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INDIAN SCHOOL SALALAH
FIRST TERM EXAMINATION – SEPTEMBER 2025



PHYSICS – Code No. 042

Class: XII

Date: 28/09/2025

Time: 3 hours

Maximum Marks: 70

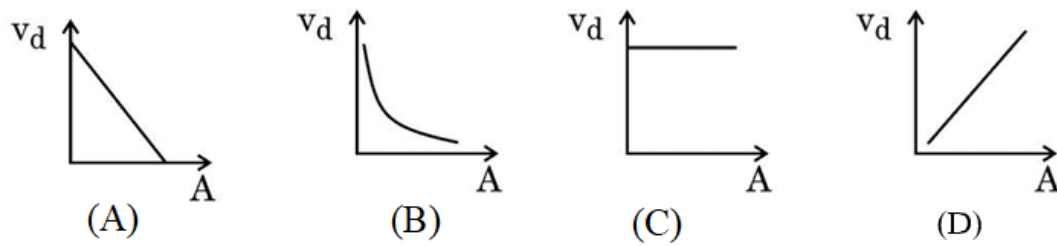
General Instructions:

- There are 33 questions in all. All questions are compulsory.
- This question paper has five sections: Section A, Section B, Section C, Section D and Section E.
- All the sections are compulsory.
- Section A contains sixteen questions, twelve MCQ and four assertion reasoning based of 1 mark each, Section B contains five questions of two marks each, Section C contains seven questions of three marks each, Section D contains two case study-based questions of four marks each and Section E contains three long answer questions of five marks each.
- There is no overall choice. However, an internal choice has been provided in two questions in Section B, one question in Section C and all three questions in Section E. You have to attempt only one of the choices in such questions.
- Use of calculators is not allowed.
- You may use the following values of physical constants where ever necessary
 - $c = 3 \times 10^8$ m/s
 - $m_e = 9.1 \times 10^{-31}$ kg
 - $m_p = 1.7 \times 10^{-27}$ kg
 - $e = 1.6 \times 10^{-19}$ C
 - $\mu_0 = 4\pi \times 10^{-7}$ T m A⁻¹
 - $h = 6.63 \times 10^{-34}$ J s
 - $\epsilon_0 = 8.854 \times 10^{-12}$ C²N⁻¹m⁻²
 - Avogadro's number = 6.023×10^{23} per gram mole

SECTION A

- 1 A diamagnetic substance is brought near the north or south pole of a bar magnet. It will be: 1
- (A) repelled by both the poles.
- (B) attracted by both the poles.
- (C) repelled by the north pole and attracted by the south pole.
- (D) attracted by the north pole and repelled by the south pole.

- 2 The area of cross-section (A) of a metallic wire increases continuously from one end of the wire to the other. When a steady current flows through, the magnitude of drift velocity (v_d) of the free electrons as a function of “A” can be shown by: 1



- 3 The current “I” is uniformly distributed across the area of cross-section of a long straight wire of radius “a”. The ratio of the magnitude of magnetic field B_1 at $a/2$ and B_2 at distance $2a$ is 1

(A) 2 (B) 1 (C) $1/2$ (D) 4

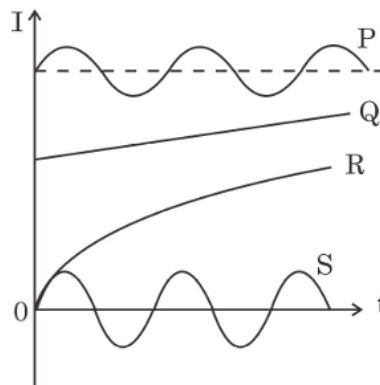
- 4 A 1 cm segment of a wire lying along X- axis carries current 0.5A along +X direction. A magnetic field is switched on in the region which is given by 1

$$\vec{B} = (0.4 \text{ mT}) \hat{j} + (0.6 \text{ mT}) \hat{k}$$

The force acting on the segment is

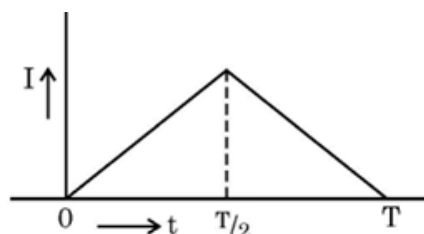
- (A) $(2\hat{j} + 3\hat{k}) \text{ mN}$ (B) $(-3\hat{j} + 2\hat{k}) \mu\text{N}$
(C) $(6\hat{i} + 4\hat{k}) \text{ mN}$ (D) $(-4\hat{i} + 6\hat{k}) \mu\text{N}$

- 5 The figure shows variation of current (I) with time (t) in four devices P, Q, R and S. The device in which an alternating current flows is: 1

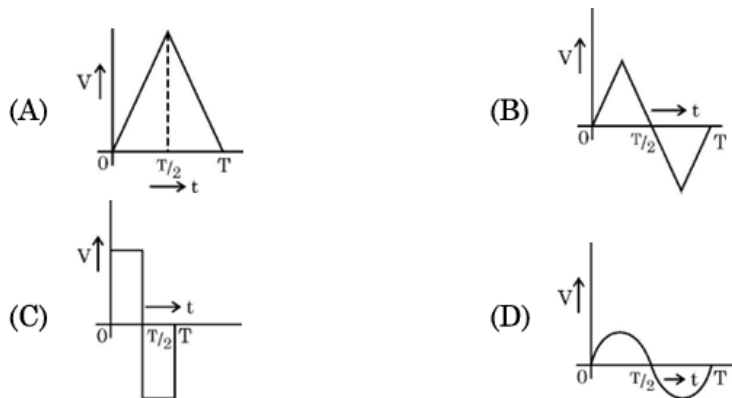


- (A) P (B) Q (C) R (D) S

- 6 Alternating current in an inductor is observed to vary with time “t” as shown in the graph for a cycle 1



Which one of the following graphs is the correct representation of the wave form of voltage V with time t ?



- 7 The electric field at a point in a region is given by 1

$$\vec{E} = \alpha \frac{\vec{r}}{|\vec{r}|^3}, \text{ where } \alpha \text{ is a constant and } r \text{ is the distance of the point from the origin.}$$

The magnitude of potential of the point is:

- (A) $\frac{\alpha}{r}$ (B) $\frac{\alpha r^2}{2}$
 (C) $\frac{\alpha}{2r^2}$ (D) $-\frac{\alpha}{r}$

- 8 Two charges $-q$ each are placed at the vertices A and B of an equilateral triangle ABC. If M is the mid-point of AB, the net electric field at C will pointing along 1

(A) CA (B) CB (C) MC (D) CM

- 9 Which one of the following has the highest frequency? 1

(A) Infrared rays (B) Gamma rays (C) Radio waves (D) Microwaves

- 10 An inductor, a capacitor and a resistor are connected in series across an ac source of voltage. If the frequency of the source is decreased gradually, the reactance of: 1

- (A) both the inductor and the capacitor decrease.
 (B) inductor decreases and the capacitor increases.
 (C) both the inductor and the capacitor increase.
 (D) inductor increases and the capacitor decreases.

- 11 A beaker is filled with water (refractive index $4/3$) up to a height H . A coin is placed at its bottom. The depth of the coin, when viewed along the near normal direction, will be 1

(A) $H/4$ (B) $3H/4$ (C) H (D) $4H/3$

- 12 A current flows through a cylindrical conductor of radius R . The current density at a point in the conductor is $j = \alpha r$ (along its axis), here α is a constant and r is distance from the axis of the conductor. The current flowing through the portion of the conductor from $r = 0$ to $r = R/2$ is proportional to: 1

(A) R (B) R^2 (C) R^3 (D) R^4

For Questions 13 to 16, two statements are given one labelled Assertion (A) and other labelled Reason (R). Select the correct answer to these questions from the options as given below.

(A) Both Assertion and Reason are true and Reason is the correct explanation of Assertion.

(B) Both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

(C) Assertion is true but Reason is false.

(D) Both Assertion and Reason are false.

- 13 **Assertion (A):** The mutual inductance between two coils is maximum when the coils are wound on each other. **1**

Reason (R): The flux linkage between two coils is maximum when they are wound on each other.

- 14 **Assertion (A):** Plane and convex mirrors cannot produce real images under any circumstance. **1**

Reason (R): A virtual image cannot serve as an object to produce a real image.

- 15 **Assertion (A):** When three electric bulbs of power 200 W, 100 W and 50 W are connected in series to a source, the power consumed by the 50 W bulb is maximum. **1**

Reason (R): In a series circuit, current is the same through each bulb, but the potential difference across each bulb is different.

- 16 **Assertion (A):** Electrostatic field lines start at positive charges and end at negative charges. **1**

Reason (R): Field lines are continuous curves without any breaks and they form closed loop.

SECTION B

- 17 An electric dipole is held in a uniform electric field. (i) Show that the net force acting on it is zero. (ii) The dipole is aligned parallel to the field. Find the work done in rotating it through the angle of 180° . **2**

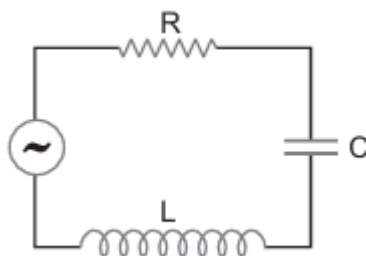
- 18 Derive the equation for the electric field due to an infinitely long uniformly charged straight conductor using a suitable diagram. Draw the graph plotting the relation between field and distance. **2**

- 19 Ohm's law is one of the basic laws in current electricity but it is not applicable in all the cases. Explain any two devices which show the limitations of ohm's law. Plot their I-V characteristics. **2**

- 20(I) A series LCR circuit is connected to an ac source of voltage V and angular frequency ω . 2
When only the capacitor is removed, the current lags behind the voltage by a phase angle " ϕ " and when only the inductor is removed, the current leads the voltage by the same phase angle. If R is the resistance in the circuit, find the expression for the current flowing and the average power dissipated in the LCR circuit.

OR

- 20(II) A series LCR circuit with $L = 4.0 \text{ H}$, $C = 100 \mu\text{F}$ and $R = 60\Omega$ is connected to a variable 240 V source as shown in 2



Calculate: (i) the angular frequency of the source which drives the circuit at resonance and (ii) the current at the resonating frequency.

- 21(I) With the help of a diagram, explain the principle of a device which changes a low voltage into a high voltage but does not violate the law of conservation of energy. Give any two reasons why the device may not be 100% efficient. 2

OR

- 21(II) Draw the impedance triangle of an LCR series circuit. Define power factor of the circuit in terms of impedance. 2

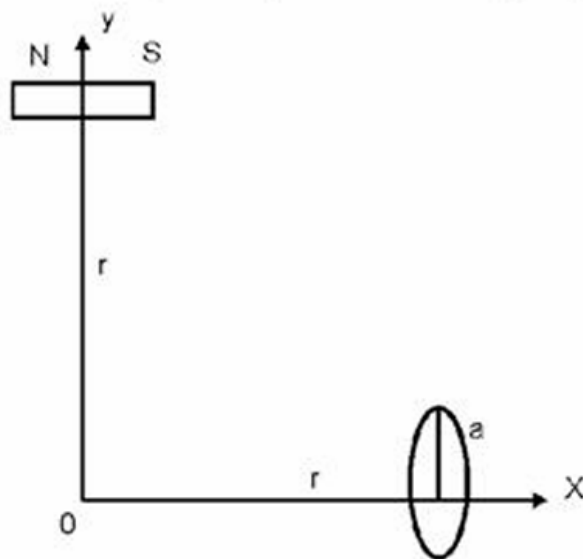
Obtain an expression for resonant frequency in terms of inductance and capacitance.

What are the values of (i) phase difference between voltage and current and (ii) power factor at this frequency?

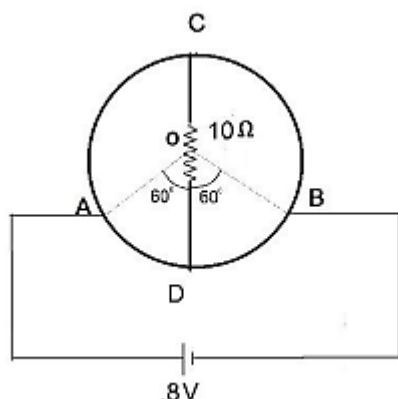
SECTION C

- 22 A charged particle, of charge $2\mu\text{C}$ and mass 10 milligram, moving with a velocity of 1000 m/s enters a uniform electric field of strength 10^3 N/C directed perpendicular to its direction of motion. Find the velocity and displacement of the particle after 10 seconds. 3
- 23 Beams of electrons and protons moving along parallel straight lines in the same direction are at a perpendicular distance of r apart. What is the nature of force between the them? 3
Derive an expression for the force between the beams.
What happens to the magnitude and direction of the force if the electron beam is replaced by another proton beam moving in the opposite direction?

- 24 A small magnet, of magnetic moment M , is placed at a distance r from the origin O with its axis parallel to x -axis as shown. A small coil, of one turn, is placed on the x -axis, at the same distance from the origin, with the axis of the coil coinciding with x -axis. For what value of current in the coil does a small magnetic needle, kept at origin, remains undeflected? What is the direction of current in the coil observing from the origin?



- 25 Draw of a labelled diagram of a.c. generator. The coil of an a.c. generator having N turns, each of area A , is rotated with a constant angular velocity ω . Deduce the expression for the alternating e.m.f. generated in the coil. What is the source of energy generation in this device? 3
- 26 An ideal inductor is connected to an ac source. The instantaneous applied voltage to the circuit is $v = v_m \sin \omega t$. Obtain the phase relation between voltage and current in the circuit. Define inductive reactance and show its relation with frequency graphically. 3
- 27(I) (a) State Kirchhoff's rules. 3
- (b) A wire of uniform cross-section and resistance of 12 ohm is bent in the shape of circle as shown in the figure. A resistance of 10 ohms is connected to diametrically opposite ends C and D . A battery of emf $8V$ is connected between A and B . Determine the current flowing through arm AD .



OR

- 27(II) (a) Draw the V - I graph of a cell. 3
- (b) A heating element connected across a battery of 100 V having an internal resistance of 1Ω draws an initial current of 10 A at room temperature 20.0°C which settles

after a few seconds to a steady value. What is the power consumed by battery itself after the steady temperature of 320.0°C is attained? Temperature coefficient of resistance averaged over the temperature range involved is $3.70 \times 10^{-4}^{\circ}\text{C}^{-1}$.

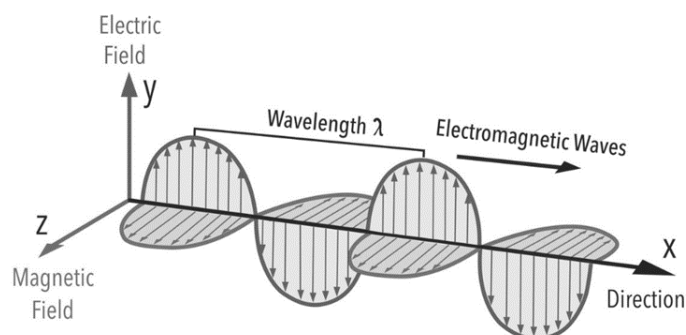
- 28 State the conditions to obtain total internal reflection. Draw the ray diagrams of totally reflecting prisms to deviate the ray of light by (i) 90° and (ii) 180° . 3

There are two media of light, A and B having refractive index $3/2$ and $\sqrt{3}$ respectively. Find the value of critical angle when the ray of light travels in the suitable direction.

SECTION D

- 29 **Nature of electromagnetic waves**

It can be shown from Maxwell's equations that electric and magnetic fields in an electromagnetic wave are perpendicular to each other, and to the direction of propagation. The electric field inside the plates of the capacitor is directed perpendicular to the plates. The magnetic field this gives rise to via the displacement current is along the perimeter of a circle parallel to the capacitor plates. So, B and E are perpendicular in this case. This is a general feature of electromagnetic waves. A linearly polarised electromagnetic wave, propagating in the x-direction with the oscillating electric field E along the y-direction and the oscillating magnetic field B along the z-direction is shown in figure.



The equation of electric field of an electromagnetic wave is given below.

$$E = \{(3 \text{ N/C}) \cos [(1.8 \text{ rad/m}) y + (5.4 \times 10^8 \text{ rad/s}) t]\} \hat{i}$$

Answer the following questions for the wave given in the equation.

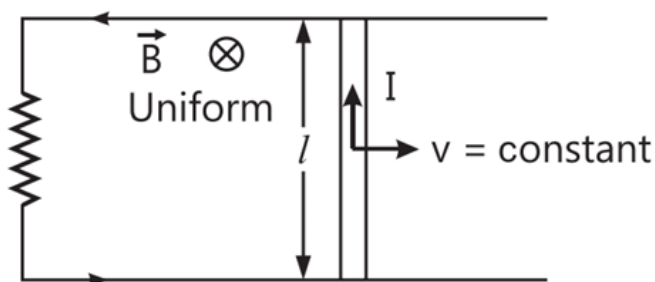
- I The direction of propagation of the wave in the given equation is 1
- (A) X – axis (B) Y – axis
(C) – X -axis (D) – Y axis
- II The amplitude of the magnetic field part of the wave is 1
- (A) $10 \times 10^{-9} \text{ T}$ (B) 3 T
(C) $1.8 \times 10^{-9} \text{ T}$ (D) $5.4 \times 10^8 \text{ T}$
- III The frequency of oscillation of a charge which may be the source of this wave: 1
- (A) 86 kHz (B) 86 MHz
(C) 38 kHz (D) 38 MHz

IV Identify the correct statement for the given wave.

1

- (A) $\frac{1}{2}\epsilon_0 E^2 > \frac{B^2}{2\mu_0}$ (B) $\frac{1}{2}\epsilon_0 E^2 < \frac{B^2}{2\mu_0}$
 (C) $\frac{1}{2}\epsilon_0 E^2 = \frac{B^2}{2\mu_0}$ (D) $\frac{1}{2}\epsilon_0 E^2 + \frac{B^2}{2\mu_0} = 0$

- 30 The emf induced across the ends of a conductor due to its motion in a magnetic field is called motional emf. It is produced due to the magnetic Lorentz force acting on the free electrons of the conductor. For a circuit shown in figure, if a conductor of length “ l ” moves with velocity $\mathbf{v}$ in a magnetic field $\mathbf{B}$ perpendicular to both its length and the direction of the magnetic field.

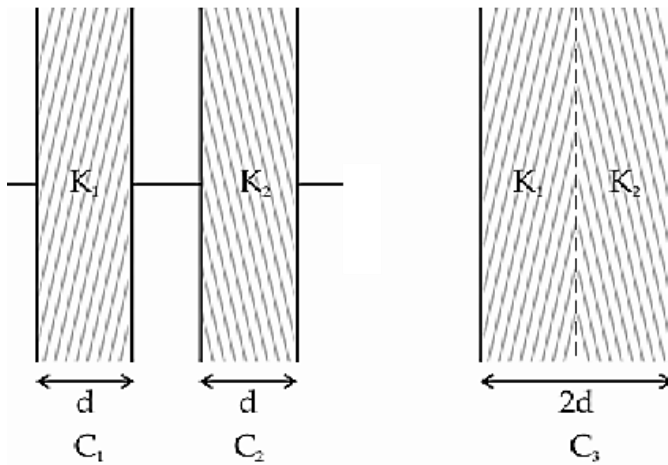


Read the given passage carefully and give the answer of the following questions:

- I A bicycle generator creates 1.5 V at 15 km/hr. What is the emf generated at 10 km/hr? 2
 II Draw the graphs showing the variation of (i) flux and (ii) induced emf with time when the conductor moves from the left end to right end of the arrangement with uniform velocity. 1
 III A conducting rod of length l is moving in a transverse magnetic field of strength B with velocity v . The resistance of the rod is R . What is the current in the rod? 1

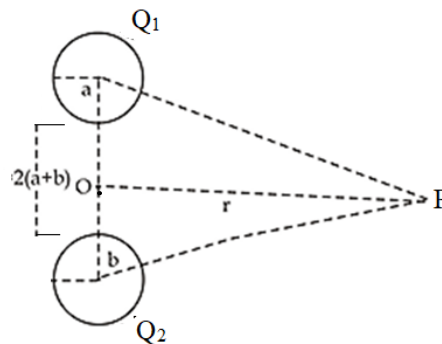
SECTION E

- 31(I) (a) Find the expression for the capacitance of a parallel plate capacitor of area A and plate separation d when a dielectric slab of thickness t ($t < d$) and dielectric constant K is introduced between the plates. What happens to the capacitance and why? 5
 (b) The capacitors C_1 , and C_2 , having plates of area A each, are connected in series, as shown. Compare the capacitance of this combination with the capacitor C_3 , again having plates of area A each, but ‘made up’ as shown in the figure.

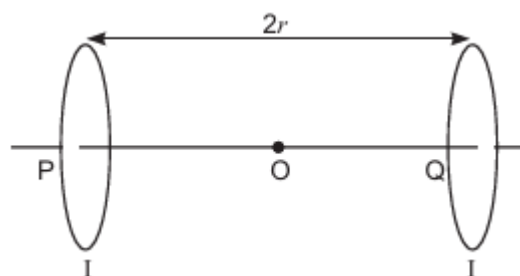


OR

- 31(II) (a) Derive the expression for electric potential due to a point charge Q , at a distance r from it. Draw a plot showing the variation of (i) electric field (E) and (ii) electric potential (V) with distance r due to a point charge Q . 5
- (b) Find the P.E. associated with a charge ' q ' if it were present at the point P with respect to the 'set-up' of two charged spheres, arranged as shown. Here O is the mid-point of the line Q_1Q_2 .



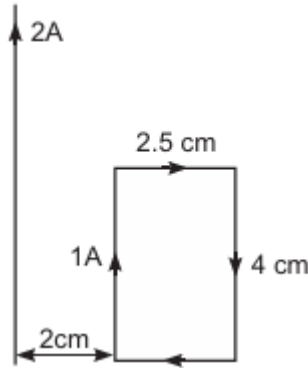
- 32(I) (i) Using Biot-Savart's law, derive an expression for magnetic field at any point on axial line of a current carrying circular loop. 5
- (ii) Two identical circular loops, P and Q , each of radius r and carrying equal currents are kept in the parallel planes having a common axis passing through O . The direction of current in P is clockwise and in Q is anti-clockwise as seen from O which is equidistant from the loops P and Q . Find the magnitude of the net magnetic field at O .



OR

32(II) (a) A rectangular loop of size $l \times b$ carrying a steady current I is placed in a uniform magnetic field $\mathbf{B}$. Prove that the torque τ magnetic moment of the loop, acting on the loop is given by $\tau = \mathbf{m} \times \mathbf{B}$, where $\mathbf{m}$ is the magnetic moment of the loop. 5

(b) A rectangular loop of wire of size $2.5 \text{ cm} \times 4 \text{ cm}$ carries a steady current of 1 A . A straight wire carrying 2 A current is kept near the loop as shown. If the loop and the wire are coplanar, find the (i) torque acting on the loop and (ii) the magnitude and direction of the force on the loop due to the current carrying wire.



33(I) (a) Draw a labelled ray diagram to show the image formation by an astronomical refracting telescope. Derive the expression for its magnifying power in normal adjustment. Write two basic features which can distinguish between a telescope and a compound microscope. 5

(b) The minimum angular magnification of an astronomical telescope at normal adjustment is 10. The length of its tube is 44 cm . Determine the focal length of the objective lens.

OR

33(II) (a) Draw a ray diagram for formation of image of a point object by a thin double convex lens having radii of curvatures R_1 and R_2 and hence derive lens maker's formula. 5

(b) A convex lens made up of a glass having refractive index 1.5 is dipped in water (refractive index $4/3$). Calculate the change in focal length.
