BUDHA DAL PUBLIC SCHOOL, PATIALA
First Term Examination (6 September 2024)
Class XII (Science)
Subject – Physics (Set - B)

Time: 3hrs **M.M. 70**

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, one question in each CBQ in Section D 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) $me = 9.1 \times 10^{-31}$ kg
- iii) $e = 1.6 \times 10^{-19}$ C
- iv) $\mu 0 = 4\pi \times 10^{-7}$ TmA−1
- v) $h = 6.63 \times 10^{-34}$ Js
- vi) $\varepsilon 0 = 8.854 \times 10^{-12}\ C^2\ N^{-1}\ m^{-2}$
- Vii) Avogadro's number = 6.023×10^{23} per gram mole

Section - A

Q1. The number of turns in a coil of galvanometer is tripled, then
- a) Both voltage and current sensitivity remains constant
- b) Voltage sensitivity increases 3 times and current sensitivity remains constant
- c) Both voltage and current sensitivity decreases by 33%.
- d) Voltage sensitivity remains constant and current sensitivity increases 3 times.

Q2. For a conductor the relation between current density $(\vec{j})$ conductivity (σ) and electric field intensity $(\vec{E})$ is

a) $\vec{j} = \sigma/\vec{E}$ b) $\vec{j} = \sigma\,\vec{E}$ c) $\vec{j} = \frac{\vec{E}}{\sigma}$ d) None of these

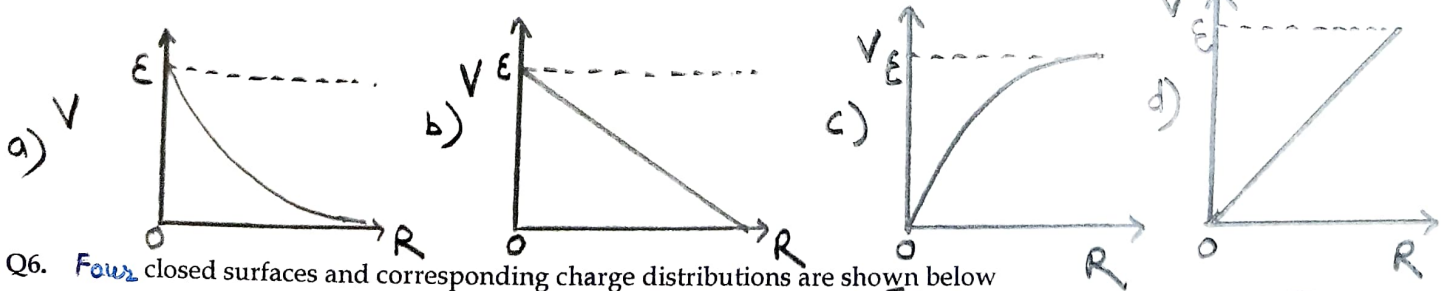
Q3. Let E_a be the electric field due to a dipole is in its axial plane distant l and let E_q be the field in the equatorial plane distant l. The relation between E_a and E_q is

a) $E_a = E_q$ b) $E_a = 2E_q$ c) $E_q = 2E_a$ d) $E_a = 3E_a$

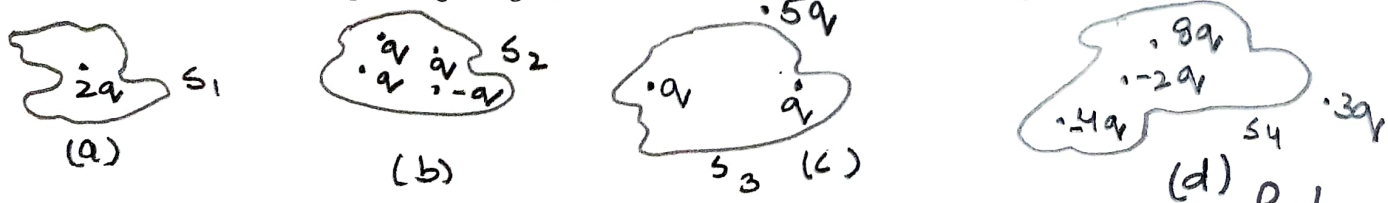
Q4. The magnetic susceptibility of a ferromagnetic substance is

a) Small and positive b) small and negative c) high and positive d) none of these

Q5. A cell having an e.m.f. ϵ and internal resistance r is connected across a variable external resistance R. As the resistance R is increased, the plot of potential difference V across R is given by



Q6. Four closed surfaces and corresponding charge distributions are shown below

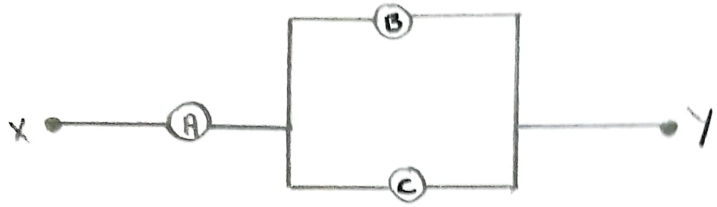


Let the respective electric fluxes through the surface be ϕ_1, ϕ_2, ϕ_3 and ϕ_4. Then

a) $\phi_1 = \phi_2 = \phi_3 = \phi_4$ b) $\phi_1 > \phi_3$; $\phi_2 < \phi_4$

c) $\phi_1 > \phi_2 > \phi_3 > \phi_4$ d) $\phi_1 < \phi_2 = \phi_3 > \phi_4$

Q7. If A, B and C are voltmeters of resistance R, 1.5 R and 3R respectively as shown in the figure. When some potential difference is applied between X and Y, the voltmeter readings are V_A, V_B and V_C respectively, then



a) $V_A \neq V_B = V_C$ b) $V_A = V_B \neq V_C$ c) $V_A \neq V_B \neq V_C$ d) $V_A = V_B = V_C$

Q8. Two charged sphere separated by distance 'd' exert same force on each other. If they are immersed in a liquid of dielectric constant 2, then what is the force exerted, if all other conditions are same?

a) F/2 b) F c) 2F d) 4 F

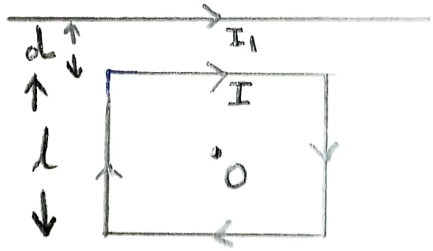
Q9. The magnetic flux linked with the coil varies with time as $\phi = 3t^2 + 4t + 9$. The magnitude of the induced e.m.f. at t = 2 s is

a) $9V$ b) $16\,V$ c) $3\,V$ d) $4\,V$

Q10. $m^2\,V^{-1}\,s^{-1}$ is the S.I unit of which of following

a) Drift velocity b) Mobility c) Resistivity d) Potential gradient

Q11. A square loop, carrying a steady current I is placed in horizontal plane near a long straight conductor carrying a steady current I_1 at a distance d from the conductor as shown in the figure. The loop will experience



a) a net repulsive force away from the conductor
b) a net torque acting upward perpendicular to the horizontal plane
c) a net torque acting downward normal to the horizontal plane
d) a net attractive force towards the conductor

Q12. If n, e, r and m have their usual meanings, then the resistance of a wire of length l and crosssectional area A is given by

a) $\frac{ne^2A}{3m\tau l}$ b) $\frac{ml}{ne^2\tau A}$ c) $\frac{m\tau l}{n^2 le}$ d) $\frac{ne^2\tau A}{2ml}$

In the following questions, a statement of Assertion (A) is followed by a statement of Reason (R). Mark the correct choice as:

a) Both A and R correct and R is the correct explanation of A.
b) Both A and R correct and R is not the correct explanation of A
c) A is not correct but R is correct.
d) A is correct but R is not correct

Q13. **Assertion (A) :** Electromagnets are made of soft iron

Reason (R) : Soft iron has high permeability and low retentivity

Q14. **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.

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

Assertion (A) : 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 (R) : $\left(\frac{q}{m}\right)$ ratio of an α-particule is more than $\left(\frac{q}{m}\right)$ ratio of a deuteron

Q16. **Assertion (A) :** If current passing through a circular loop is doubled, then magnetic flux linked with the circular loop will also become two times.

Reason (R) : No flux will link through the coil by its own current.

Section - B

Q17. Explain principle construction, working and theory of transformer.

Q18. The magnitude of electric field in (NC^{-1}) in a region varies with the distance r (in m) to appoint r (in m) as E = 10 r + 5.

By how much does the electric potential increase in moving from a point r = 1 m to a point r = 10 m.

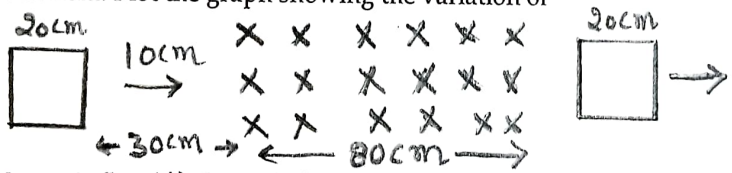
Q19. Two capacitors of capacitance 3 μF and 6 μF are charged to potentials of 2 V and 5 V respectively. These two charged capacitor are connected in series. Find the potential across each of the two capacitors now.

Q20. Deduce an expression for the capacitance of parallel plate capacitor when a dielectric slab is introduced between the plates. The thickness of slab is less than plate separation.

OR

A slab of material of dielectric constant K has the same area as the plates of a parallel plate capacitor but has a thickness $\frac{3d}{4}$, where d is the separation of plates. How is the capacitance changed when the slab is inserted between the plates?

Q21. A square loop of side 20 cm is initially kept 30 cm away from a region of uniform magnetic field of 0.1 T as shown in figure. It is then moved towards right with a velocity of 10 cm s^{-1} till it goes out of magnetic field. Plot the graph showing the variation of

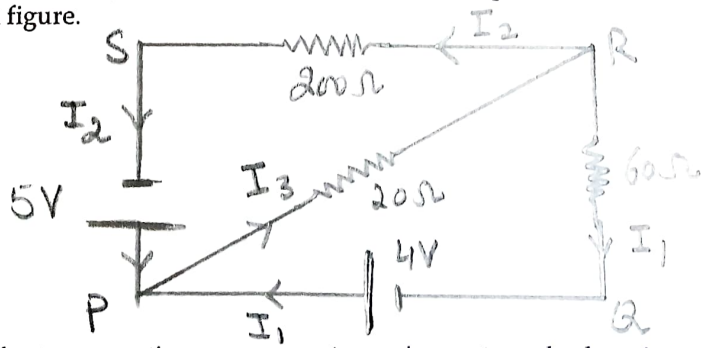


a) Magnetic flux (ϕ) through the loop with time (f)

b) Induced e.m.f. (ε) in the loop with time t.

Section - C

Q22. Apply Kirchhoffs rule to the loops PSRP and PRQP to write the expressions for the currents I_1, I_2, I_3 in the circuit as shown in figure.



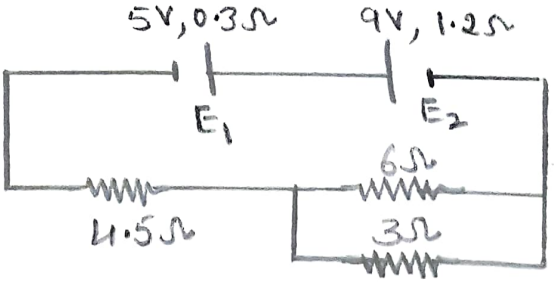
Q23. Derive an expression for torque acting on a current carrying rectangular loop in a uniform magnetic field.

Q24. Show that a current loop behaves as a magnetic dipole. Hence write an expression for its magnetic dipole moment.

OR

Describe the important properties of diamagnetic, paramagnetic and ferromagnetic substances.

a) Two cells E1 and E2 in circuit as shown in figure have e.m.f. 5V and 9V and internal resistance of 0.3 Ω and 1.2 Ω respectively. Calculate the value of current flowing through the resistance of 3 Ω.



b) Define internal resistance of a cell. Obtain a relation between terminal potential difference and e.m.f. of a cell.

Q26. The current flowing through an inductor of self inductance L is continuously increasing. Plot a graph showing the variation of

a) Magnetic flux versus current

b) Induced e.m.f. versus dI/dt

c) Magnetic potential energy stored versus the current

Q27. Applying Biot Savart's law to find the magnetic field due to a circular current carrying loop at a point on the axis of loop. Write the rules to find the direction of magnetic field.

Q28. Derive an expression for mutual inductance of two long solenoids. State the factors on which it depends. Also define coefficient of coupling.

Section - D

Case Based Questions:

Q29. **Read the following passage and answer the questions:**

Coulomb's law explain that the force between two charged particles is directly proportional to the product of the magnitude of charges and inversely proportional to the square to distance between them.

It will make coulomb's law similar to law of gravitation in the sense that both are inverse square laws. There are however two major differences between them. One being attractive in nature and the second being the electrostatic force (repulsive) nearly 10^{36} times stronger than gravitational force.

a) A piece of paper when brought near a charged body is attracted towards it but after touching the body, it falls away. Why?

b) Force of attraction between two point charges placed at a distance d is F. What distance apart should they be kept in the same medium so that the force between them is F/3?

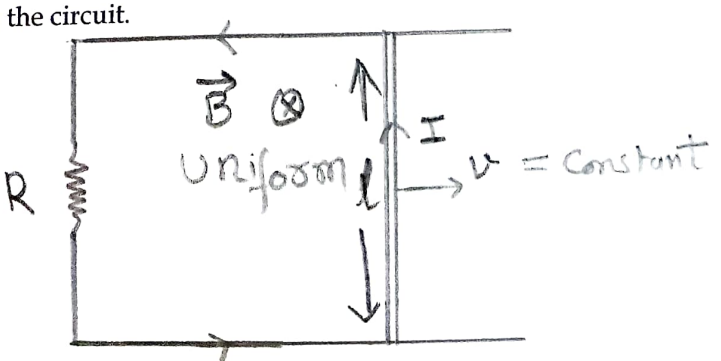
c) A charge Q is divided into two parts q and (Q-q). How the charge Q and q be related so that when q and (Q-q) are placed at certain distance apart experiences maximum electrostatic repulsion.

OR

If two objects repel one another then both carry either positive charge or negative charge. How would you determine whether these charges are positive or negative?

Q30. **Read the following passage and answer the questions:**

The e.m.f. induced across the ends of a conductor due to its motion in a magnetic field is called motional e.m.f. 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 v in a magnetic field B perpendicular to both its length and the direction of the magnetic field, then all the induced parameters are possible in the circuit.



a) What do you mean by motional e.m.f.? The direction of current induced in a wire moving in a magnetic field is found by which law?

b) Write the dimensional formula of e.m.f. in S.I. system.

c) A bicycle generator creates 1.5 V at 15km/hr. How much e.m.f. is generated at 10 km/hr?

OR

A railway track running north-south has two parallel rails 1.5 m apart. Calculate the e.m.f. induced between the rails when a train passes at a speed of 90 km h-1 Horizontal component of earth's magnetic field at a place is 0.3×10^{-4} T and angled of dip is 60^0.

Section - E

Q31. a) An electric field is uniform, and in the positive x-direction for positive x and uniform with the same magnitude in the negative x-direction for negative x. It is given that

$\vec{E} = 200\hat{\imath}\, NC^{-1}\ for\ x > 0$ $\qquad$ $\vec{E} = 200\hat{\imath}\, NC^{-1}\ for\ x < 0$

A right circular cylinder of length 20 cm and radius 5 cm has its centre at the origin and its axis along the x-axis so that one face is x = +10 cm and the other is at x = - 10 cm.

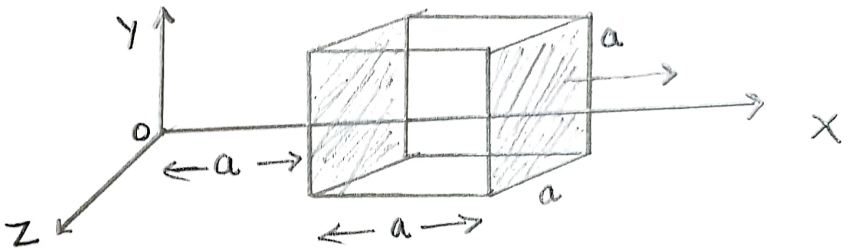
i) What is the net outward flux through each flat face?

ii) What is the flux through the side of the cylinder?

b) Apply Gauss theorem to calculate the electric field due to an infinite plane sheet of charges.

OR

a) The electric field components in figure are $E_x = \alpha x^{1/2}, E_y = E_z = 0$ in which $\alpha = 800\ N/Cm^2$. Calculate (i) the flux $\emptyset_E$ through the cube and (ii) the charge with I the cube. Assume that $\alpha = 0.1\ m$.



b) Using Gauss theorem calculate the electric field of a thin infinitely long straight line of charge having linear charge density $\lambda\ Cm^{-1}$

Q32. a) Write an expression for the power factor of series LCR circuit connected to an a.c. source. When is the value of the power factor of a.c. circuit maximum and minimum?

b) A circuit contains an inductor of 80 mH and capacitor of 250 μF connected in series to a 240 V, 100 rad/s supply. The resistance of the circuit is negligible.

i) Obtain rms value of current

ii) What is the total average power consumed by the circuit?

OR

a) Two large parallel thin plates having uniform charge densities $+\sigma\ and\ -\sigma$ kept in X-Z plane at a distance d apart. Sketch the equipotential surface due to electric field between the plates. If a particle of mass m and charge -q remains stationary between the plates, what is the magnitude and direction of the field?

b) Prove that there is always loss of energy on sharing charges between two capacitors when connected through a thin wire of negligible resistance.

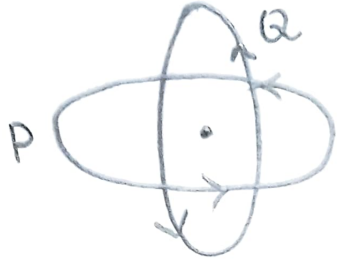
c)

Q33. a) When a charged particle moving with velocity $\vec{v}$ is subjected to magnetic field $\vec{B}$, the force acting on it is non zero. Would the particle gain any energy?

b) A proton and an alpha particle enter at right angles into a uniform magnetic field of intensity B. Calculate the ratio of the radii of their paths, when they enter the field with the (i) same momentum (ii) same kinetic energy

OR

a) Two identical circular wires P and Q, each of radius R and carrying current I are kept in perpendicular plane such that they have a common centre. Find the magnitude and direction of the net magnetic field at the common centre of two coil.



A charged particle of mass 'm', charge 'q' moving at uniform velocity 'v' enters a uniform magnetic field 'B' acting normal to the plane of paper. Deduce expression for the (i) radius of the circular path in which it travels (ii) kinetic energy of the particle assuming (v<<c)