioactive disintegration taking place per second.</p> <p style="text-align: center;"><b>OR</b></p> <p><math>R = -\frac{dN}{dt}</math>, where N is the total number of radionuclides at any time 't'.</p> <p>SI unit-becquerel(Bq)</p>	Definition	$\frac{1}{2}$	Unit	$\frac{1}{2}$	<p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p>	1
Definition	$\frac{1}{2}$						
Unit	$\frac{1}{2}$						
4.	<p>along -ve z axis OR <math>-\hat{k}</math></p> <p>(Even if the student writes perpendicular to the direction of motion award full marks)</p>	1	$\frac{1}{2}$				
5.	<table style="width: 100%; border-collapse: collapse;"> <tr> <td style="padding: 2px 10px;">Calculation of <math>\lambda</math></td> <td style="text-align: right; padding: 2px 10px;"><math>\frac{1}{2}</math></td> </tr> <tr> <td style="padding: 2px 10px;">Length of antenna</td> <td style="text-align: right; padding: 2px 10px;"><math>\frac{1}{2}</math></td> </tr> </table> <p>(i) <math>\lambda = \frac{c}{v} = \frac{3 \times 10^8}{6 \times 10^8} = 0.5\text{m}</math></p> <p>(ii) <math>L = \frac{\lambda}{4} = 0.125 \text{ m}</math></p>	Calculation of $\lambda$	$\frac{1}{2}$	Length of antenna	$\frac{1}{2}$	$\frac{1}{2}$	
Calculation of $\lambda$	$\frac{1}{2}$						
Length of antenna	$\frac{1}{2}$						

Q.No.	Marks	Total marks
-------	-------	-------------

**OR**

$L = \frac{\lambda}{2} = 0.25 \text{ m}$	1/2	1
--	-----	---

(award full mark even if the student writes the answer directly)

6.	Formula	1/2
	Substitution	1/2
	Calculation	1/2
	Result	1/2

When point is taken on the line between the two charges

1/2

$$V = K \left[ \frac{q_1}{x} + \frac{q_2}{(1-x)} \right] = 0$$

1

Substitution & calculation,

$$x = 1/3 \text{ m (from } -2\mu \text{ c)}$$

1/2

Or 0.33 m

Alternatively: If point is taken on the extended line, beyond  $-2\mu \text{ c}$ .

1/2

$$V = K \left[ \frac{q_1}{y} + \frac{q_2}{(1+y)} \right] = 0$$

1

Calculation,

$$y = 1 \text{ m (from } -2 \mu \text{ C)}$$

1/2

2

7.	Calculation of R (using colour code)	1
	Calculation of I	1/2
	Expressing I in mA	1/2

Q.No.	Marks	Total marks
-------	-------	-------------

Calculation of 'R' =  $60 \times 10^4 \Omega$

1

Calculation of I;  $I = \frac{V}{R} = 0.5 \times 10^{-4} \text{ A}$

½

In mA, I = 0.05 mA

½

2

8.

Formula	½
Correct substitution	½
Calculation and correct result	1

i) Formula  $S = G \frac{I_g}{I - I_g}$

½

ii) Substitution

½

$$S = \frac{30 \times 2 \times 10^{-3}}{0.3 - 2 \times 10^{-3}}$$

Calculation & Result

½ + ½

$S \approx 0.20 \Omega$

2

9.

Formula for output current	½
Formula for efficiency	½
Calculation and result	½ + ½

$$I_o = \frac{V_o}{R_o}$$

½

$$= \frac{20}{20} = 1 \text{ A}$$

½

$$\eta = \frac{P_o}{P_{in}} = \frac{V_o I_o}{V_{in} I_m}$$

½

$$\frac{80}{100} = \frac{20 \times 1}{200 \times I_m}$$

$I_m = 0.125 \text{ A}$

½

2

Q.No.	Marks	Total marks
-------	-------	-------------

**OR**

Formula of Z	½
Calculation of Z	½
Formula of I	½
Calculation of I	½

- (i)  $Z = \sqrt{\omega^2 L^2 + R^2}$   
or  
 $Z = \sqrt{4\pi^2 f^2 L^2 + R^2}$  ½
- (ii)  $Z = \sqrt{4\pi^2 (50)^2 (2 \times 10^{-3})^2 + (20)^2}$  ½  
 $\approx 20 \Omega$
- (iii)  $I = \frac{E}{Z}$  ½
- (iv)  $I = \frac{100}{20} \text{ A} = 5 \text{ A}$  ½ 2

**10.**

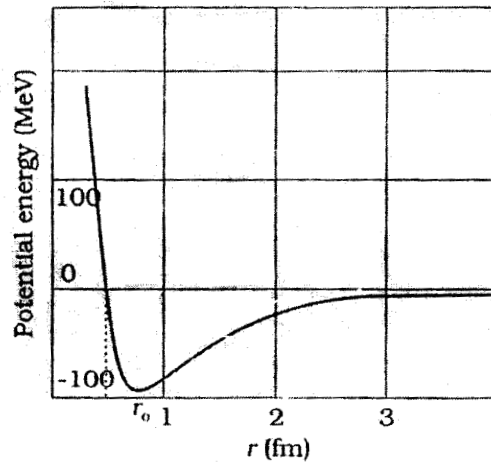
Definition	1
(If only formula of R.P. is given award ½ mark)	
Correct answers	½ + ½

- (i) R.P. of microscope is reciprocal of the minimum separation of two near points, seen as distinct 1  
OR  
R.P. of microscope is reciprocal of the smallest distance between two point object, which are just resolved by the microscope.
- (ii) increases, (with increase of  $\mu$ ) ½
- (iii) decreases, (with increase of  $\lambda$ ) ½ 2

11.

Graph	1
Correct answers	1/2 + 1/2

(i) Graph :



1

(ii) for  $r > r_0$  Attraction

1/2

(iii) for  $r < r_0$  Repulsion

1/2

2

12.

Correct Answer	1
Graph	1

(If X and Y are correctly identified but the identification of biasing is incorrect or not given at all, award 1/2 mark only.)

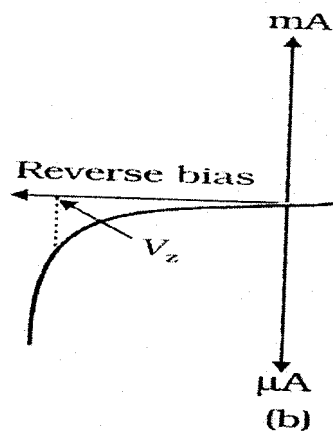
(X → p-Type)

(Y → n-Type)

1

(i) Reverse biased

(ii) Graph :



1

2

13.

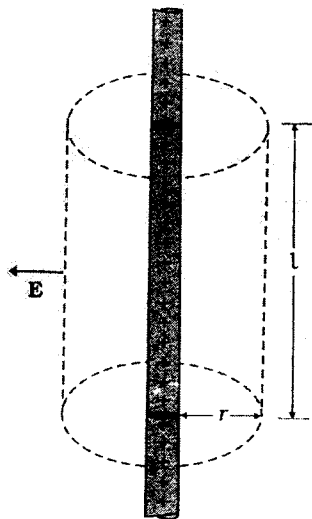
Statement	1
Diagram	½
Derivation	1½

**Statement :**

Net electric flux through to a closed surface is equal to  $\frac{1}{\epsilon_0}$  times the total net charge enclosed within the surface.

1

(If the student just writes  $\oint \mathbf{E} \cdot d\mathbf{s} = \frac{q}{\epsilon_0}$ , award 1/2 mark only)

**(ii) Diagram:-**

½

**(iii) Derivation:-**

$$\oint \mathbf{E} \cdot d\mathbf{s} = \int_{S_1} \bar{\mathbf{E}} \cdot d\bar{\mathbf{s}}_1 + \int_{S_2} \bar{\mathbf{E}} \cdot d\bar{\mathbf{s}}_2 + \int_{S_3} \bar{\mathbf{E}} \cdot d\bar{\mathbf{s}}_3 \quad \frac{1}{2}$$

$$= 0 + 0 + 2\pi r \ell$$

Also,  $q = \lambda \ell$  (where  $\lambda$  is charge per unit length)

$$(E) \cdot (2\pi r \ell) = \frac{1}{\epsilon_0} \lambda \ell \quad \text{OR} \quad E 2\pi r \ell = \frac{q}{\epsilon_0} \quad \frac{1}{2}$$

$$E = \frac{\lambda}{2\pi \epsilon_0 r} \quad \text{OR} \quad E = \frac{q}{2\pi \epsilon_0 r \ell} \quad \frac{1}{2} \quad 3$$



Q.No.	Marks	Total marks
-------	-------	-------------

14.	Principle and Explanation	1½
	Expression for	
	Field	½
	Potential Difference	½
	Capacitance	½

**Principle:**

- (i) When an uncharged, grounded conducting plate is placed near a charged conducting plate a charge, of the opposite sign, gets induced on the second plate. 1½
- (ii) This reduces the potential of first plate, without any change in the charge present in it.
- (iii) This increases the capacitance.

$$E = \frac{\sigma}{\epsilon_0} \quad \text{½}$$

$$V = \frac{\sigma}{\epsilon_0} d \quad \text{½}$$

$$C = \frac{\epsilon_0}{d} A \quad \text{½} \quad \text{3}$$

15.	2 Reasons for fault	½ + ½
	Causes and reason for more deflection at B	½ + ½
	Causes and reason for less deflection at 'B'	½ + ½

**Possible Faults**

- (a) The negative terminal of  $E'$  is connected to point X. ½
- (b)  $|E'| > |E|$  ½

(i) If galvanometer shows more deflection at B  
**Cause :** Negative terminal of  $E'$  is connected to X ½

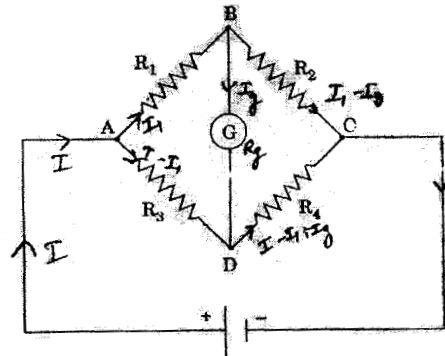
**Reason :** Potential difference across wire and the cell  $E'$  send current through the galvanometer in the same sense and the galvanometer deflection increases with an increase in the length of the wire. ½

(iii) If galvanometer shows less deflection at B  
**Cause :**  $|E'| > |E|$  ½

**Reason :** Potential difference across the potentiometer wire opposes  $E'$  and current in galvanometer decreases with an increase in the length of the wire. ½ 3

OR

Circuit with current distribution	1
Writing two correct loop equation	1/2 + 1/2
Result	1



1

**Loop Equations**

(Loop ABDA)  $- I_1 R_1 - I_g R_g + (I - I_1) R_3 = 0$  1/2

(Loop BCDB)  $-(I_1 - I_g) R_2 + (I - I_1 + I_g) R_4 + I_g R_g = 0$  1/2

(or any equivalent equations)

**Derivation of Result**

as  $I_g = 0, I_1 R_1 = (I - I_1) R_3$

$I_1 R_2 = (I - I_1) R_4$

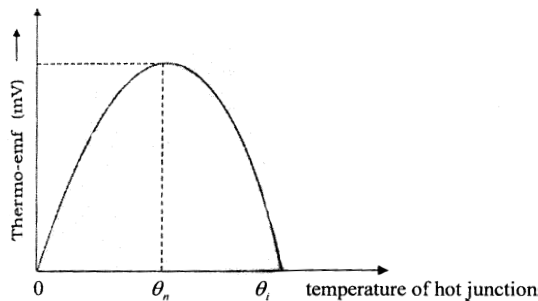
$\frac{R_1}{R_2} = \frac{R_3}{R_4}$  1 3

16.

Seebeck Effect	1
Graph	1
Explanation	1/2+1/2

When two dissimilar metals are joined together to form two junctions, and these are kept at different temperatures, a net emf develops in the system. 1

**Graph :**

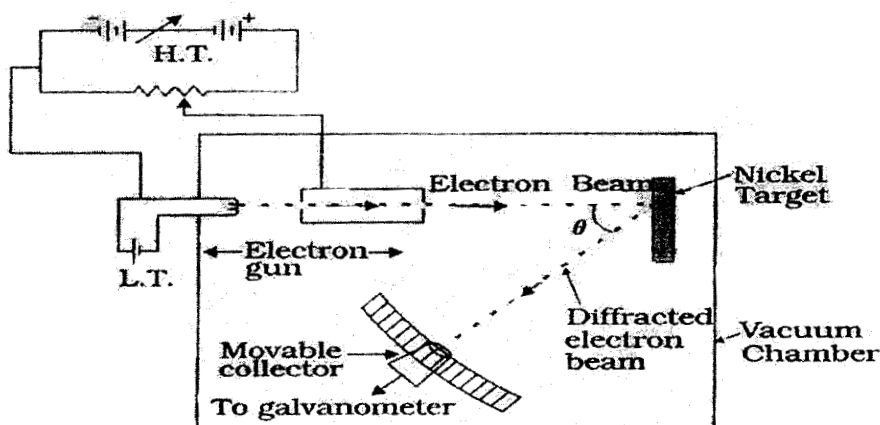


1

Q.No.		Marks	Total marks				
	Neutral temperature unaffected	1/2					
	Temperature of inversion decreases	1/2	3				
<b>17.</b>	<table border="1"> <tr> <td>Correct Identification of each radiation</td> <td>1/2 + 1/2 + 1/2</td> </tr> <tr> <td>One more application of each (other than given one)</td> <td>1/2 + 1/2 + 1/2</td> </tr> </table>	Correct Identification of each radiation	1/2 + 1/2 + 1/2	One more application of each (other than given one)	1/2 + 1/2 + 1/2		
Correct Identification of each radiation	1/2 + 1/2 + 1/2						
One more application of each (other than given one)	1/2 + 1/2 + 1/2						
	(i) <b>Radiation: Infrared</b>	1/2					
	Application: night vision/ Thermal Sensor/ Green house effect/ relieve in muscular pain/ in remote control devices	1/2					
	(ii) <b>Radiation: U.V radiation</b>	1/2					
	Application: food preservation/ water purification/ forensic science/ sterilization of surgical instruments	1/2					
	(iii) <b>Radiation: X-rays</b>	1/2					
	Application: Medical diagnosis/ detection of mechanical fault/ radio therapy detectors/ study of crystal structure	1/2	3				
<b>18.</b>	<table border="1"> <tr> <td>Formula (for f, v, I each)</td> <td>1/2 + 1/2 + 1/2</td> </tr> <tr> <td>Substitution and correct result</td> <td>1/2 + 1/2 + 1/2</td> </tr> </table>	Formula (for f, v, I each)	1/2 + 1/2 + 1/2	Substitution and correct result	1/2 + 1/2 + 1/2		
Formula (for f, v, I each)	1/2 + 1/2 + 1/2						
Substitution and correct result	1/2 + 1/2 + 1/2						
	$\frac{1}{f} = (\mu - 1) \left( \frac{1}{R_1} - \frac{1}{R_2} \right)$	1/2					
	OR						
	$f = \frac{R}{2(\mu - 1)}$						
	f = 25 cm	1/2					
	$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$						
	v = -25cm	1/2					
	$\frac{I}{0} = \frac{v}{u} = 2$	1/2					
	OR						
	$\frac{I}{0} = \frac{f}{f + u}$	1/2					
	∴ I = +10 cm	1/2	3				

19.

Schematic diagram	1 ½
Explanation	1 ½



1½

**key points** for brief explanation:

- accelerated electrons are scattered by Nicol crystal and collected by collector which is connected to the galvanometer.
- Strong peak of intensity (current) appeared for accelerating potential of 54 V, at a scattering angle of 50°.
- Wavelength value, obtained by diffraction measurement of electrons, is in excellent agreement with the de-Broglie wavelength of electrons accelerated through a potential difference of 54V.

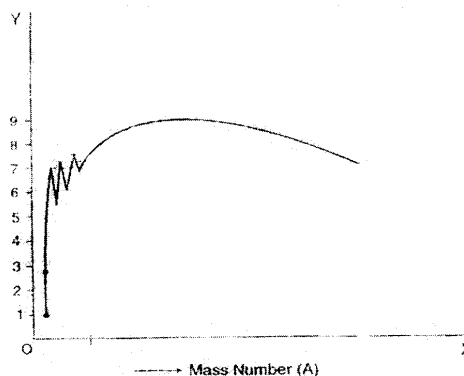
1½

3

20.

Graph	1
Calculation of $\Delta m$	1
Calculation of BE	½
BE per nucleon	½

**Graph :**



1

Q.No.	Marks	Total marks
-------	-------	-------------

**Calculation** of  $\Delta m$  for  $^{40}_{20}\text{Ca}$

$$m = (20 \times 1.007825 + 20 \times 1.008665) - 39.962589$$

$$= 0.367211 \text{ amu}$$

$$\text{BE} = 0.367211 \times 931 \text{ Mev}$$

$$= 341.87 \text{ Mev}$$

$$\text{BE per nucleon} = 8.547 \text{ Mev}$$

1

1/2

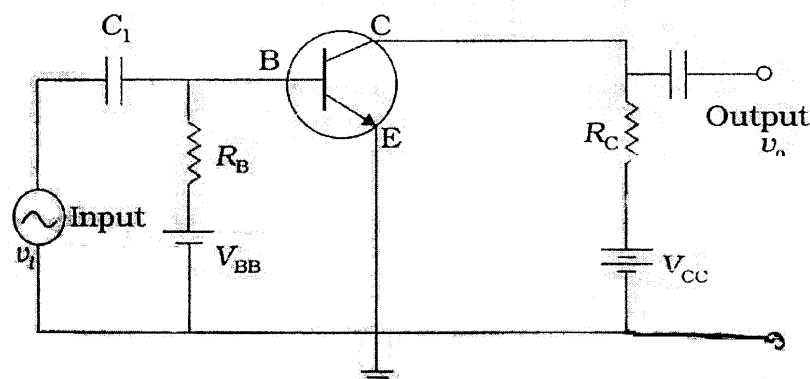
1/2

3

21.

Circuit diagram	1 1/2
Phase relation	1/2
Two reasons	1/2 + 1/2
(Award 1 mark even if the reasons are not given)	

**Circuit diagram of CE Amplifier**



1 1/2

Phase relation between input and output signal is  $180^\circ$  OR  $\pi$  radian.

1/2

High current gain/ cascading is easier/ high power gain (Any two)

1/2+1/2

3

(Award 1 mark even if the reasons are not given)

22.

Explanation	1
Energy Band diagrams	1+1

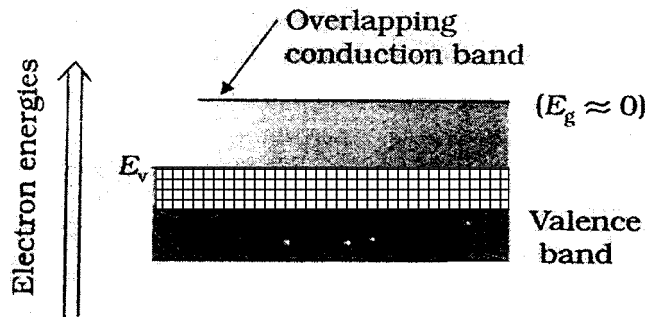
Isolated atoms have discrete energy levels in a crystal, the presence of large number of closely packed atoms, leads to inter atomic interaction and the energy levels get spread out or broadened into energy bands.

1

**OR**

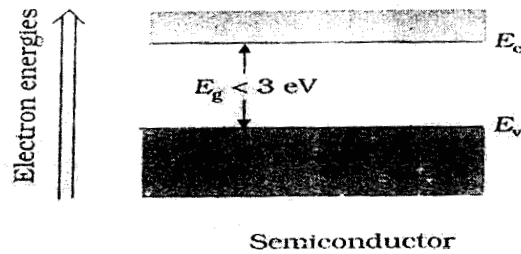
(any other alternate explanation)

1



1

3



23.

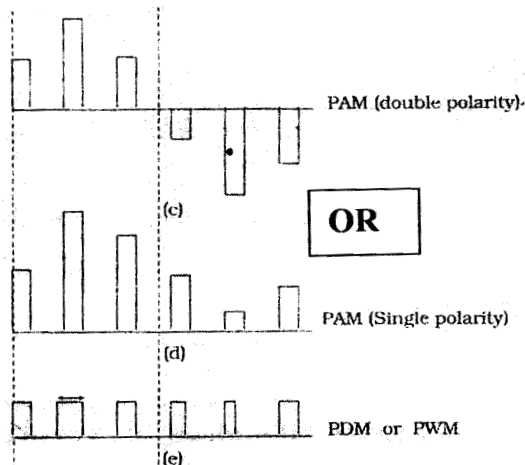
Definition	1
Explaining the need of modulation	1
Diagram for PAM and PDM	1/2 + 1/2

A Process by which some characteristic of the transmitted carrier wave is varied in accordance with the information message signal

1

- (i) To design antenna of practicable size.
- (ii) to avoid intermixing of different signals
- (iii) to increase power radiation by antenna
- (iv) to increase the operating range. **(Any one)**

1



1/2

1/2

3

Q.No.	Marks	Total marks
-------	-------	-------------

24.	Expanded form	1
	Four reasons	$\frac{1}{2} \times 4 = 2$

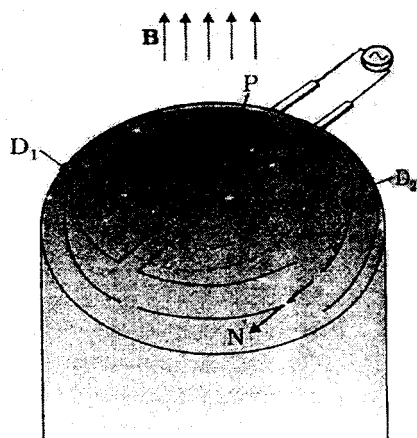
LASER = Light Amplification by Stimulated Emission of Radiation 1

**Reasons:**

- (1) Highly energetic
- (2) Monochromatic
- (3) Coherent
- (4) Highly directional
- (5) Size compatible with that of optical fiber
- (6) Emitted light can be modulated by small variations in the information signal voltage
- (7) Thermal stability

**(Any Four)**  $\frac{1}{2} \times 4 = 2$  3

25.	Diagram	1
	Principle	1
	Construction	1
	Derivation	$1\frac{1}{2}$
	Interpretation	$\frac{1}{2}$



**Principle:**

A beam of charged particles describes a circular path when subjected to a uniform magnetic field directed perpendicular to their plane of motion. The beam can be accelerated time and again by a high frequency electric field of correctly adjusted frequency applied between two dees. 1

Q.No.	Marks	Total marks
-------	-------	-------------

**Construction :**

Consists of two semi circular disc like metal containers  $D_1$  and  $D_2$  connected to high frequency alternating voltage

1

A magnetic field is applied perpendicular to the plane of the dees.

Derivation

$$\frac{mv^2}{r} = BqV$$

$$\frac{v}{r} = \frac{Bq}{m}$$

1½

$$\omega = \frac{Bq}{m}$$

$$2\pi f = \frac{Bq}{m}$$

$$f = \frac{Bq}{2\pi m}$$

**Interpretation :**

Frequency does not depend on the speed of the charged particle  
(Any other correct alternate method)

½

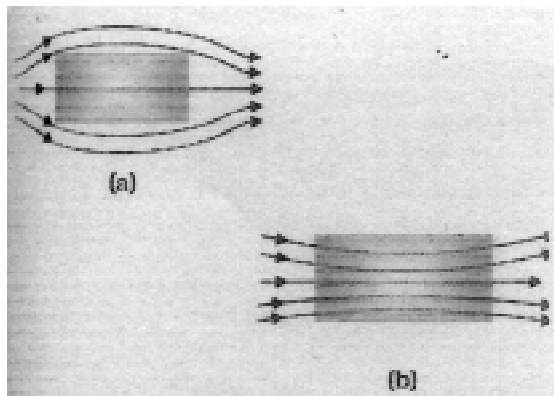
5

**OR**

Distinguishing for each property	1+1+ ½
One example for each type	½ + ½ + ½
Diagrams	½ + ½
(Even if coercivity is not mentioned award ½ mark)	

	<b>Dia</b>	<b>Para</b>	<b>Ferro</b>	
(i) Susceptibility	Very small and negative	Small and negative	High and Positive	1
(ii) Permeability	Less than one	Greater than one	very large compared to one	1 ½
(iii) Coercivity	—	—	Exists	
Example one each	Bi,Cu,Pb,Si,N, H <sub>2</sub> O (Or any other example)	Al, Na, Ca, O, CuCl <sub>2</sub>	Fe, Ni, Co and their alloys	½+½/2





1/2

1/2

5

26.

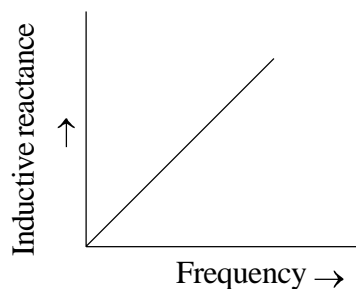
Definition	1
Graph	1
Derivation & Conclusions	2 1/2 + 1/2

**Definition :**

Inductive reactance is a measure of the opposition offered by the given inductor to the flow of any alternating current.

1

**Graph :**



1

**Derivation :**

$$E = E_0 \sin \omega t$$

$$E - L \frac{dI}{dt} = 0$$

1/2

$$\frac{dI}{dt} = \frac{E}{L} = \frac{E_0}{L} \sin \omega t$$

$$I = \frac{E_0}{L} \int \sin \omega t dt$$

1/2

$$= -\left(\frac{E_0}{\omega L}\right) \cos \omega t = -I_0 \cos \omega t \text{ where } I_0 = \frac{E_0}{\omega L}$$

1/2

**or**  $I = I_0 \sin \left( \omega t - \frac{\pi}{2} \right)$

1

Current lags behind the voltage by a phase angle of  $\frac{\pi}{2}$ .

1/2

5

**OR**

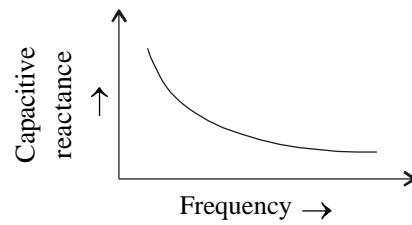
Definition	1
Graph	1
Derivation & Conclusions	2½+½

**Definition :**

Capacitive reactance is measure of the opposition offered by a capacitor to the flow of an alternating current through it.

1

**Graph :**



1

**Derivation :**

$$E = E_0 \sin \omega t$$

$$q = CE = CE_0 \sin \omega t$$

½

$$I = \frac{dq}{dt}$$

$$= \omega CE_0 \cos \omega t$$

½

put  $\omega CE_0 = I_0$ . Also  $\cos \omega t = \sin(\omega t + \pi / 2)$

½

$$\therefore I = I_0 \sin (\omega t + \pi / 2)$$

1

$\Rightarrow$  I leads E in phase by  $\pi/2$

½

5

27.

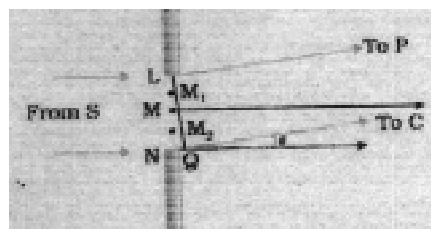
Condition	1
Diagram	1
Explanation	2
Sketch of the pattern	1

**Condition :**

Size of the obstacle /aperture should be comparable with the wave length of the incident light.

1

**Diagram :**



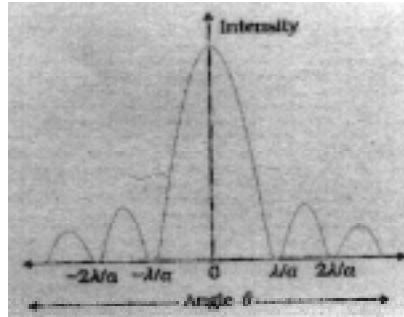
1

**Explanation :** Let a plane wave front be incident slit on LM of width 'a'. To consider diffraction effects at any point P, directed at an angle  $\theta$  to the incident rays, the wave front is divided into a number of parts, with each part treated as a secondary wave front Path difference between secondary wave front from L and M =  $a \sin \theta$

2

**For minima**  $a \sin \theta = n\lambda$

**For maxima**  $a \sin \theta = (2n + 1) \frac{\lambda}{2}$



1

5

**OR**

Definition of Coherent sources	1
Need for coherent sources	1
Three distinguishing features	1+1+1

**Definition :**

Two sources with same frequencies having a (time independent) stable phase difference (or zero phase difference)

1

**Need :**

If phase difference is variable, the interference term averages to zero.

1

**OR**

Intensity at each point will vary and no sustained interference will be observed

**Differences : (Any Three)**

3

5

Interference	Diffraction
All bright and dark fringes are of equal width.	Width of secondary maxima keeps on decreasing.
All bright fringes are of equal intensity	Intensity of bright fringes keeps on decreasing
Good contrast between bright and dark fringes .	Poor contrast between secondary maxima and minima.
At $\theta = \frac{\lambda}{a}$ , a bright fringe is formed	At $\theta = \frac{\lambda}{a}$ , a dark fringe is formed
Pattern is formed due to superposition of two different wave fronts.	Pattern is formed due to superposition of wavelets of the same wave front.