Indian School Al Wadi Al Kabir
Assessment – I (2025-2026)

Class: XII	Subject: Physics (042)	Max. marks: 70
Date: 16/09/2025	Set- II	Time: 3 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, 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 two questions 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 wherever necessary.

$c = 3 \times 10^8\ ms^{-1}$, $h = 6.626 \times 10^{-34} Js$, $e = 1.602 \times 10^{-19}\ C$,

$\mu_0 = 4\pi \times 10^{-7}\ T\ m\ A^{-1}$,

$\epsilon o = 8.854 \times 10^{-12}\ C^2N^{-1}m^{-2}$, $m_e = 9.1 \times 10^{-31} kg$,

$m_p = 1.673 \times 10^{-27} kg$, Avogadro's number $N_A = 6.023 \times 10^{23}\ /mol^{-1}$

SECTION A (16 x 1 = 16 marks)

[1] If the net electric flux through a closed surface is zero, then we can infer

[a] no net charge is enclosed by the surface.

[b] uniform electric field exists within the surface.

[c] electric potential varies from point to point inside the surface.

[d] charge is present inside the surface.

[2] A point charge is placed at the centre of a hollow conducting sphere of internal radius 'r' and outer radius '2r'. The ratio of the surface charge density of the inner surface to that of the outer surface will be

[a]1:1 [b] 2:1 [c] 1:2 [d] 4:1

[3] An infinite long straight wire having a charge density λ is kept along Y′ Y axis in XY plane .Then the coulomb's force on a point charge 'q' at a point [X,0] will be:

[a] attractive and $\frac{q\lambda}{2\pi X\varepsilon_0}$ [b] attractive and $\frac{q\lambda}{\pi X\varepsilon_0}$

[c] repulsive and $\frac{q\lambda}{2\pi X\varepsilon_0}$ [d] repulsive and $\frac{2\,q\lambda}{\pi X\varepsilon_0}$

[4] An electric dipole consisting of charges + q and – q separated by a distance L is in stable equilibrium in a uniform electric field 'E'. The electrostatic potential energy of the dipole is

[a] q LE [b] zero [c] – q LE [d] – 2 q EL

[5] A charge Q is kept at the centre of a circle of radius r. A test charge q0 is carried from a point X to the point Y on this circle such that arc XY subtends an angle of 60° at the centre of the circle. The amount of work done in this process will be

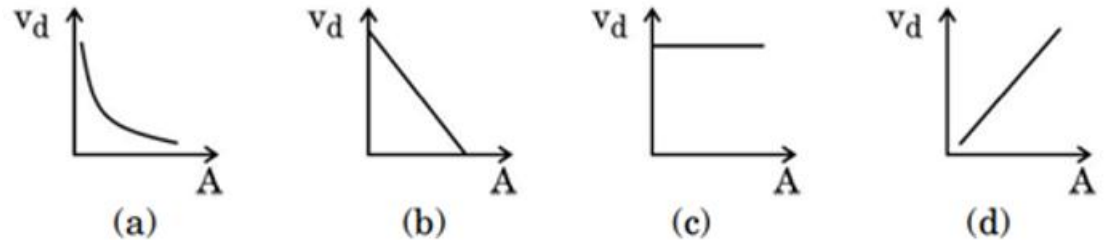
[a] $\frac{KQq_0}{2r}$ [b] $\frac{KQq_0}{r}$ [c] $\frac{Kq_0}{r}$ [d] Zero

[6] A hollow metal sphere of radius 20 cm is charged such that the potential on its surface is 30V. What is the [i]electric field at the centre[ii] potential at the centre?

[a] E = 3N/C ,V = 0V [b] E = 0 N/C , V = 30V

[c] E = 0 N/C ,V = 0V [d] E = 0, V = infinity

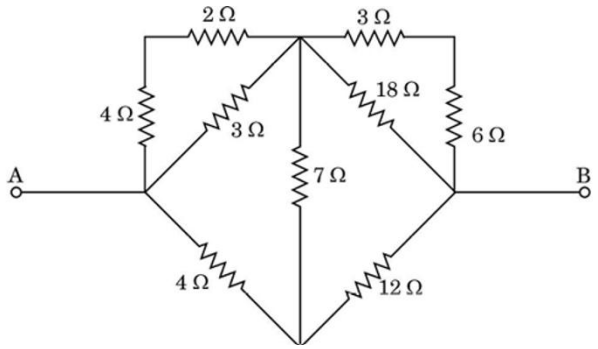
[7] A steady current flows through a metallic wire whose area of cross-section 'A' increases continuously from one end of the wire to the other. The magnitude of drift velocity 'Vd' of the free electrons as a function of area 'A' can be shown by:



[8] A constant voltage is applied between the two ends of a uniform metallic wire; heat 'H' is developed in it. If another wire of the same material, double the radius and twice the length as compared to the original wire is used, then the heat developed in it will be

[a] H/2 [b] H [c] 2H [d] 4H

[9] The effective resistance between points A and B in the given circuit is:



[a] 6 ohm [b] 8/3 ohm [c] 16/3 ohm [d] 2 ohm

[10] If the potential difference V applied across a conductor is increased to 2V with its temperature kept constant, the drift velocity of free electrons in a conductor

[a] remain the same [b] become half of its previous value

[c] be double of its initial value [d] become zero.

[11] Two wires of the same length are shaped into a square of side 'a' and a circle with radius 'r'. If they carry the same current , the ratio of their magnetic moment is

[a] $2:\pi$ [b] $\pi: 2$ [c] $\pi:4$ [d] $4:\pi$

[12] Substances which have permeability less than the permeability of free space are known as

[a] bipolar [b] ferromagnetic [c] paramagnetic [d] diamagnetic

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 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.

[13]**Assertion(A)** : Two electric bulbs of 50 and 100 Watt are given. When connected in series, 50 watt bulb glows more, but when connected in parallel 100 watt bulb glows more.

Reason(R): In series combination, power is directly proportional to the resistance of the circuit. But in a parallel combination, power is inversely proportional to the resistance of the circuit.

[14] **Assertion(A)** : At a higher temperature, ferromagnetic substance behaves as a paramagnetic substance.
Reason(R) : There is certain temperature called the Curie temperature upto which it behaves as a ferromagnetic.

[15] **Assertion(A)**: The Acceleration of a magnet falling through a copper ring decreases.
Reason(R): The induced current produced in a circuit always flows in such a direction that it opposes the change or cause that produces it.

[16] **Assertion(A)**: At resonance, the power factor of the LCR circuit is 1.
Reason(R): At resonance, both the voltage and current are in phase.

SECTION B [5 X2 = 10]

[17][I] Derive an expression for the capacitance of a parallel plate capacitor of area 'A' and 'd' as the separation of the sheets.

OR

[17] [II] Derive an expression to find the electrostatic potential energy for a system of 3 charges q1,q2 and q3 separated by a distance r12, r23 and r31, respectively.

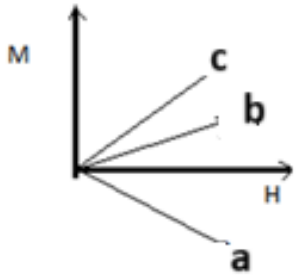
[18] Derive the mathematical relation for the resistivity of a material in terms of relaxation time and number density.

[19][I] Derive an expression to find the torque acting on a rectangular current loop kept in a uniform magnetic field of strength 'B'.

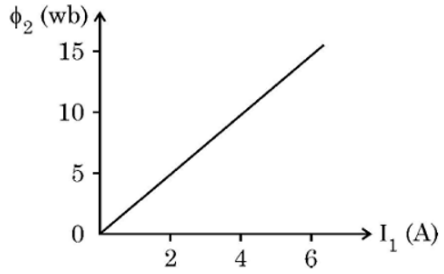
OR

[19][II] With the help of a labelled diagram, explain the working of a moving coil galvanometer and hence derive the relationship between the current and the deflection produced.

[20] The following fig. shows the variation of intensity of magnetization versus the applied magnetic field intensity H, for 3 magnetic materials: a','b' and 'c'.
[i] Identify the materials a' and 'b'.
[ii] Draw the variation of susceptibility with temperature for 'a'



[21] Two coils C1 and C2 are placed close to each other. The magnetic flux $\emptyset_2$ linked with the coil C2 varies with the current I_1 flowing in coil C1, as shown in the figure.



Find
[i] the mutual inductance of the arrangement
[ii] the rate of change of current $d[\frac{I_1}{dt}]$ that will induce an emf of 100V in coil C2.

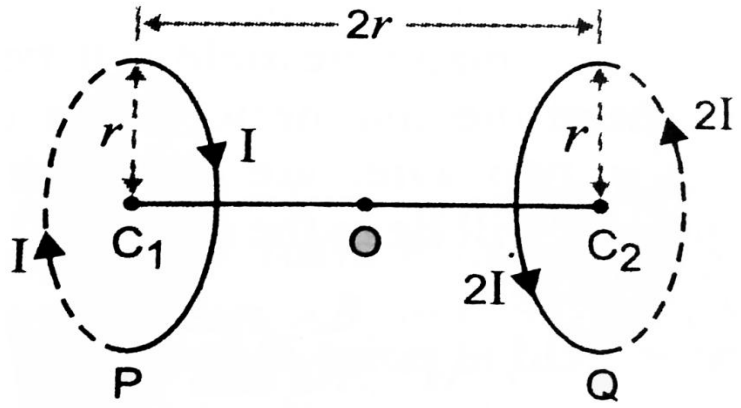
SECTION C [7 X3=21]

[22] Two isolated metallic spheres S1 and S2 of radii 1 cm and 3 cm, respectively, are charged such that both have the same surface charge density $\frac{2}{\pi}$ x10^{-9} $\frac{C}{m^2}$ .They are placed far away from each other and connected by a thin wire. Calculate the new charge on sphere S1.

[23] What is drift velocity? Derive an expression to find the relation between current I, area of the conductor 'A' and the drift velocity 'V'.

[24] To convert a given galvanometer into a voltmeter of ranges 2 V, V and V/2 , resistances R1, R2 and R3 ohms respectively, are required to be connected in series with the galvanometer. Obtain the relationship between R1, R2 and R3.

[25] Two identical circular loops, P and Q each of radius 'r' and carrying currents I and 2I respectively are lying in parallel planes such that they have a common axis. Their centres are distance 2r apart. The direction of current in both the loops is clockwise as seen from 'O' which is equidistant from both the loops. Find the magnitude of the net magnetic field at point 'O'



[26][I] Define coefficient of self induction of a coil . Derive the expression for self-inductance 'L' of a long solenoid of length $'\ell'$ and area of cross-section 'A'

OR

[26] [II] What is the basic principle of ac generator? With the help of a labelled diagram explain the construction and working of ac generator.

[27] An ideal inductor of 5/π H inductance is connected to a 200 V, 50 Hz ac supply. (a) Calculate the rms and peak value of current in the inductor. (b) What is the phase difference between the current through the inductor and the applied voltage? How will it change if a small resistance is connected in series with this inductor in the circuit?

[28] A 200 V variable frequency ac source is connected to a series combination of L = 5 H,

C = 80 μF and R = 40 ohm. Calculate (i) angular frequency 'ωo' of source to get the maximum current in the circuit, (ii) current amplitude at resonance and (iii) the power dissipation in the circuit.

SECTION D

[29] **CASE STUDY [4 marks]**

Faraday cages shield their contents from static electric fields. An electric field is a force field surrounding a charged particle, such as an electron or proton. These cages often look distinctly, well, cage like. Some are as simple as chain-link fences or ice pails. Others use a fine metallic mesh. Regardless of their exact appearance, all Faraday cages take electrostatic charges, or even certain types of electromagnetic radiation, and distribute them around the exterior of the cage.

Answer the following questions:

[1] Inside a Faraday Cage, which of the following are correct?

[a] electric field, E = 0, Potential V = 0

[b] electric field, E = E, Potential V = 0

[c] electric field, E = E, Potential V = variable

[d] electric field, E = 0, Potential V = constant

[2] A charge 'Q' is residing on the outer surface of a Faraday Cage of inner radius 'r1' and outer radius 'r2'. A charge 'q' is placed at the centre of the Cage, then its surface charge density on the inner surface is

[a] $\frac{+q}{4\pi r_1^2}$ [b] $\frac{-q}{4\pi r_1^2}$

[c] $\frac{Q-q}{4\pi r_1^2}$ [d] Zero

[3] A charge 'Q' is residing on the outer surface of a Faraday Cage of inner radius 'r1' and outer radius 'r2'. A charge 'q' is placed at the centre of the Cage, then its surface charge density on the outer surface is

[a] $\frac{+q}{4\pi r_2^2}$ [b] $\frac{-q}{4\pi r_2^2}$

[c] $\frac{Q+q}{4\pi r_2^2}$ [d] Zero

[4] An isolated point charge +q is placed inside the Faraday cage. Its surface must have a charge equal to-

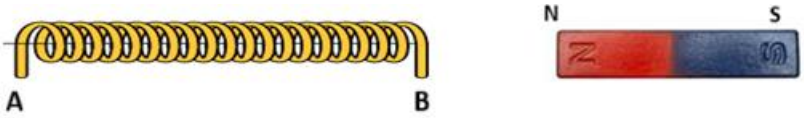
[a]Zero [b] +q

[c] –q [d]+2q

[30] **CASE STUDY[4 marks]**

Faraday's law of electromagnetic induction, also known as Faraday's law, is the basic law of electromagnetism which helps us to predict how a magnetic field would interact with an electric circuit to produce an electromotive force (EMF). This phenomenon is known as electromagnetic induction. The fig. given below shows Faraday's Experiment:

Fig.[a]



Answer the following questions:

[1] In the above figure [a], a magnet is moving into the coil to produce an electric current. What is the polarity of the end A of the coil?

[2] The current flowing through an inductor of self-inductance L is continuously increasing. Plot a graph showing the variation of Magnetic flux versus current

[3] State Lenz's law. "The Lenz's law is a consequence of the principle of conservation of energy." Justify this statement based on the above figure [a]

SECTION E[3x5 =15]

[31] [I] [a]Derive an expression to find the force between two current-carrying parallel conductors of infinite length, if both the currents I1 and I2 are in the same direction. Hence define 1 ampere.

[b]An alpha particle is projected with velocity $\vec{v}$ = [3 x10^5m/s]$\hat{\imath}$ into a region in which magnetic field $\vec{B}$ = [0.4T]$\hat{\imath}$ + [0.3T] $\hat{\jmath}$ 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 x 10^7C/kg.

OR

31[II] [a] Using Biot- Savart's law, derive an expression for the magnetic field at a distance 'r' from the centre of circular coil of number of turns 'N' , radius 'r' carrying a current 'I'.

[b] An electron revolves in a circular orbit of radius r with angular speed ω. Find the magnetic field at the centre of the electron orbit ?

[32][I] [i] What is mutual induction ?

[ii] Derive an expression. Find the mutual inductance of 2 coils , if I2 is the current flowing through the coil of radius r2 and number of turns N2.

[iii] When a current of 4A between two coils changes to 12A in 0.5s in primary coil, and induces an emf of 50mV in the secondary, calculate the mutual inductance between the two coils.

OR

[32][II][i] Derive an expression for the induced emf developed across a conductor of length L coil is rotated at a constant angular speed $'\omega'$ in a uniform magnetic field B.

[ii]A 0.1 m long conductor carrying a current of 50A is held perpendicular to a magnetic field of 1.25 x10^{-3}T. What is the mechanical power required to move the conductor with a speed of 1m/s ?

[33][I][i] Draw a schematic diagram of a step-up transformer. Explain its working principle. Deduce the expression for the secondary to primary voltage in terms of the number of turns in the two coils, and write the expression for the transformation ratio.

[ii] The primary coil of an ideal step-up transformer has 100 turns and transformation ratio is also 100. The input voltage and power are 220 V and 1100 W respectively. Calculate(a) the number of turns in the secondary coil (b) the current in the primary coil.

OR

[33][II] [i] A series LCR circuit is connected to an ac source having E = E_0 Sinωt. Using Phasor diagram, derive the expression for the peak value of current I_0 , the phase relationship between the applied voltage and the current, the expression for Impedance 'Z'

[ii] In a series LCR circuit with an AC source, R = 300 Ω, C = 20 μF, L = 1.0 henry, εrms = 50 V and ν = 50/π Hz. Find the rms current in the circuit.