HALF YEARLY EXAMINATION, 2024-25

PHYSICS

Time – 3:00 Hrs. **Class – XII** **M.M. : 70**

Date – 12.09.2024 (Thursday)

Name of the student _____Section _____

GENERAL INSTRUCTIONS:

(1) There are 33 questions in all. All questions are compulsory.

(2) This question paper has five sections: Section A, Section B, Section C, Section D and Section E.

(3) All the sections are compulsory.

(4) **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**.

(5) There is no overall choice. However, an internal choice has been provided in one question 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.

(6) Use of calculators is not allowed.

(7) You may use the following values of physical constants where ever necessary.

(i) $c = 3 \times 10^8$ m/s (ii) $m_e = 9.1 \times 10^{-31}$ kg (iii) $e = 1.6 \times 10^{-19}$ C

(iv) $\mu_0 = 4\pi \times 10^{-7}$ H/m (v) $h = 6.63 \times 10^{-34}$ Js

SECTION - A

Q.1 A negatively charged object X is repelled by another charged object Y. However, an object Z is attracted to object Y. Which of the following is the most possibility for the object Z?

(a) Positively charged only (b) Negatively charged only

(c) Neutral or positively charged (d) Neutral or negatively charged

Q.2 The electric flux through a closed Gaussian surface depends upon

(a) net charge enclosed and permittivity of the medium

(b) net charge enclosed, permittivity of the medium and the size of the Gaussian surface

(c) net charge enclosed only

(d) permittivity of the medium only

Q.3 In a region, the intensity of an electric field is given by $\vec{E} = \left(2\hat{i} + 3\hat{j} + \hat{k}\right) NC^{-1}$. The electric flux through a surface $\vec{S} = 10\hat{i}$ in the region is

(a) 5 N-m^{2}C^{-1} (b) 10 N-m^{2}C^{-1} (c) 5 N-m^{2}C^{-1} (d) 20 N-m^{2}C^{-1}

Q.4 The electric field due to an electric dipole at a distance r from its centre in axial position is E. If the dipole is rotated through an angle of 90° about its perpendicular axis, then the magnitude of electric field at the same point will be

(a) E (b) E/4 (c) E/2 (d) 2E

Q.5 Choose the correct statement.

(a) Kirchhoff's first law (KCL) of electricity is based on conservation of charge while the

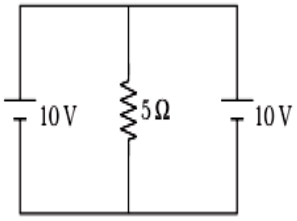
second law (KVL) is based on conservation of energy.

(b) Kirchhoff's first law of electricity (KCL) is based on conservation of energy while the second law(KVL) is based on conservation of charge.

(c) Kirchhoff's both laws are based on conservation of charge.

(d) Kirchhoff's both laws are based on conservation of energy.

Q.6 Current through the 5 Ω resistor is



(a) 2A (b) 4A (c) zero (d) 1A

Q.7 The terminal potential difference of a cell is greater than its emf when it is

(a) being discharged (b) open circuit

(c) being charged (d) being either charged or discharged

Q.8 An electron is moving along the negative direction of X-axis in a magnetic field directed along the positive direction of Y-axis. The electron will be deflected along the direction of

(a) X-axis (b) Y-axis (c) Z-axis (d) None of these

Q.No. 9 to 12 consist of two statements each linked as Assertion and Reason. While answering these questions you are required to choose any one of the following four responses.

(a) If both Assertion and Reason are true and Reason is the correct explanation of Assertion.

(b) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

(c) If Assertion is true but Reason is false.

(d) If Assertion is false but Reason is true.

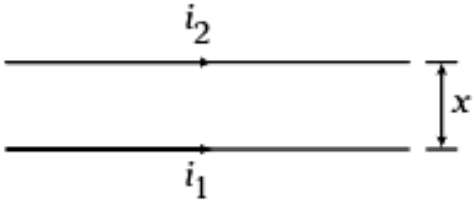
Q.9 **Assertion :** An α-particle and a deuteron having same kinetic energy enter in a uniform magnetic field perpendicular to the field. Then, radius of circular path of α-particle will be more.

Reason : q / m ratio of an α-particle is equal to the q /m ratio of a deuteron.

Q.10 **Assertion**: When a charged particle moves perpendicular to a uniform magnetic field, then its speed remains constant.

Reason: Magnetic force acts parallel to the velocity of the particle.

Q.11 **Assertion** : Upper wire shown in figure is fixed. At a certain distance x, lower wire of mass m can remain in equilibrium.



Reason : The above equilibrium of lower wire is stable equilibrium.

Q.12 **Assertion**: When a ferromagnetic rod is inserted inside an inductor, then alternating

current through it increases.

Reason: By inserting the ferromagnetic rod inside the inductor, coefficient of self-induction and hence the inductive reactance increases.

Q.13 If the velocity of charged particle has both perpendicular and parallel components while moving through a magnetic field, then what is the path followed by the charged particle?

(a) Circular (b) Elliptical (c) Linear (d) Helical

Q.14 A current loop in a magnetic field

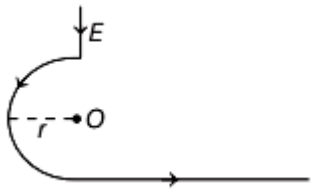
(a) experiences a torque whether the field is uniform or non-uniform in all orientations

(b) can be in equilibrium in one orientation

(c) can be equilibrium in two orientations, both the equilibrium states are unstable

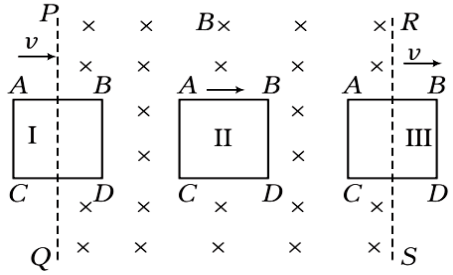
(d) can be in equilibrium in two orientations, one stable while the other is unstable

Q.15 In the given figure, what is the magnetic field induction at point O?



(a) $\frac{\mu_0 I}{4\pi r}$ (b) $\frac{\mu_0 I}{4r} + \frac{\mu_0 I}{2\pi r}$ (c) $\frac{\mu_0 I}{4r} + \frac{\mu_0 I}{4\pi r}$ (d) $\frac{\mu_0 I}{4r} - \frac{\mu_0 I}{4\pi r}$

Q.16 A square loop ABCD of edge a moves to the right with a velocity v, parallel to AB. There is a uniform magnetic field of magnitude B, directed into the paper, in the region between PQ and RS only. I, II and III are three positions of the loop.



(i) The emf induced in the loop has magnitude Bav in all three positions.

(ii) Induced emf is zero in position II.

(iii) The induced current is anti-clockwise in position I.

(iv) The induced current is clockwise in position III. Choose the correct option.

(a) (i), (iii) (b) (ii), (iii), (iv) (c) (i), (ii) (d) (iii), (iv)

SECTION – B

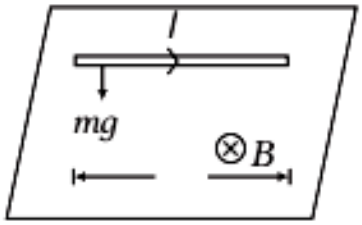
Q.17 An electric dipole is placed in a uniform electric field E with its dipole moment p parallel to the field. Find the work done in turning the dipole till its dipole moment points in the direction opposite to E.

OR

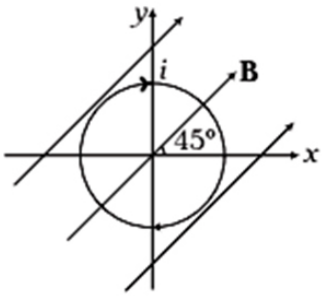
Find out the expression for the potential energy of a system of three charges q_1,q_2 and q_3 located at r_1, r_2 and r_3 with respect to the common origin O.

Q.18 An alternating voltage = $200\sqrt{2}\sin(100t)$ is connected to a 1 μF capacitor through an AC ammeter. What will be the reading of the ammeter?

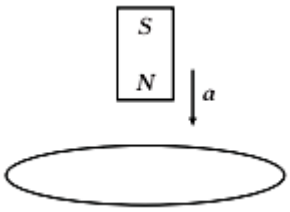
Q.19 A straight wire of mass 200 g and length 1.5 m carries a current of 2 A. It is suspended in mid air by a uniform horizontal magnetic field B. What is the magnitude of the magnetic field?



Q.20 A circular loop of radius R = 20 cm is placed in a uniform magnetic field B = 2T in XY-plane as shown in figure. The loop carries a current i = 1.0 A in the direction shown in figure. Find the magnitude of torque acting on the loop.



Q.21 A bar magnet is freely falling along the axis of a circular loop as shown in figure. State whether its acceleration 'a' is equal to, greater than or less than the acceleration due to gravity g. Justify your answer.



SECTION - C

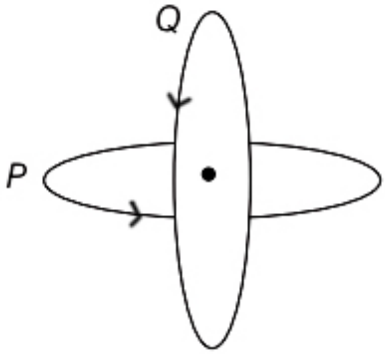
Q.22 Derive expression for capacitance of a parallel plate capacitor.

Q.23 Derive the condition of a balanced wheat-stone bridge.

OR

Derive an expression for drift velocity of electrons in a conductor.

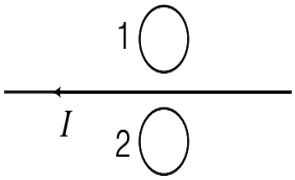
Q.24 Two identical loops P and Q each of radius 5 cm are lying in perpendicular planes such that they have a common centre as shown in the figure. Find the magnitude and direction of the net magnetic field at the common centre of the two coils, if they carry currents equal to 3 A and 4 A, respectively.



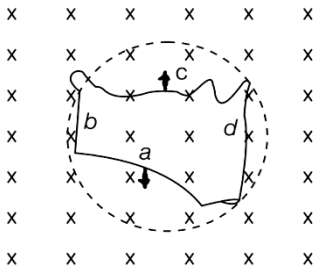
Q.25 A long straight wire of a circular cross-section of radius a carries a steady current I. The current is uniformly distributed across the cross-section. Apply Ampere's circuital law to calculate the magnetic field at a point in the region for (i) r <a and (ii) r >a

Q.26 Define the term 'mutual-inductance' and write its SI unit.The mutual inductance of two co-axial coils is 2 H. The current in one coil is changed uniformly from zero to 0.5 A in 100 ms. Find the (a) change in magnetic flux through the other coil and (b) emf induced in the other coil during the change.

Q.27 (a) State lenz'slaw . Predict the direction of induced current in metal rings 1 and 2 when current I in the wire is steadily increasing?



(b) A flexible wire of irregular shape, abcd as shown in the figure, turns into a circular shape when placed in a magnetic field which is directed normal to the plane of the loop away from the reader. Predict the direction of the induced current in the wire.



Q.28 Obtain the expression for the mutual inductance of two long co-axial solenoids S_1 and S_2 wound one over the other, each of length L and radii r_1 and r_2 and n_1 and n_2 number of turns per unit length, when a current I is set up in the outer solenoid S_2.

SECTION - D

Q.29 A conductor contains a large number of loosely bound electrons which we call free electrons or conduction electrons. The remaining material is a collection of relatively heavy positive ions which we call lattice. These ions keep on vibrating about their mean positions. The average amplitude depends on the temperature. Occasionally, a free electron collides or interacts in some other fashion with the lattice. The speed and direction of the electron changes randomly at each such event. As a result, the electron moves in a zig-zag path. As there is a large number of free electrons moving in random directions, the number of electrons crossing an area ΔS from one side very nearly equals the number crossing from the other side in any given time interval. The electric current through the area is, therefore, zero. Ohm's law tells us that the conductivity (or resistivity) of a material is independent of the electric field existing in the material. This is valid for conductors over a wide range of field.

(i) The product of resistivity and conductivity of a cylindrical conductor depends on
(a) temperature (b) material (c) area of cross section (d) none of these

(ii) A metallic resistor is connected across a battery. If the number of collisions of the free electrons with the lattice is somehow decreased in the resistor (for example, by cooling it), the current will
(a) increase (b) decrease (c) remain constant (d) become zero.

(iii) As the temperature of a metallic resistor is increased, its resistivity
(a) increases (b) decreases
(c) remains constant (d) may increase or decrease.

(iv) In an electric circuit containing a battery, the charge (assumed positive) inside the battery

(a) always goes from the positive terminal to the negative terminal

(b) may go from the positive terminal to the negative terminal

(c) always goes from the negative terminal to the positive terminal

(d) does not move

Q.30 Electric charge is an intrinsic property of elementary particles like electrons, protons, etc. Due to charge on elementary particles, attraction or repulsion force occurs between them. There are two types of charges; one is positive and other is negative. Electric field lines do not pass through a conductor.

(i) Charge on a body which carries 50 excess electrons is

(a) 6.4×10^{-18}C (b) -6.4×10^{-18}C (c) -6.4×10^{-19}C (d) none of these

(ii) Which of the following charge does not exist on any type of charged body?

(a) 9e/3 (b) –5e (c) +5e (d) e/5

(iii) A body is positively charged, it implies that

(a) there is negative as well as positive charge in the body but the positive charge is more than negative charge

(b) there is negative as well as positive charge in the body but the negative charge is more than positive charge

(c) there is only positive charge in the body

(d) None of the above

(iv) Electric lines of forces

(a) intersect at positive charge to each other

(b) intersect at negative charge to each other

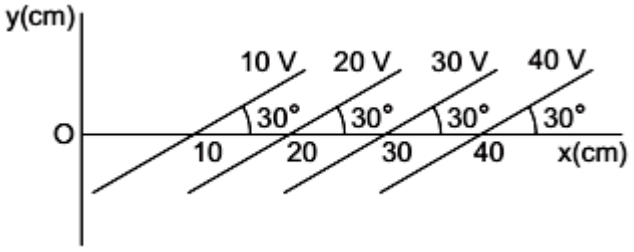
(c) do not intersect each other

(d) are not responsible for attraction for two like charges .

SECTION - E

Q.31 (i) Write two properties of equipotential surfaces ?

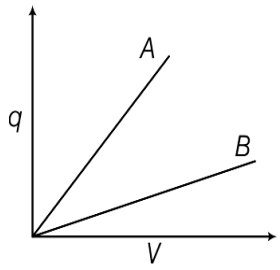
(ii) Some equipotential surfaces are shown in figure .



Find the magnitude and the direction of the electric field?

OR

(i) The given graph shows the variation of charge q versus potential difference V for two capacitors $C_1$and C_2. Both the capacitors have same plate separation but plate area of C_2 is greater than that C_1. Which line (A or B) corresponds to C_2 and why?



(ii) A 5 μF capacitor is charged to 12 V. The positive plate of this capacitor is now connected to the negative terminal of a 12 V battery and vice versa. Calculate the heat developed in the connecting wires.

Q.32 Draw a labelled diagram of a moving coil galvanometer and explain its theory and working. What is the function of radial magnetic field inside the coil? How it is produced?

OR

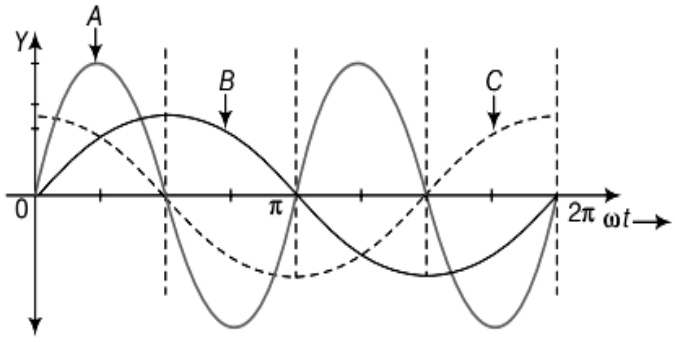
(a) Find the condition under which the charged particles moving with different speeds in the presence of electric and magnetic field vectors can be used to select charged particles of a particular speed.

(b) Two long straight parallel conductors carry steady current I_1 and I_2 separated by a distance d. If the currents are flowing in the opposite direction, show how the magnetic field set up in one produces an repulsive force on the other. Obtain the expression for this force.

Q.33 Derive an expression for the average power of a series LCR circuit connected to an a.c. source. What do you mean by power factor? When is the value of the power factor of an a.c. circuit minimum and maximum?

OR

A device X is connected to an AC source, $V = V_0 \sin \omega t$. The variation of voltage, current and power in one cycle is shown in the following graph.



(i) Identify the device X.

(ii) Which of the curves A, B and C represent the voltage, current and the power consumed in the circuit? Justify the answer.

(iii) How does its impedance vary with frequency of the AC source? Show graphically.

(iv) Obtain an expression for the current in the circuit and its phase relation with AC voltage.