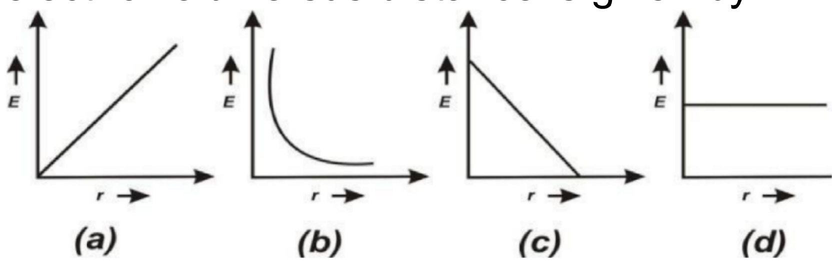
Pre-Board Examination : 2025-26
Sub : Physics

(The figures in the margin indicate full marks for the questions)

Time – 3 hours **Full marks-70**

1.	**Each of the following questions carries 1 mark**
1	An electric dipole of dipole moment 2×10^{-8} C m in a uniform electric field experiences a maximum torque of 6×10^{-4} Nm. The magnitude of electric field is – (a) 2.2×10^{3} Vm^{-1} (b) 1.2×10^{4} Vm^{-1} (c) 3×10^{4} Vm^{-1} (d) 4.2×10^{3} Vm^{-1}
Ans	Electric dipole moment, $p = 2\times10^{-8}$ N/C Maximum torque, $\tau = 6\times10^{-4}$ N-m $\theta = 90°$ The torque acting on the dipole: $\tau = pE\sin\theta$ $\Rightarrow 6\times10^{-4} = 2\times10^{-8}\times E$ $\Rightarrow E = 3\times10^{4}$ Vm^{-1}
2	For a point charge, the graph between electric field versus distance is given by: - 

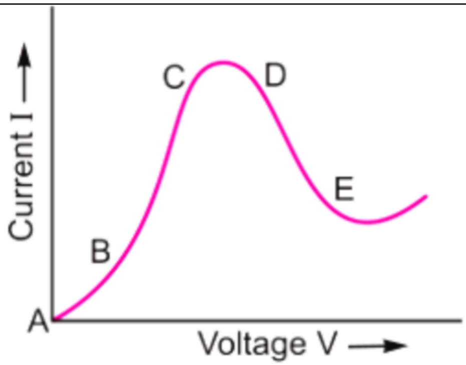
Ans	Electric field, $E = \frac{Q}{4\pi \epsilon_0 r^2}$ or $E \propto \frac{1}{r^2}$ Ans -(b)
3	Equipotential surfaces due to a uniform linear charge distribution are - approximately (a) Spheres (b) Planes (c) Cylindrical (d) Circular Ans-(c) Cylindrical
Ans	The equipotential surfaces are **coaxial cylinders** around the linear charge distribution .
4	A charge *q* with velocity $\vec{v} = (3\hat{i} + 4\hat{j})$ moves through a magnetic field $\vec{B} = 3\hat{k}\,T$. The force F on charge is - (a) $(12\hat{i} - 9\hat{j})N$ (b) $(12\hat{i} + 9\hat{j})N$ (c) $(-12\hat{i} + 9\hat{j})N$ (d) $(-12\hat{i} - 9\hat{j})N$
Ans	$\vec{\mathbf{F}} = q(\vec{\mathbf{v}} \times \vec{\mathbf{B}})$ The given values are: Charge: q Velocity: $\vec{\mathbf{v}} = 3\hat{i} + 4\hat{j} + 0\hat{k}$ Magnetic Field: $\vec{\mathbf{B}} = 0\hat{i} + 0\hat{j} + 3\hat{k}$ T $\vec{\mathbf{v}} \times \vec{\mathbf{B}} = 12\hat{i} - 9\hat{j}$ $\vec{\mathbf{F}} = q(\vec{\mathbf{v}} \times \vec{\mathbf{B}}) = q(12\hat{i} - 9\hat{j})$

5	If a galvanometer is to be used in place of a voltmeter, then we must connect with the galvanometer a - (a) Low resistance in parallel. (b) High resistance in series. (c) High resistance in parallel. (d) Low resistance in series
Ans	(b) High resistance in series
6	Which material has negative susceptibility (a) Paramagnetic (b) Ferromagnetic (b) Diamagnetic (d) None of these
Ans	(b)Diamagnetic
7	In a ferromagnetic material at room temperature (a) magnetic moment of each molecule is zero. (b) the individual molecules have non-zero magnetic moment which are all perfectly aligned. (c) domains are partially aligned. (d) domains are all perfectly aligned.
Ans	(c) domains are partially aligned.
8	When a 12 W light bulb is connected with a step-down transformer with output of 24 V. The value of the peak current through the bulb is (a) $1/\sqrt{2}$ A (b)$\sqrt{2}$ A. (c) 2 A (d) $2\sqrt{2}$ A.

Ans	$$P = V_{RMS} I_{RMS} \quad I_{RMS} = \frac{P}{V_{RMS}}$$ given values ($P = 12\,\text{W}$ and $V_{RMS} = 24\,\text{V}$): $$I_{RMS} = \frac{12\,\text{W}}{24\,\text{V}} = 0.5\,\text{A}$$
9	A beam of light travels from air into a medium, its speed and wavelength in the medium are 1.5×10^{8} $ms^{-1}$and 230 nm respectively.The wavelength of light in air will be - (a) 230 nm (b) 345 nm (c) 460 nm (d) 690 nm
Ans	$$n = \frac{c}{v_m}$$ given values, where $v_m = 1.5 \times 10^{8}\,\text{m/s}$: $$n = \frac{3.0 \times 10^{8}\,\text{m/s}}{1.5 \times 10^{8}\,\text{m/s}} = 2.0$$ $$n = \frac{\lambda_a}{\lambda_m} \qquad \lambda_a = n \times \lambda_m = 2.0 \times 230\,\text{nm} = 460\,\text{nm}$$
10	A proton, a neutron, an electron and an α-particle have same energy. Then their de Broglie wavelengths compare as (a) $\lambda_p = \lambda_n > \lambda_e > \lambda_\alpha$ (b) $\lambda_\alpha < \lambda_p = \lambda_n < \lambda_e$ (c) $\lambda_e < \lambda_p = \lambda_n > \lambda_\alpha$ (d) $\lambda_e = \lambda_p = \lambda_n = \lambda_\alpha$

Ans	$\lambda = \frac{h}{\sqrt{2Em}}$ $\lambda \propto \frac{1}{\sqrt{m}}$ $\lambda_e > \lambda_p > \lambda_n > \lambda_\alpha$
11	Taking the Bohr radius as a_0 = 53pm, the radius of Li^{++} ion in its ground state, on the basis of Bohr's model, will be about (a) 53 pm (b) 27 pm (c) 18 pm (d) 13 pm
Ans	The formula for the radius r_n of an orbit n in a hydrogen-like atom with atomic number Z is: $r_n = \frac{n^2 a_0}{Z}$ $r_1 = \frac{1^2 \times 53\text{pm}}{3} \approx 17.67\text{pm} \approx 18\text{pm}$
12	Piece of copper and of silicon are initially at room temperature. Both are heated to temperature T. The conductivity of – (a) Both increases (b) Copper increases and silicon decreases (c) Both decreases (d) Copper decreases and silicon increases
Ans	(b) Copper increases and silicon decreases
13	**Assertion:** According to Bohr's atomic model the ratio of angular momenta of an electron in first excited state and in ground state is 2:1. **Reason:** In a Bohr's atom the angular

	momentum of the electron is directly proportional to the principal quantum number.
Ans	Ans-(a)
14	**Assertion:** The focal length of an equi-convex lens of radius of curvature Rmade of material of refractive index 1.5, is equal to R. **Reason :** The radius of curvature of both the surfaces of equi-convex lens is positive.
Ans	Ans-(c) Assertion is correct, reason is incorrect **(c)** $\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = (1.5 - 1)\left(\frac{1}{R} - \frac{1}{-R}\right)$ or $f = R$.
15	**Assertion:** On increasing the intensity of light, the number of photoelectrons emitted is more. Also the kinetic energy of each photon increases but the photoelectric current is constant. **Reason:** Photoelectric current is independent of intensity but increases with increasing frequency of incident radiation.
Ans	Ans-(D). If assertion and reason both are false.
16	**Assertion:** The energy gap between the valence band and conduction band is greater in silicon than in germanium. **Reason:** Thermal energy produces fewer

	minority carriers in silicon than in germanium.
Ans	Ans-(a) Both A and R are true and R is the correct explanation of A.
Section B	
17	Graph showing the variation of current versus voltage for a material GaAs as shown in figure. Identify the region of (i) Negative resistance (ii) Where Ohm's law is obeyed. Also justify your answer.
Ans	 (i) In region DE, material GaAs (Gallium Arsenide) offers negative resistance, because slope $\frac{\Delta V}{\Delta I} < 0$ (ii) (ii) The region BC approximately passes through the origin, (or current also increases with the increase of voltage).
18	A convex lens of focal length 25 cm is placed

	coaxially in contact with a concave lens of focal length 20 cm. Determine the power of the combination. Will the system be converging or diverging in nature?
Ans	The power (**P**) of a lens is calculated using the formula $P = 1/f$, where the focal length (**f**) must be in meters. For the convex lens: $f_1 = +25\,\text{cm} = +0.25\,\text{m}$ $P_1 = \frac{1}{0.25\,\text{m}} = +4.0\,\mathbf{D}$ For the concave lens: $f_2 = -20\,\text{cm} = -0.20\,\text{m}$ $P_2 = \frac{1}{-0.20\,\text{m}} = -5.0\,\mathbf{D}$ The total power ($\mathbf{P_{total}}$) of lenses in contact is the sum of their individual powers: $P_{total} = P_1 + P_2 = +4.0\,\text{D} + (-5.0\,\text{D}) = -1.0\,\mathbf{D}$ The power of the combination is **-1.0 D**, and the system will be **diverging** in nature.
	OR Ray of light passing through an equilateral triangular glass prism from air undergoes minimum deviation when angle of incidence is 3/4th of the angle of prism. Calculate the speed of light in the prism.

Ans

The prism is equilateral, so the angle of the prism is $A = 60^\circ$.

The angle of incidence is given as $i = \frac{3}{4}A = \frac{3}{4} \times 60^\circ = 45^\circ$

Under minimum deviation conditions,

$A + \delta_m = i + e$ (where $i = e$),

so $\delta_m = 2i - A = 2(45^\circ) - 60^\circ = 90^\circ - 60^\circ = 30^\circ$

The refractive index (μ) of the prism $\mu = \dfrac{\sin\left(\frac{A+\delta_m}{2}\right)}{\sin\left(\frac{A}{2}\right)}$

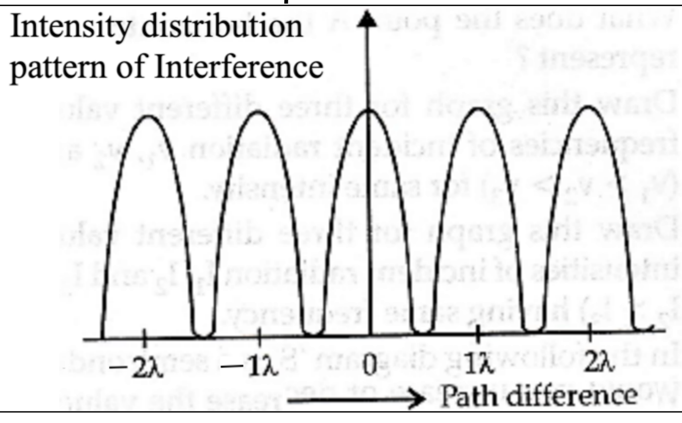
$$\mu = \frac{\sin\left(\frac{60^\circ+30^\circ}{2}\right)}{\sin\left(\frac{60^\circ}{2}\right)} = \frac{\sin(45^\circ)}{\sin(30^\circ)} = \frac{1/\sqrt{2}}{1/2} = \frac{2}{\sqrt{2}} = \sqrt{2}$$

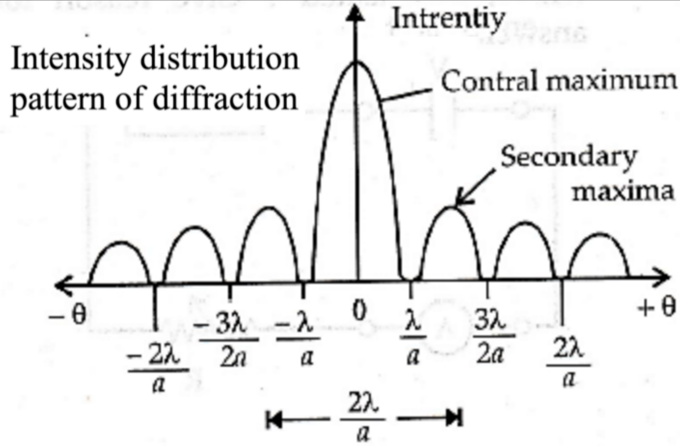
The refractive index is related to the speed of light in the medium (v) and the speed of light in air/vacuum ($c \approx 3 \times 10^8$ m/s) by the formula $v = \dfrac{c}{\mu} = \dfrac{3 \times 10^8 \text{ m/s}}{\sqrt{2}}$.

$$v \approx 2.1213 \times 10^8 \text{ m/s}$$

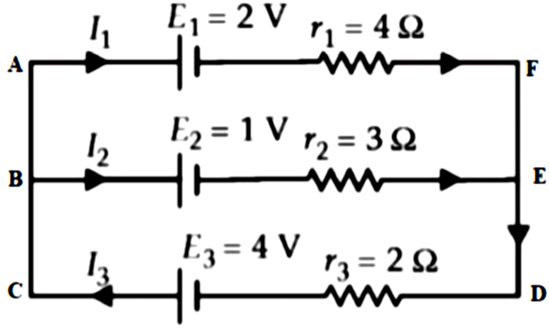
19 Draw the intensity pattern for single slit diffraction and double slit interference.Hence state two differences between interference and diffraction patterns.

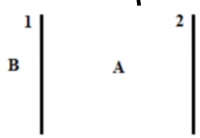
Ans

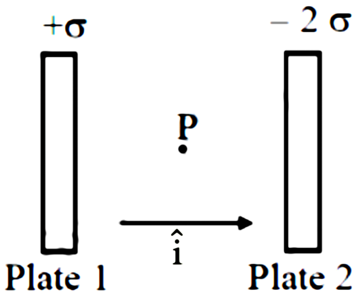


	 Difference : (i) Interference fringes are of same intensity whereas diffraction fringes are of different intensity. (ii) Fringe width is of the same size in interference whereas it is not so in diffraction.
20	Calculate the velocity of an electron in the ground state of the hydrogen atom.
Ans	Given: Separation between the two charges, $r = 0.53\ \text{Å} = 0.53 \times 10^{-10}$ m By Coulomb's Law, force, $F = \frac{1}{4\pi\epsilon_0}\frac{q_1 q_2}{r^2}$ $\Rightarrow F = \frac{9 \times 10^9 \times (1.6\times10^{-19})^2}{(0.53\times10^{-10})^2}$ Here, $q_1 = q_2 = e$ $= 8.2 \times 10^{-8} N$ Now, mass of an electron, $M_e = 9.12 \times 10^{-31}$ kg

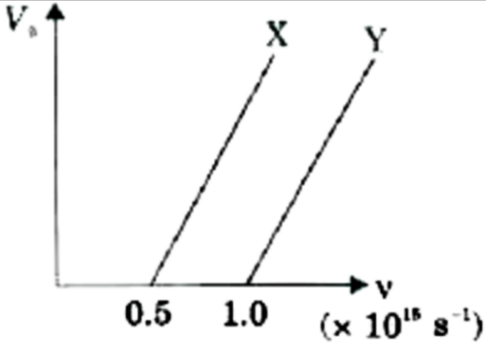
	The necessary centripetal force is provided by the Coulombian force. $\Rightarrow F_e = \frac{M_e v^2}{r} \quad \Rightarrow v^2 = \frac{M_e}{r F_e}$ $\Rightarrow v^2 = 0.4775 \times 10^{13} = 4.775 \times 10^{12}$ $\Rightarrow v = 2.18 \times 10^6 \text{ m/s}$
21	Write any two distinguishing features between conductors and semiconductors in the basis of energy band diagram.
Section C	
22	(a) Explain with the help of a diagram the formation of depletion region and barrier potential in a p-n junction. (b) A student wants to use two p-n junction diodes to convert alternating current into direct current. Draw the labelled circuit diagram used. Also draw the input and output voltage waveforms.
23	On the basis of electron drift, derive an expression for resistivity of a conductor in terms of number density of free electrons and relaxation time. Also explain the dependence of resistivity of metals using obtained expression. Or, Use Kirchhoff's rules to find the currents I_1, I_2 and I_3 in the circuit diagram shown.

	
Ans	From Kirchhoff's first law $I_3 = I_1 + I_2$ ...(i) For applying Kirchhoff's second law to mesh ABDC $-2 - 4I_1 + 3I_2 + 1 = 0 \Rightarrow 4I_1 - 3I_2 = -1$ **...(ii)** Applying Kirchoff's II law to mesh ABCEA $-2 - 4I_1 - 2I_3 + 4 = 0$ $\Rightarrow 4I_1 + 2I_3 = 2 \Rightarrow 2I_1 + I_3 = 1$ **Using (i) we get** $\Rightarrow 2I_1 + (I_1 + I_2) = 1 \Rightarrow 3I_1 + I_2 = 1$ **...(iii)** **Solving (ii) and (iii), we get** $I_1 = \frac{2}{13} A, I_2 = 1 - 3I_1 = \frac{7}{13} A$ so, $I_3 = I_1 + I_2 = \frac{9}{13} A$
24	State the principle of working of a moving coil galvanometer. Also write formula of its current sensitivity. (i) What is the function of uniform radial field and how is it produced in a moving coil galvanometer? (ii) Why is it necessary to introduce a cylindrical soft iron core inside the coil of a

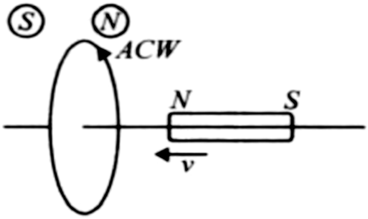
	galvanometer?
Ans	(i) In uniform radial field $\sin\theta = 1$, so the torque acting on the coil will always be $\tau = nIBA$ (maximum). To produce radial magnetic field pole pieces of permanent magnets are made cylindrical and a soft iron core is placed between them. The soft iron core helps in making the field radial. (ii) The cylindrical soft iron core, when placed inside the coil of a galvanometer, makes the magnetic field stronger and radial in the space between it and pole pieces, such that whatever the position of the rotation of the coil is the magnetic field is always parallel to its plane.
25	Define electric dipole moment and write its SI unit. Derive an expression for the electric field on the equatorial line due to an electric dipole. Or, Two thin infinite sheets 1 and 2 having surface charge densities $+\sigma$ and -2σ respectively are as shown in the diagram. Find the magnitude and direction of electric field at points A and B. 

Ans	 Let $\hat{i}$ be the unit vector directed from left to right Let P and Q are two points in the inner and outer region of two plates respectively charge densities on plates are $+\sigma$ and -2σ Electric field at point P in the inner region of the plates $$\vec{E}_1 = \frac{\sigma}{2\varepsilon_0}\hat{i} \text{ and } \vec{E}_2 = \frac{2\sigma}{2\varepsilon_0}\hat{i}$$ ∴Net electric field in the inner region of the plates (at P) is $$\vec{E} = \vec{E}_1 + \vec{E}_2 = \left(\frac{\sigma}{2\varepsilon_0} + \frac{\sigma}{\varepsilon_0}\right)\hat{i} = \frac{3\sigma}{2\varepsilon_0}\hat{i}$$
26	Which constituent radiations of electromagnetic spectrum is used - (i) in RADAR systems used in aircraft navigation (ii) in photographs of internal parts of human body/as a diagnostic tool in medicine (iii) for taking photographs of sky, during night and fog conditions. Give reason for your answer in each case.
Ans	**(i) RADAR Systems (Aircraft Navigation): Microwaves** **Reason:** Microwaves have short wavelengths and can be focused into narrow, directional beams, allowing for precise detection of objects and accurate distance measurement for navigation. **(ii) Photographs of Internal Body Parts/Medicine:**

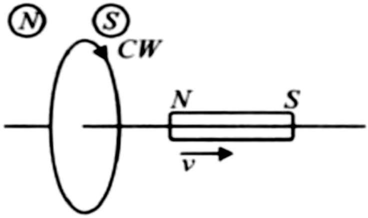
	X-rays **Reason:** X-rays have very short wavelengths, enabling them to pass through soft tissues but get absorbed by denser materials like bones and organs, creating shadows on film or detectors for internal imaging. **(iii) Night/Fog Photography (Sky): Infrared (IR) Radiation** **Reason:** Infrared radiation (heat) penetrates fog and atmospheric moisture better than visible light and is emitted by warm objects, allowing cameras to "see" in the dark or through haze by detecting these heat signatures.
27	The following graph shows the variation of stopping potential (V_o) with frequency (ν) of the incident radiation for two photosensitive surfaces X and Y. (i) Which of the metals has larger threshold wavelength? Give reason. Explain giving reason, which metal gives out electrons having larger kinetic energy, for the same wavelength of incident radiation? (iii) If the distance between the light source and metal X is halved, how will the kinetic energy of emitted from it change? Give reason

	
Ans	(i) Since, $\lambda \propto \frac{1}{v}$ As the threshold frequency of metal Y is greater than of metal X. Thus metal X has greater threshold wavelength. (ii) The kinetic energy of the emitted electrons depends on the work function of metal Y is greater than that X The kinetic energy of electrons emitted from metal X will have greater kinetic energy . (iii) If the distance between light source and metal is changed , the intensity of the light falling on the surface will decrease. But the kinetic energy of the emitted electron is independent of the intensity of the light falling and hence there will be no change in the kinetic energy of the emitted electrons.

28	Draw a plot of binding energy per nucleon (B.E/A) as a function of mass number A. (a) Write two important conclusions that can be drawn regarding the nature of nuclear force. (b) Use this graph to explain the release of energy in both the processes of nuclear fission and fusion.
Section D	
29	**<u>Read the text carefully and answer the questions</u>** The phenomena of induction of emf across a coil due to change in magnetic flux linked with it is called electromagnetic induction. The current produced due to this induced emf is called induced current. Lenz's law states that the direction of induced current in a circuit is such that it opposes the change which produces it. Thus, if the magnetic flux linked with a closed-circuit increase, the induced current flows in such a direction that magnetic flux is created in the opposite direction of the original magnetic flux. If the magnetic flux linked with the closed-circuit decreases, the induced current flows in such a direction so as to create magnetic flux in the direction of the original flux.



(Rest)
(Coil face behaves as North pole to oppose the motion of magnet.)



(Rest)
(Coil face behaves as South pole to oppose the motion of magnet.)

(a) Which of the following statements is correct?

(i)The induced e.m.f is not in the direction opposing the change in magnetic flux so as to oppose the cause which produces it.

(ii)The relative motion between the coil and magnet produces change in magnetic flux.

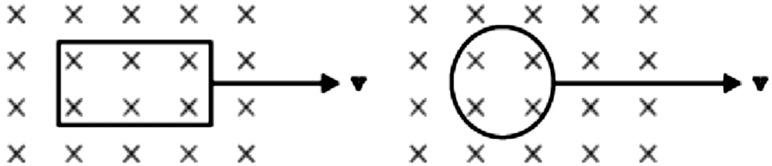
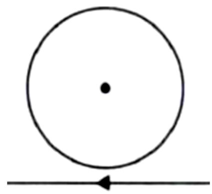
(iii)Emf is induced only if the magnet is moved towards coil.

(iv) Emf is induced only if the coil is moved towards magnet.

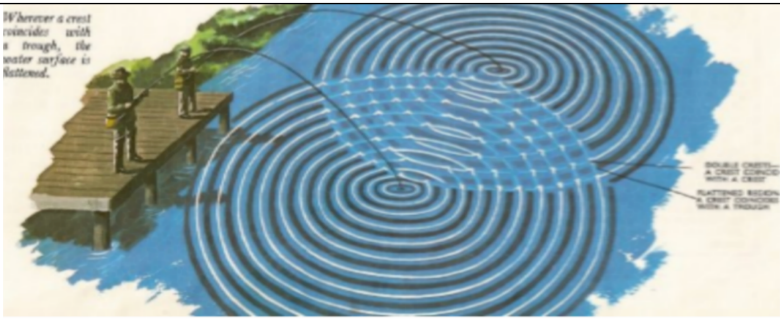
(b) Current in a circuit falls from 5.0 A to 0.0 A in 0.1 s. If an average emf of 200 V induced, give an estimate of the self-inductance of the circuit.

(i) 50 H (ii) 40 H (iii) 4 H (iv) 20 H

(c) A rectangular loop and a circular loop are moving out of a uniform magnetic field region to a field-free region with a constant velocity v. In which loop do you expect the induced emf to be constant during the passage out of the field region? The field is normal to the loops.

	 (i) Circular (ii) Rectangular (iii) Both of them (iv) None of them **(d)** Near a circular loop of conducting wire as shown in the figure, an electron moves along a straight line. The direction of the induced current if any in the loop is  (i) Variable (ii) Clockwise (ii) Anticlockwise (iv) Zero Or, Two coils A and B are kept in a horizontal tube along the axis of tube without touching each other. The mutual inductance between the coils depends upon. (i) Number of turns in coils (ii) Geometrical Shapes of coils (iii) Relative orientation of coils (iv) All of these
<u>Ans</u>	a)(ii) The relative motion between the coil and magnet produces change in magnetic flux. Reason - According to Faraday's law of

	electromagnetic induction, an electromotive force (emf) is induced in a coil when the magnetic flux through it changes. This change in magnetic flux is caused by the relative motion between the coil and the magnet. b) $$\Delta I = I_{\text{final}} - I_{\text{initial}} = 0.0\,\text{A} - 5.0\,\text{A} = -5.0\,\text{A}$$ $$\Delta t = 0.1\,\text{s}$$ rate of change of current is $\frac{\Delta I}{\Delta t} = \frac{-5.0\,\text{A}}{0.1\,\text{s}} = -50\,\text{A/s}$ $$\mathcal{E} = L\left\|\frac{\Delta I}{\Delta t}\right\|$$ $$\Rightarrow L = \frac{\mathcal{E}}{\left\|\frac{\Delta I}{\Delta t}\right\|} = \frac{200\,\text{V}}{50\,\text{A/s}} = 4\,\text{H}$$ c) (iv) None of them d) (iv) zero Or d) (iv)
30	<u>Read the text carefully and answer the questions</u>



Rohit and Rajiv were both creating a series of circular waves by jiggling their legs in water. The waves form a pattern similar to the diagram as shown. Their friend, Anita, poured an oil drop on surface of water they all amazed to see the beautiful patterns of ripples which became very colourful..

(a) Name the phenomenon involved in the activity

(i) Reflection (ii) Refraction

(ii) Interference (iv) Polarization

(b) When the distance between slits in Young's double slit experiment decreases the fringe width -

(i) increases (ii) decreases

(iii) remains same (iv) Becomes zero

(c) Ratio of amplitudes of two waves from two coherent sources propagating simultaneously in a medium is 1:2 then the ratio of maximum intensity to the minimum intensity due to

	superposition of waves is - (i) 1:2 (ii) 1:9 (iii) 4:1 (iv) 9:1 **(d)** When a monochromatic source of light of wave length 650 nm is replaced by another source of wavelength 780 nm. The ratio of width of central maximum in these cases is - (i) 6:5 (ii) 5:6 (iii) 3:1 (iv) 5:3 Or, The width of fringes obtained in Young's double slit experiment does not depend upon- (a) Distance between plane of slits and screen slits (c) Medium in which the setup is placed (b) Distance between (d) None of these
Ans	(a) (ii)Interference (b) The fringe width (β) in Young's double-slit experiment is given by the formula: $$\beta = \frac{\lambda D}{d}$$ The correct option is **(i)** **increases**. (c)

	The maximum amplitude (A_{max}) and minimum amplitude (A_{min}) for two coherent waves are given by: $A_{max} = A_1 + A_2$ $A_{min} = \|A_1 - A_2\|$ The ratio of maximum to minimum intensity is: $\frac{I_{max}}{I_{min}} = \frac{kA_{max}^2}{kA_{min}^2} = \left(\frac{A_{max}}{A_{min}}\right)^2 = \left(\frac{A+2A}{A-2A}\right)^2$ $\frac{I_{max}}{I_{min}} = \left(\frac{3A}{A}\right)^2 = (3)^2 = 9$ The ratio of maximum intensity to minimum intensity is $9 : 1$ (d) The width of the central maximum (W) in a single-slit diffraction pattern is directly proportional to the wavelength of light (λ), assuming the slit width and screen distance remain constant . The relationship can be described by the formula $W \propto \lambda$ To find the ratio of the widths (W_1/W_2) for the two different wavelengths $\lambda_1 = 650 \text{ nm}$ and $\lambda_2 = 780 \text{ nm}$ $\frac{W_1}{W_2} = \frac{\lambda_1}{\lambda_2} = \frac{650 \text{ nm}}{780 \text{ nm}} = \frac{65}{78} = \frac{5}{6}$ Or (d) (iv)

Section E	
31	(a) Derive an expression for the electric potential at any point due to an electric dipole. (b) An electric dipole of length 4cm, when placed with its axis making an angle of 60^0 with a uniform electric field, experiences a torque of $4\sqrt{3}$ Nm. Calculate the potential energy of the dipole, if it has a charge of ±8 nC.
Ans	The relationship between torque (τ), electric dipole moment ($\vec{p}$), and electric field ($\vec{E}$) is given by the formula $\tau = pE\sin(\theta)$ given torque $\tau = 4\sqrt{3}$ Nm $\theta = 60^\circ$ $pE = \frac{\tau}{\sin(\theta)}$ $= \frac{4\sqrt{3}}{\sin(60^\circ)} = \frac{4\sqrt{3}}{\sqrt{3}/2} = 8\,\text{Nm}$ The potential energy (U) of an electric dipole in a uniform electric field is given by $U = -\vec{p}\cdot\vec{E} = -pE\cos(\theta) = -8\cos(60^\circ)$ $U = -8 \times \frac{1}{2} = -4\,\text{J}$
	Or, (a) Obtain expression for capacitance of parallel plate capacitor when no dielectric is

	placed between the plates. (b) A capacitor of capacity C is charged fully by connecting it to a battery of emf E. It is then disconnected from the battery. If the separation between the plates of the capacitor is doubled then how the following parameters will change: - i) Charge stored in the capacitor ii) Field strength between the plates iii) Energy stored by the capacitor
Ans	(i) Charge Stored in the Capacitor When a capacitor is disconnected from a battery, it becomes an isolated system. According to the law of conservation of charge, the charge Q has no path to leave the plates. Therefore, the charge stored remains constant at Q=CE **(ii): Electric Field Strength** The electric field strength E_{field} between the plates of a parallel plate capacitor is given by the formula $E_{field} = \frac{\sigma}{\epsilon_0}$, where σ is the surface charge density = Q/A. Since the charge and the area of the plates

	A are both constant, the electric field strength **remains constant.** Alternatively, using $V = \frac{Q}{C}$ and $C = \frac{\epsilon_0 A}{d}$, we see $E_{field} = \frac{V}{d} = \frac{Q}{Cd} = \frac{Q}{\epsilon_0 A}$, which is independent of the separation d **<u>(iii): Energy Stored by the Capacitor</u>** The capacitance C of a parallel plate capacitor is inversely proportional to the separation d, expressed as $C = \frac{\epsilon_0 A}{d}$. If the separation is doubled (d′=2d), the new capacitance becomes $C' = \frac{C}{2}$. The energy stored U is calculated using $U = \frac{Q^2}{2C}$ Since Q is constant and C is halved, the new

	energy $U' = \frac{Q^2}{2(C/2)} = 2(\frac{Q^2}{2C}) = 2U$ Thus, the energy stored in the capacitor is **doubled**.
32	(a) An ac source of voltage V = V_0 sin ωt is connected to a series combination of L, C and R. Use the phasor diagram to obtain the expression for impedance of the circuit and phase angle between voltage and current. Find the condition when current will be in phase with the voltage. What is the circuit in this condition called? b) In a series LR circuit, X_L= R and power factor of the circuit is P_1. When capacitor with capacitance C is connected in series to LR such that X_L = X_C, the power factor becomes P_2. Calculate P_1/P_2.
Ans	**b)** In a series **LR circuit**, the impedance Z_1 is given by $Z_1 = \sqrt{R^2 + X_L^2}$. Given that $X_L = R$, the impedance becomes $Z_1 = \sqrt{R^2 + R^2} = R\sqrt{2}$. The power factor P_1 is the ratio of resistance to impedance: $P_1 = \frac{R}{Z_1} = \frac{R}{R\sqrt{2}} = \frac{1}{\sqrt{2}}$

When a capacitor is added in series, forming an **LCR circuit**, the impedance Z_2 is given by $Z_2 = \sqrt{R^2 + (X_L - X_C)^2}$.
Given the condition $X_L = X_C$, and the circuit is at **resonance**.

$$\therefore \quad Z_2 = \sqrt{R^2 + 0^2} = R.$$

The new power factor P_2 is:

$$P_2 = \frac{R}{Z_2} = \frac{R}{R} = 1$$

$$\frac{P_1}{P_2} = \frac{1/\sqrt{2}}{1} = \frac{1}{\sqrt{2}}$$

Or,

(a) What is the principle of working of a Transformer? With the help of a neat and labelled diagram, explain working of a step u transformer and obtain the expression for ratio of secondary to primary voltage in terms of the number of turns in the two coils.
(b)Write any four losses in a real transformer

33 (a) Draw a labelled ray diagram showing the image formation by a compound microscope. Define its magnifying power. Deduce the expression for the magnifying power of the microscope.
(b) Explain :
(i) Why must both the objective and the eye

	piece of a compound microscope have short focal lengths? (ii) Why is the objective of a compound microscope being of short aperture?
Ans	(i) Why must both the objective and the eye piece of a compound microscope have short focal lengths? **(a) High Magnification:** The magnification (M) of a compound microscope is the product of the objective's magnification (m_o) and the eyepiece's angular magnification (m_e). Since m_o and m_e are inversely proportional to their respective focal lengths, smaller focal lengths yield a higher total magnification. **(b)Optimal Image Formation:** A short focal length objective produces a highly magnified, real, and inverted image of a tiny object. <u>(ii) Why the objective has a small aperture:</u> **(a) Reduced Aberration:** A small aperture (small diameter) limits the light to pass through the center of the lens, reducing spherical aberration (blurring) and chromatic aberration (color fringing), which leads to sharper images. **(b) Brighter Images:** While a larger lens collects more light, a small, short-focal-length lens brings light rays together more effectively, increasing brightness.

	Or (a) Draw a ray diagram to show the refraction of light through a glass prism. Hence derive the relation for refractive index of material of prism. (b) Draw the graph between the angle of incidence and angle of deviation.