Periodic Test -1
Subject: Physics
Date: 12/06/25
Time: 3 hours
Maximum Marks: 70

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Invigilator's Sign:

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General Instructions:

- This Question paper contains 6 printed pages.
- There are 33 questions in total. All questions are compulsory.
- This question paper contains Five Sections A, B, C, D and E. Each Section is compulsory.
- Section A has 12 MCQ's and 4 Assertion Reason of 1 mark each.
- Section B has 5 short answer type questions of 2 marks each.
- Section C has 7 short answer type questions of 3 marks.
- Section D has 2 case-based question of 4 marks.
- Section E has 3 Long answer type questions of 5 marks each.
- You may use the following values of physical constants wherever necessary.
- Calculators are not allowed.
- $c = 3 \times 10^8$ m/s
- $m_e = 9.1 \times 10^{-31}$ kg
- e = 1.6 x 10-19 C
- $\mu 0 = 4\pi \times 10^{-7}$
- $h = 6.63 \times 10^{-34}$ Js
- $\varepsilon_0 - 8.854 \times 10^{-12}$
- Avogadro's number = 6.023×10^{23} per gram mole

Section A

1. The electric field inside a charged conductor in electrostatic equilibrium is:
   a) Zero b) Constant c) Maximum d) Minimum
2. Which of the following statements about the electric field lines is correct?
   a) Electric field lines are always parallel to the surface of the conductor.
   b) Electric field lines never intersect each other.
   c) Electric field lines always form closed loops.
   d) Electric field lines can intersect each other.
3. The position of the charge inside the enclosing surface is changed in such a way that the total charge remains constant. Then the total normal electric flux through the enclosing surface:
   a) Increases b) Decreases
   c) Changes randomly d) Remains Unchanged
4. The potential energy of a system of two charges is zero. What does this imply?
   a) The charges are at infinite distance.
   b) The charges are of opposite sign and are close to each other.
   c) The charges are of the same sign and are close to each other.
   d) The charges are of opposite sign and are at infinite distance.
5. What is the electric potential energy of a system of three charges placed at the vertices of an equilateral triangle, each charge being equal to +q?
   a) U = 0 b) U= Infinity c) $3kq^2/r$ d) $9kq^2/r$
6. The capacitance of a parallel plate capacitor is increased by:
   a) Increasing the distance between the plates
   b) Decreasing the distance between the plates
   c) Increasing the area of the plates
   d) Both b and c
7. The internal resistance of a cell is 1 ohm. If the external resistance is 9 ohms, the total resistance in the circuit will be:
   a) 10 ohms b) 9 ohms c) 1 ohm d) 0.1 ohms

8. What is the number of electrons passing through a wire per minute. The current flowing through it is 500mA.
a) 1.875×10^{-20} b) 2.875×10^{-20}
c) 5.275×10^{-20} d) 1.275×10^{-20}
9. What is the SI unit of mobility?
a) V/m b) $m^2V^{-1}s^{-1}$
c) m^2V^{-2} d) $m^2V^{-2}s^{-1}$
10. The magnetic field at the center of a circular coil carrying current is:
a) Zero b) Maximum c) Minimum d) Indeterminate
11. In a current-carrying conductor placed in a magnetic field, the direction of the force acting on the conductor is given by:
a) Fleming's Right Hand Rule
b) Fleming's Left Hand Rule
c) Ampere's Right Hand Rule
d) Lenz's Law
12. The magnetic force on a moving charge is zero when:
a) The charge is at rest
b) The velocity of the charge is parallel to the magnetic field
c) The charge is moving perpendicular to the magnetic field
d) Both a and b

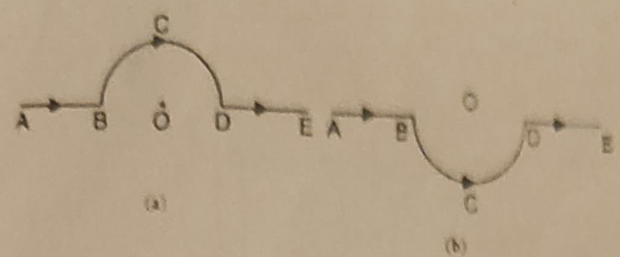
From Q13 to Q16, Choose one of the following.
a) Both Assertion and Reason are true, and the Reason is the correct explanation of the Assertion.
b) Both Assertion and Reason are true, but the Reason is not the correct explanation of the Assertion.
c) The Assertion is true, but the Reason is false.
d) The Assertion is false, but the Reason is true.
13. Assertion: A current-carrying conductor experiences a force when placed in a magnetic field.
Reason: The magnetic force on a moving charge is always perpendicular to both the velocity of the charge and the magnetic field.
14. Assertion: There is no current in metals in the absence of electric field.
Reason: Motion of electrons is random in metals.
15. Assertion: The electric potential at the surface of a uniformly charged spherical conductor is constant.
Reason: The electric field outside a uniformly charged spherical conductor is radially symmetric, and the potential is the same at every point on the surface.
16. Assertion: In a cavity within a conductor, the electric field is zero.
Reason: Charges in a conductor reside only at its surface.

Section-B

17. Draw electric field lines around a negative charge and an electric dipole.
18. Three point charges q1=+2μC, q2=−4μC, and q3=+6μC are placed at the corners of an equilateral triangle of side 0.1 m. Calculate the total electric potential energy of the system.
19. Derive an expression for drift velocity of electrons in a conductor.
20. A current of 5 A flows through a straight conductor of length 2m. The conductor is placed in a magnetic field of strength 0.3T. Find the force on the conductor if the angle between the conductor and magnetic field is 30∘.
21. The plates of a charged capacitor are connected by a voltmeter. If the plates of the capacitor are moved further apart, what will be the effect on the reading of the voltmeter? Give reason.

Section-C

22. a. Why is it necessary to have a radial magnetic field in a moving coil galvanometer?
b. A straight wire carrying a current of 12A is bent into a semicircular arc of radius 2.0 as shown in the figure (a). What is the direction and magnitude of B at the centre of the arc? Would your answer change if the wore were bent into a semicircular arc of same radius but in the opposite way as shown in the figure (b)?



23. A capacitor with capacitance C=10μF is charged to a potential difference of 50V. After disconnecting the battery, the capacitor is connected to another uncharged capacitor of capacitance 15μF in parallel. Find the common potential across the two capacitors.

OR

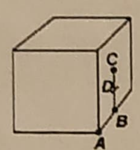
Find the energy stored in a parallel plate capacitor of capacitance 5μF when a potential difference of 200V is applied across the plates.
A parallel plate capacitor has plates of area A=6m2 and plate separation d=0.02m. The capacitor is filled with a dielectric of dielectric constant K=4. If the potential difference across the plates is 200V, find the charge on the capacitor and the electric field between the plates.

24. Give an expression for the capacitance of a parallel plate capacitor.
How does the energy stored in a capacitor change when the distance between the plates is increased?

25. a. What are equi-potential surfaces?
b. A charge of +3C is placed at the origin. What is the electric potential at a point on the x-axis at a distance of 2m from the charge?

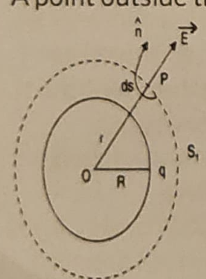
26. a. Two charges +3C and −3 μC are placed 5m apart. Find the electric field at the midpoint of the line joining the charges.
b. Use this principle of superposition to calculate the resultant electric field at a point due to two-point charges q1=5μC and q2=−5 μC placed 10 m apart.

27. a. Derive the expression for the electric field due to a uniformly charged infinite line of charge with linear charge density λ.
b.What will be the total flux through the faces of the cube with side of length a if a charge



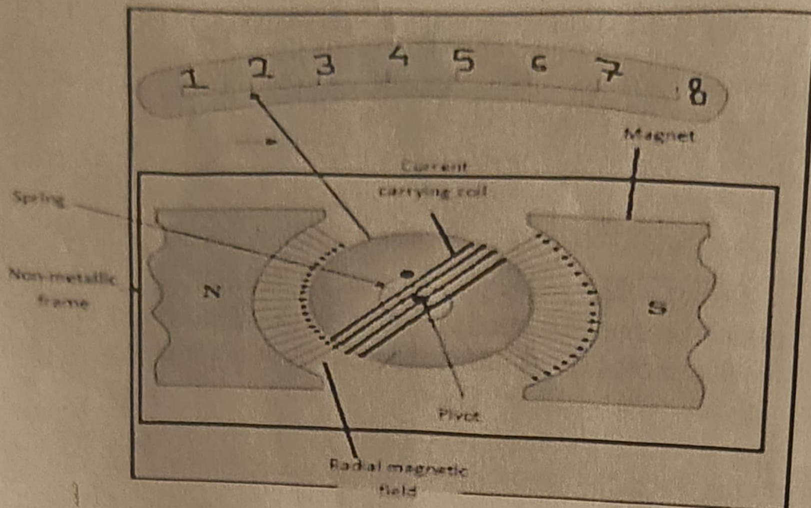
q is placed at
(i) A: a corner of the cube
(ii) B: mid-point of an edge of the cube

28. A charged spherical shell of radius R carries a total charge Q. Deduce the expression for the electric field at:
A point inside the shell (r<R).
A point outside the shell



Section-D

29. The galvanometer is a device used to detect the current flowing in a circuit, or a small potential difference applied to it. It consists of a coil with many turns, free to rotate about a fixed axis, in a uniform radial magnetic field formed by using concave pole pieces of a magnet. When a current flows through the coil, a torque acts on it.



(a)What is the principle of moving coil galvanometer?
(i) Torque acting on a current carrying coil placed in a uniform magnetic field.
(ii) Torque acting on a current carrying coil placed in a non-uniform magnetic field.
(iii) Potential difference developed in the current carrying coil.
(iv) None of these.

(b) If the field is radial, then the angle between magnetic moment of galvanometer coil and the magnetic field will be
(i) 0° (ii) 30° (iii) 60° (iv)90°

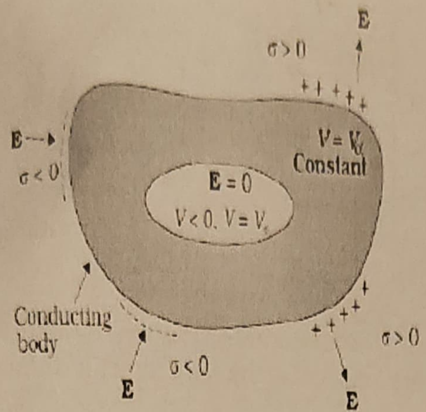
(c)Why are pole pieces made concave in the moving coil galvanometer?
(i) To make magnetic field radial.
(ii) To make magnetic field uniform.
(iii) To make the magnetic field non-uniform.
(iv) None of these

(d)What is the function of radial field in the moving coil galvanometer?
(i) To make the torque acting on the coil maximum.
(ii) To make the magnetic field strong.
(iii) To make the current scale linear.
(iv) All the above

OR

If the rectangular coil used in the moving coil galvanometer is made circular, then what will be the effect on the maximum torque acting on the coil in magnetic field for the same area of the coil?
(i) Remains the same
(ii) Becomes less in circular coil
(iii) Becomes greater in circular coil
(iv) Depends on the orientation of the coil

30. Consider a conductor with a cavity, with no charges inside the cavity. A remarkable result is that the electric field inside the cavity is zero, whatever be the size and shape of the cavity and whatever be the charge on the conductor and the external fields in which it might be placed i.e. any cavity in a conductor remains shielded from outside electric influence: the field inside the cavity is always zero. This is known as electrostatic shielding. Faraday Cages uses this effect to protect sensitive instruments from outside electrical influence.



(a) A metallic shell having inner radius R1 and outer radii R2 has a point charge Q kept inside cavity. Electric field in the region R1 < r < R2 where r is the distance from the centre is given by
(i) Depends on the value of r (ii) Zero
(iii) Constant and nonzero everywhere (iv) None of the above

(b)The electric field inside the cavity is depend on
(i)Size of the cavity
(ii)Shape of the cavity
(iii) Charge on the conductor
(iv) None of the above

(c) Electrostatic shielding is based
(i) electric field inside the cavity of a conductor is less than zero
(ii) electric field inside the cavity of a conductor is zero
(iii) electric field inside the cavity of a conductor is greater than zero
(iv) electric field inside the cavity of a plastic is zero

(d) During the lightning thunderstorm, it is advised to stay
(i) inside the car (ii) under trees
(iii) in the open ground (iv) on the car

OR

Which of the following material can be used to make a Faraday cage (based on electrostatic shielding)
(a) Plastic (b) Glass (c) Copper (d) Wood

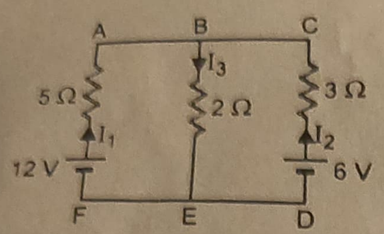
Section-E

31. a. Two-point charges $q1 = 10 \times 10^{-8}$ C and $q2 = -5 \times 10^{-8}$ C are separated by a distance of 100 cm in air.
(i) Find at what distance from the 1st charge, q1, would the electric potential be zero.
(ii) Also calculate the electrostatic potential energy of the system.
Two charges −q and +q are located at points A (0, 0, −a) and B (0, 0, +a) respectively. How much work is done in moving a test charge from point P (7, 0, 0) to Q (−3, 0, 0)?

OR

a. Derive an expression for the torque experienced by an electric dipole placed in a uniform electric field.
b. An electric dipole of dipole moment 5×10^{-6}Cm is placed in a uniform electric field of 10×10^{5}N/C^2. Find the torque acting on the dipole when it makes an angle of 30° with the field.

32. a. Using Kirchoff's laws in the electrical network shown in figure, calculate the values of I1, I2 and I3.



b. Why does the resistance of a conductor increase with temperature, while the resistance of a semiconductor decreases?

OR

a. Two cells of emf 1.5 V and 2 V have internal resistances 1Ω and 2Ω respectively are connected in parallel to pass a current in the same direction through an external resistance of 5Ω.
(i)Draw the circuit diagram.
(ii)Using Kirchhoff's laws, calculate the current through each branch of the circuit and potential difference across 5Ω resistor.

b. Define electric conductivity of a metal. How is it related with j, the current density and E, the intensity of electric field along the wire?

33. Two long straight parallel conductors carrying currents in the same direction attract each other. Explain why. What happens if the currents are in opposite directions?
A 15 cm long conductor carrying a current of 5A is placed perpendicular to a magnetic field of 0.2 T. Calculate the force acting on the conductor.

OR

A circular coil of radius 20 cm carries a current of 4A. Find the magnetic field at a point on its axis at a distance of 20 cm from the center using Biot-Savart's law.
A cylindrical conductor of radius 5 cm carries a current of 10A uniformly distributed over its cross-section. Find the magnetic field at:
(i) A point inside the conductor at a radius of 1 cm
(ii) A point outside the conductor at a radius of 3 cm.