Vaishnavi Yadav XII - B

APEEJAY SCHOOL, PANCHSHEEL PARK

Class – XII

Subject – Physics

MIDTERM EXAMINATION (2024-25)

Name of the student:

Time Allowed: 3hr

Date:

M.M.:70

General Instructions:

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

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

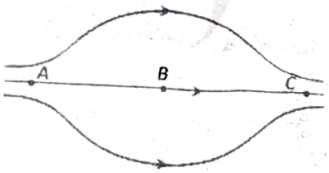
(3) **Section A** contains sixteen questions, twelve MCQ and four Assertion Reasoning based of 1 mark each, **Section B** contains five questions of two marks each, **Section C** contains seven questions of three marks each, **Section D** contains three long answer questions of five marks each. **Section E** contains two case study based questions of four marks each.

(4) 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 D. You have to attempt only one of the choices in such questions.

(5) Use of calculators is not allowed.

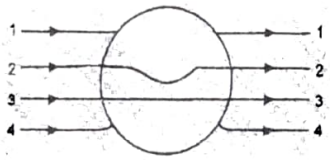
SECTION A

1 The figure shows some of the electric field lines corresponding to an electric field. The relation between electric field intensity at three point is: 1



(a) $E_A > E_B > E_C$ (b) $E_A = E_B = E_C$ (c) $E_A = E_C > E_B$ (d) $E_A = E_C < E_B$

2 A metallic solid sphere is placed in a uniform electric field. The lines of force following the path(s) showing in the figure. Which line is showing the correct path? 1



(a) 1 (b) 2 (c) 3 (d) 4

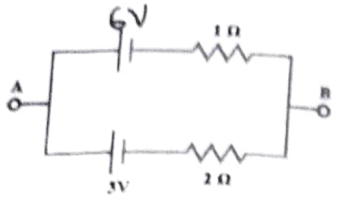
3 Three charges 2q, -q and –q lies at vertices of a triangle. The value of E and V at centroid of triangle will be: 1

(a) $E \neq 0$ and $V \neq 0$ (b) $E = 0$ and $V = 0$ (c) $E \neq 0$ and $V = 0$ (d) $E = 0$ and $V \neq 0$

4 A capacitor plates are charged by a battery with 'V' volts. After charging battery is disconnected and a dielectric slab with dielectric constant K is inserted between its plates, the potential across the plates of a capacitor will become 1

(a) Zero (b) V/2 (c) V/K (d) VK

5 Two batteries of different emfs and different internal resistances are connected as shown in the figure. The voltage across AB in volts is 1



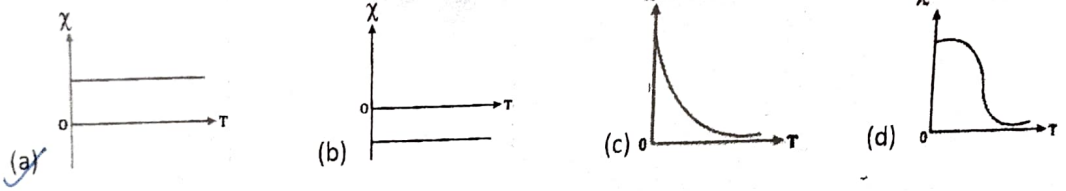
(a) 4 (b) 5 (c) 6 (d) 7

6 A uniform wire of length l and radius r has a resistance of 100 Ω. It is recast into a wire of radius r/2. The resistance of new wire will be 1
(a) 400 Ω (b) 100 Ω (c) 200 Ω (d) 1600 Ω

7 A current loop in a magnetic field 1
(a) Can be in equilibrium in one orientation.
(b) Can be in equilibrium in two orientations, both the equilibrium states are unstable.
(c) Can be in equilibrium in two orientations, one stable while the other is unstable.
(d) Experiences a torque whether the field is uniform or non – uniform in all orientations.

8 The magnetic moment of a current (I) carrying circular coil of radius r and number of turns N varies as: 1
(a) r^3 (b) r^2 (c) r (d) r^{-2}

9 The variation of magnetic susceptibility χ with temperature, for a diamagnetic substance, is best represented by 1



10 Which of the following statements is correct? 1
(a) Magnetic field lines do not form closed loops.
(b) Magnetic field lines start from north pole and end at south pole of a magnet.
(c) The tangent at a point on a magnetic field represents the direction of the magnetic field at that point.
(d) Two magnetic field lines may intersect each other.

11 A coil having n turns and resistance $R\Omega$ is connected with a galvanometer of resistance $4R\Omega$. This combination is moved in time t seconds from a magnetic field the magnetic flux linked with the coil changes from W_1 weber to W_2 weber. The induced current in the circuit is 1

(a) $-\frac{W_2 - W_1}{5\,Rnt}$ (b) $-\frac{n(W_2 - W_1)}{5\,Rt}$ (c) $-\frac{(W_2 - W_1)}{Rnt}$ (d) $-\frac{n(W_2 - W_1)}{Rt}$

12 Two wires of same length are shaped into a square and a circle if they carry same current, ratio of magnetic moment is : 1
(a) 2 : π (b) π : 2 (c) π : 4 (d) 4 : π

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 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:** The equatorial plane of a dipole is an equipotential surface. **1**
Reason: The electric potential at any point on equatorial plane is zero.

14 **Assertion:** Electric potential and electric potential energy are different quantities. **1**
Reason: For a system of positive test charge and point charge electric potential energy = electric potential.

15 **Assertion**: If the distance between parallel plates of a capacitor is halved and dielectric constant is three times, then the capacitance becomes 6 times. **1**
Reason: Capacity of the capacitor does not depend upon the nature of the material.

16 **Assertion**: The induced emf will be same and current will be different in two identical loops of copper and aluminium, when rotated with same speed in the same magnetic field. **1**
Reason: Induced emf is proportional to rate of change of magnetic field while induced current depends on resistance of wire.

SECTION B

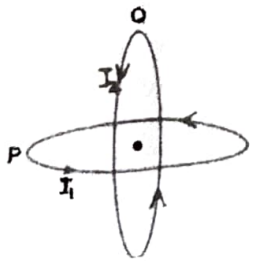
17 Two point charges of charge values Q and q are placed at a distance of x and x/2 respectively from a third charge of charge value 4q, all charges being in the same straight line. Calculate the magnitude and nature of charge Q, such that the net force experienced by the charge q is zero. (Assume q is located between charges 4q and Q). **2**

18 Calculate the amount of work done in rotating a dipole from stable equilibrium to unstable equilibrium and state whether energy is released or consumed. **2**

19 A potential difference of 6 V is applied across a conductor of length 0.12 m. Calculate the drift velocity of electrons, if the electron mobility is 5.6×10^{-6} m^2 V^{-1} s^{-1}. **2**

20 Define magnetic susceptibility of a material. What does negative susceptibility signify? **2**

21 Two identical circular coils, P and Q each of radius R, carrying currents 1 A and $\sqrt{3}$ A respectively, are placed concentrically and perpendicular to each other lying in the XY and YZ planes. Find the magnitude and direction of the net magnetic field at the centre of the coils. **2**



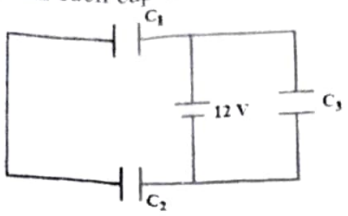
OR

A proton and a deuteron with the same initial kinetic energy enter a magnetic field in a direction perpendicular to the direction of the field. Find the ratio of the radii of the circular trajectories described by them. 3

SECTION C

22 A particle of charge 2μC and mass 1.6g is moving with a velocity $4\hat{i}$ ms^{-1}. At t = 0 the particles enters in a region having an electric field $E = (80\hat{i} + 60\hat{j})$ N C^{-1}. Find the velocity of particle at t = 5s. 2+1

23 Three identical capacitors C_1, C_2 and C_3 of capacitance 6μF each are connected to a 12 V battery as shown. Find the charge on each capacitor.



24 Define resistivity of a conductor and give its SI unit. Plot a graph showing the variation of resistivity with temperature for (i) Copper (ii) Nichrome (iii) Semiconductor. How does one explain such a behaviour, using the mathematical expression of the resistivity of a conductor? 1½ + 1½

25 How do convert a galvanometer into an ammeter? A moving coil galvanometer, whose coil resistance is 100 Ω, shows full scale deflection when 1mV is put across it. How can it be converted into a voltmeter of range (0-1V)? 3

26 (a) Derive an expression for magnetic field intensity due to a magnetic dipole at a point on its axial line. 3

(b) A magnetised needle of magnetic moment 4.8×10^{-2} JT^{-1} is placed at 30° with the direction of uniform magnetic field of 3×10^{-2} T. Calculate the torque acting on the needle.

27 Draw the magnetic field lines for a current carrying solenoid, when a rod made of – 3
(i) Copper (ii) Aluminium (iii) Iron are inserted in the solenoid.

28 Define self-inductance and give its unit. Write down the expression for the self-inductance of a long solenoid of length L and having N turns. 3

OR

Define mutual inductance between two long coaxial solenoids. Find out the expression for the mutual inductance of inner solenoid of length l having the radius r_1 and the number of turns n_1 per unit length due to the second outer solenoid of same length and n_2 number of turns per unit length.

SECTION D

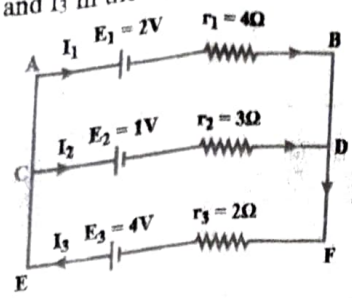
29 (a) Derive an expression for drift velocity of electrons in a conductor. Hence deduce Ohm's law. 2+1+2

(b) A conductor of length L is connected to a dc source of emf ε. If this conductor is replaced by another conductor of same material and same area of cross-section but of length 3L, how will the drift velocity change?

(c) A wire whose cross-sectional area is increasing linearly from its one end to the other, is connected across a battery of V volts. Which of the following quantities remain constant in the wire? (a) drift velocity (b) current density (c) electric current (d) electric field. Justify your answer.

OR

(a) State the two rules that serve as general rules for analysis of electrical circuits. 2+3
(b) Use these rules to write the three equations that may be used to obtain the values of the three unknown currents I_1, I_2 and I_3 in the branches of the circuit shown in figure.

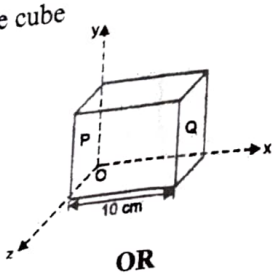


30 (a) With the help of a neat and labelled diagram explain the principle and working of a moving coil galvanometer. 2+1+1+1
(b) What is the function of uniform radial field and how is it produced?
(c) Define current sensitivity of a galvanometer. How is current sensitivity increased?
(d) Comment on the statement "Increasing Current sensitivity may not increase the voltage sensitivity".

OR

(a) 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 same direction, show how the magnetic field set up in one produces an attractive force on the other. Obtain the expression for this force. Hence define one ampere. 3+2
(b) Alpha particle and proton enter inside the magnetic field with same kinetic energy, find the ratio of their radii.

31 (a) State Gauss' law. Using this law, obtain the expression for the electric field at a point due to uniformly charged infinite plane sheet. 2+1+2
(b) Also, plot the variation of electric field(E) due to uniformly charged infinite long sheet with distance(r) from the sheet.
(c) Electric field $\vec{E}$ in a region given by $\vec{E} = (5x^2+2)\hat{\imath}$. A cube of side 10 cm is placed in the region as show in figure. Calculate
(i) the electric flux through the cube
(ii) the net charge enclosed by the cube



OR

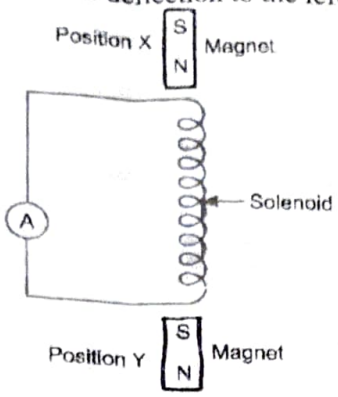
(a) Define an ideal electric dipole. Give an example. 1+2+2
(b) Derive an expression for the torque experienced by an electric dipole in a uniform electric field. What is net force acting on this dipole.
(c) An electric dipole of length 2cm is placed with its axis making an angle of 60° with respect to uniform electric field of 10^5 N/C. If it experiences a torque of $8\sqrt{3}$ Nm, calculate the magnitude of charge on the dipole and its potential energy.

SECTION E

Read the following paragraph and answer the questions that follow. 1+1+2

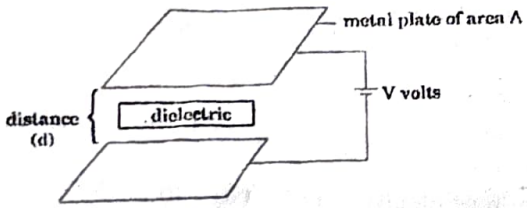
32 A solenoid is held in a vertical position and connected to a sensitive, centre-zero ammeter. A vertical bar magnet is held stationary at position X just above the upper end of the solenoid as

shown. The magnet is released and it falls through the solenoid. During the initial stage of the fall, the sensitive ammeter shows a small deflection to the left



(i) Explain why the ammeter shows a deflection.
(ii) The magnet passes the middle point of the solenoid and continues to fall. It reaches position Y. Describe and explain what is observed on the ammeter as the magnet falls from the middle point of the solenoid to position Y.
(iii) Suggest two changes in the apparatus that would increase the initial deflection of the ammeter

33



1+1+2

A parallel plate capacitor is an arrangement of two identical metal plates kept parallel, a small distance apart. The capacitance of a capacitor depends on the size and separation of the two plates and also on the dielectric constant of the medium between the plates. Like resistors, capacitors can also be arranged in series or parallel or a combination of both. By virtue of electric field between the plates, charged capacitors store energy.

(a) The capacitance of a parallel plate capacitor increases from 10μF to 80μF on introducing a dielectric medium between the plates. Find the dielectric constant of the combination.
(b) n capacitors, each of capacitance C, are connected in series. Find the equivalent capacitance of the combination.
(c) A capacitor is charged to a potential (V) by connecting it to a battery. After some time, the battery is disconnected and a dielectric is introduced between the plates. How will the potential difference between the plates, and the energy stored in it be affected? Justify your answer.

OR

(c) Find the equivalent capacitance between points A and B, if capacitance of each capacitor is C.