No. of Printed Pages/Questions: 6 /24

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HALF YEARLY EXAMINATION - (2026 – 2027)

Class : XII **Max. Marks: 50**
Subject: Physics (042) **Time: 2 Hours**

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, eight MCQ and four assertion reasoning based of 1 mark each, Section B contains four questions of two marks each, Section C contains four questions of three marks each, Section D contains two case study-based questions of four marks each and Section E contains two long answer questions of five marks each.
(5) There is no overall choice. However, an internal choice has been provided in two questions in Section B, Section C and all two 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. $m_p = 1.7 \times 10^{-27}$ kg
iv. $e = 1.6 \times 10^{-19}$ C
v. $\mu_0 = 4\pi \times 10^{-7}$ T m A^{-1}
vi. $h = 6.63 \times 10^{-34}$ J s
vii. $\varepsilon_0 = 8.854 \times 10^{-12}$ $C^2N^{-1}m^{-2}$
viii. Avogadro's number = 6.023 X 10^{23} per gram mole

SECTION A

Q1. Which one of the following statements is correct? Electric field due to static charges is
(a) Conservative and field line do not form closed loops.
(b) Conservative and field lines form closed loops.
(c) Non-conservative and field lines do not form closed loops.
(d) Non-conservative and field lines form closed loops

Q2. Two point charges A and B of magnitude + 8 x 10^{-6} C and -8×10^{-6} C respectively are placed at a distance d apart. The electric field at the middle point O between the charges is 6.4×10^4 NC. The distance 'd' between the point charges A and B is:
(a)2 m (b)3 m
(c)1 m (d)4 m

Q3. If the electric potential at any point (x, y, z)m in space is given by $V = 3x^2$ volt. The electric field at the point (1, 0, 3) m will be
(a)3 Vm^{-1}, directed along positive x-axis. (b)3 Vm^{-1}, directed along negative x- axis.
(c)6 Vm^{-1}, directed along positive x-axis. (d)6 Vm^{-1}, directed along negative x-axis

Q4. At room temperature (27°C), the resistance of a heating element is 50Ω. The temperature coefficient of the material is 2.4 × 10^{-4} °C^{-1}. The temperature of the element, when its resistance is 62 Ω, is
(a)1030 Ω (b)1027 Ω
(c)927 Ω (d)930 Ω

Q5. A wire of length 25 m and cross-sectional area 5 mm^2 having resistivity of $2 \times 10^{-6} \Omega$ m is bent into a complete circle. The resistance between diametrically opposite points will be

(a)100 Ω (b)2.5 Ω

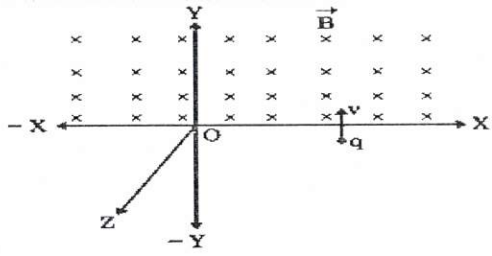
(c)12.5 Ω (d)50 Ω

Q6. A current of 5 A passes through a copper conductor (resistivity = 1.7×10^{-8} Ωm) of radius of cross-section 5 mm. Find the mobility of the charges if their drift velocity is 1.1×10^{-3} m / s.

(a)1.3 m^2/Vs (b)1.0 m^2/Vs

(c)1.8 m^2/Vs (d)1.5 m^2/Vs

Q7. A particle having charge +q enters a uniform magnetic field $\vec{B}$ as shown in the figure. The particle will describe:



(a)circular path in XZ plane (b)semicircular path in XY plane

(c)helical path with its axis parallel to Y-axis (d)semicircular path in YZ plane

Q8. The dimensions of the rate of change of magnetic flux are:

(a)$[\![MLT^{-3}A^{-1}]\!]$ (b)$[\![ML^2T^{-3}A^{-1}]\!]$

(c)$[\![ML^2T^{-2}A^{-1}]\!]$ (d)$[\![ML^2T^{-3}A^{-2}]\!]$

For Questions 9 to 12, 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.

Q9. Assertion (A): The cylindrical soft iron core in a moving coil galvanometer only makes the magnetic field radial and does not affect the strength of the magnetic field.

Reason (R): In a moving coil galvanometer, the plane of the coil is always perpendicular to the magnetic field.

Q10. Assertion (A): All atoms have a net magnetic moment.

Reason (R): A current loop does not always behave as a magnetic dipole.

Q11. Assertion (A): Induced emf produced in a coil will be more when the magnetic flux linked with the coil is more.

Reason (R): Induced emf produced is directly proportional to the magnetic flux.

Q12. Assertion (A): It is difficult to move a magnet into a coil of large number of turns when the circuit of the coil is closed.

Reason (R): The direction of induced current in a coil with its circuit closed, due to motion of a magnet, is such that it opposes the cause.

SECTION B

Q13. An electric dipole consists of point charges −1.0 pC and +1.0 pC located at (0,0) and (3 mm, 4 mm) respectively in x−y plane. An electric field E=2× $10^5 \frac{V}{m}\hat{\imath}$ is switched on in the region. Find the torque τ acting on the dipole

Q14.(I) Define self-inductance of a coil. Show that magnetic energy required to build up the current I in a coil of self-inductance L is given by $\frac{1}{2}LI^2$.

OR

14.(II) Two coplanar and concentric coils 1 and 2 have respectively the number of turns N_1 and N_2 and radii r_1 and r_2 ($r_2 \gg r_1$) placed in the air. Deduce the expression for mutual inductance of this system.

Q15.(I) A short bar magnet of magnetic moment 0.9 J/T is placed with its axis at 30° to a uniform magnetic field. It experiences a torque of 0.063 J.

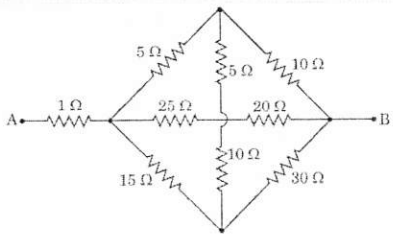
(i) Calculate the magnitude of the magnetic field.

(ii) In which orientation will the bar magnet be in stable equilibrium in the magnetic field?

OR

Q15.(II) An alpha particle is projected with velocity $\vec{V} = (3.0\times 10^5 \text{ m/s})\hat{\imath}$ into a region in which magnetic field $\vec{B} = [(0.4 \text{ T})\,\hat{\imath} + (0.3 \text{ T})\,\hat{\jmath}\,]$ exists. Calculate the acceleration of the particle in the region. $\hat{\imath}$, $\hat{\jmath}$ and $\hat{k}$ are unit vectors along x, y and z axis respectively and charge to mass ratio for alpha particle is 4.8× 10^7 C/kg

Q16. Find the equivalent resistance between points A and B for the network shown in the figure



SECTION C

Q17. Derive an expression for the magnetic field, due to a circular coil of N turns, each of radius r carrying current I, at a distance x from the centre along its axis.

Q18.(I) A current of 1.6 A flows through a wire when a potential difference of 1.0 V is applied across it. The length and cross-sectional area of the wire are 1.0 m and 1.0 × 10^{-7} m^2 respectively. Calculate:

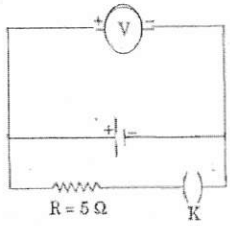
(i) Electric field across the wire

(ii) Current density

(iii) Average relaxation time (τ) (Number density of free electrons in the wire is 9.0 × 10^{28} m^{-3})

OR

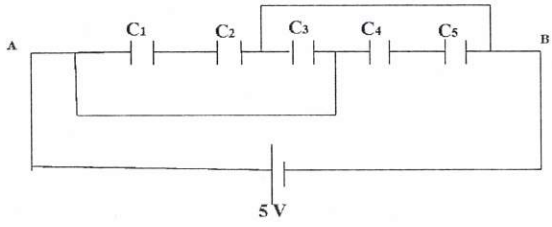
Q18.(II) Write any two factors on which internal resistance of a cell depends. The reading on a high resistance voltmeter, when a cell is connected across it, is 2.2 V. When the terminals of the cell are also connected to a resistance of 5 Ω as shown in the circuit, the voltmeter reading drops to 1.8V. Find the internal resistance of the cell.



Q19.(I) Derive an expression for potential energy of an electric dipole in an external uniform electric field . When is the potential energy of the dipole (i) maximum, and (ii) minimum?

OR

Q19.(II).In the figure given below,



find the

(i)Equivalent capacitance of the network between points A and B. Given: $C_1 = C_5 = 8\ \mu F$, $C_2 = C_3 = C_4 = 4\ \mu F$.

(ii)maximum charge supplied by the battery, and

(iii)total energy stored in the network

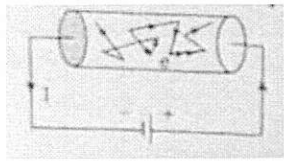
Q20. Two coils, one of radius 0·5 cm having 10 turns and the other of radius 5 cm having 50 turns are placed coaxially in air such that their centres are coincident. Calculate:

(i)the magnetic flux through the smaller coil if the larger coil carries a current of 3 A, and

(ii)the mutual inductance of the two coils.

SECTION D

Q21. Metals have a large number of free electrons nearly 10^{28} per cubic metre. In the absence of electric field, average terminal speed of the electrons in random motion at room temperature is of the order of $10^5 ms^{-1}$. When a potential difference V is applied across the two ends of a given conductor, the free electrons in the conductor experiences a force and are accelerated towards the positive end of the conductor. On their way, they suffer frequent collisions with the ions/atoms of the conductor and lose their gained kinetic energy. After each collision, the free electrons are gain accelerated due to electric field, towards the positive end of the conductor and lose their gained kinetic energy in the next collision with the ions/atoms of the conductor. The average speed of the free electrons with which they drift towards the positive end of the conductor under the effect of applied electric field is called drift speed of the electrons.



(i)Magnitude of drift velocity per unit electric field is

(a) current density (b)resistivity

(c)current (d)mobility

(ii)The drift speed of the electrons depends on:

(a)dimensions of the conductor (b)number density of free electrons in the conductor

(c)Both (a) and (b) (d) Neither (a) nor (b)

(iii)Drift speed of electrons in a conductor is very small i.e., $V_d = 10^{-4}\ ms^{-1}$.The electric bulb glows immediately. When the switch is closed because:

(a)drift velocity of electron increases when switch is closed.

(b)electrons are accelerated towards the negative end of conductor.

(c)the electrons of conductor move towards the positive end and protons of conductor move towards negative end of the conductor.

(d)the drifting of electrons takes place at the entire length of conductor.

(iv)The number density of free electrons in a copper conductor is 8.5×10^{28} m^{-3}. How long does an electron take to drift from one end of a wire 3.0 m long to its other end ?The area of cross section of wire is 2×10^{-6} m^2 and carrying a current of 3.0 A.

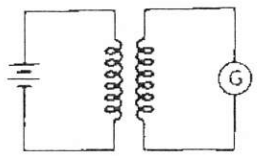
(a)8.1×10^4 s
(b) 2.7×10^4 s
(c) 9×10^3 s
(d) 3×10^3 s

OR

(iv)The S.I unit of drift velocity is:

(a)ms^{-2}
(b)ms^{-1}
(c)ms
(d)m^2s^{-1}

Q22. Mutual inductance is the phenomenon of inducing emf in a coil, due to a charge of current in the neighbouring coil. The amount of mutual inductance that links one coil to another depends very much on the relative positioning of the two coils, their geometry and relative separation between them. Mutual inductance between the two coils increases μ_r times if the coils are wound over an iron core of relative permeability μ_r.



(i)A short solenoid of radius a, number of turns per unit length n_1, and length L is kept coaxially inside a very long solenoid of radius b, number of turns per unit length n_2.What is the mutual inductance of the system?

(a)$\mu_o\pi b^2n_1n_2L$
(b)$\mu_o\pi a^2n_1n_2L^2$
(c)$\mu_o\pi a^2n_1n_2L$
(d) $\mu_o\pi b^2n_1n_2L^2$

(ii)If a change in current of 0.01 A in one coil produces a change in magnetic flux of 2×10^{-2} weber in another coil, then the mutual inductance between coils is:

(a)0
(b)0.5 H
(c)2 H
(d)3 H

(iii)Mutual inductance of two coils can be increased by:

(a)decreasing the number of turns in the coils
(b)increasing the number of turns in the coil
(c)Winding the coils on wooden cores
(d)None of these

(iv)When a sheet of iron is placed in between the two co-axial coils, then the mutual inductance between the coils will:

(a)increase
(b)decrease
(c)remains same
(d)cannot be predicted

OR

(iv)The S.I unit of mutual inductance is:

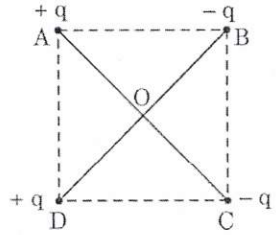
(a)Ohm
(b)mho
(c)Henry
(d)Tesla

SECTION E

Q23.(I) (i)Derive an expression for the electric field at a point on the equatorial plane of an electric dipole consisting of charges q and −q separated by a distance 2a.

(ii)The distance of a far off point on the equatorial plane of an electric dipole is halved. How will the electric field be affected for the dipole?

(iii)Two identical electric dipoles are placed along the diagonals of a square ABCD of side $\sqrt{2}$ m as shown in the figure. Obtain the magnitude and direction of the net electric field at the centre (O) of the square.



OR

23.(II)(i)Define electric potential at a point and write its SI unit.

(ii)Two capacitors are connected in series. Derive an expression of the equivalent capacitance of the combination.

(iii)Two point charges +q and −q are located at points (3a, 0) and (0, 4a) respectively in x-y plane. A third charge Q is kept at the origin. Find the value of Q, in terms of q and a, so that the electrostatic potential energy of the system is zero.

Q24.(I)(i)Identify the following magnetic materials:

(a)A material having susceptibility (χ) = −0.00015.

(b)A material having susceptibility (χ) = 10^{-5}.

(ii)Mention two properties of soft iron due to which it is preferred for making an electromagnet.

(iii)State Gauss's law for magnetism.

OR

Q24.(II)(i)Using Ampere's circuital law, obtain the expression for the magnetic field due to a long solenoid at a point inside the solenoid on its axis.

(ii)Derive an expression for the force between two long parallel current carrying conductors.

(iii)Use this expression to define S.I. unit of current.

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