# Indian School Al Wadi Al Kabir

## Assessment I (2024-2025)

Class: XII | Sub: Physics (042) | Max. Marks: 70

Date: 24/09/2024 | Set - I | 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 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 wherever necessary:

   $c = 3 \times 10^{8}\ ms^{-1}$

   $h = 6.626 \times 10^{-34} Js$

   $e = 1.602 \times 10^{-19}\ C$

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

   $\epsilon o = 8.854 \times 10^{-12}\ C^2N^{-1}m^{-2}$

   $\frac{1}{4\pi\epsilon 0} = 9 \times 10^{9}\ N\ m^2\ C^{-2}$

   $m_e = 9.1 \times 10^{-31} kg$

   $m_n = 1.675 \times 10^{-27} kg$

   $m_p = 1.673 \times 10^{-27}\ kg$

   Avogadro's number $N_A = 6.023 \times 10^{23}\ /mol^{-1}$

   Boltzmann Constant $= 1.38 \times 10^{-23}\ J/K$

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**SECTION- A (16 x 1 = 16)**

1. An object has charge of +1 C and gains $5.0 \times 10^{18}$ electrons. The net charge on the object becomes

   (a) - 0.80 C (b) +0.80 C (c) +1.80 C (d) +0.20 C

2. The magnitude of the electric field due to a point charged object at a point distance of 4.0 m is 9 N/C. From the same charged object, the electric field of magnitude, 16 N/C will be at a distance of

   (a) 1 m (b) 2m (c) 3m (d) 6m

3. A charge *Q* is placed at the centre of a cube. The flux of the electric field through the six surfaces of the cube is

   (a) $\frac{Q}{6\varepsilon_0}$ (b) $\frac{Q}{\varepsilon_0}$ (c) $\frac{Q}{6L^2}$ (d) $\frac{Q}{3L^2}$

4. A point charge P lies at a distance 'x' from the mid-point of an electric dipole on its axis, the electric potential at point P is proportional to

(a) $\frac{1}{x^2}$ (b) $\frac{1}{x^3}$ (c) $\frac{1}{x^4}$ (d) $\frac{1}{x^{1/2}}$

5. Three capacitors each of 4 μF are to be connected in such a way that the effective capacitance of the combination is 6 μF, this can be achieved by connecting,

(a) All three in parallel (b) All three in series
(c) Two in series and 1 in parallel (d) Two in parallel and 1 in series

6. How can you increase the capacity of a parallel plate capacitor?

(a) Decrease the area of the plate (b) Increase the area of the plate
(c) Increase the distance between the plate (d) None of the above

7. The SI unit of mobility of charge carriers is (V stands for voltage):

(a) $\Omega\ s^{-1}$ (b) $m^2\ V^{-1}\ s^{-1}$ (c) $m\ s^{-1}\ V^{-1}$ (d) $\Omega\ m$

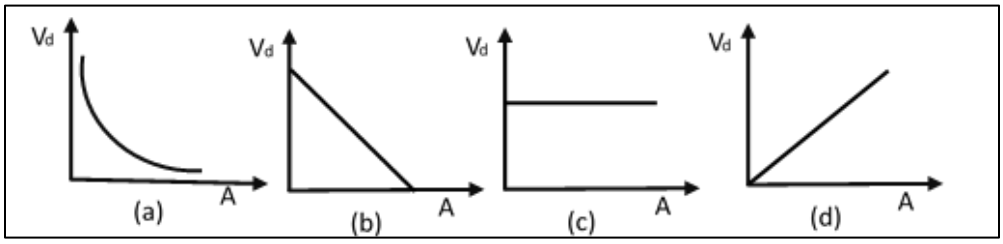
8. The conductivity of a metal decreases with the increase in temperature on account of

(a) decrease in number density of electrons. (b) decrease in resistivity.
(c) decrease in relaxation time. (d) increase in mean free path.

9. The emf and internal resistance of a cell are E and r respectively. It is connected across an external resistance R = 2r. The potential drop across the terminals of the cell will be:

(a) $\frac{E}{4}$ (b) $\frac{E}{2}$ (c) $\frac{2}{3}$E (d) $\frac{E}{3}$

10. 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 ($V_d$) of the free electrons as a function of 'A' can be shown by,




11. Two long parallel wires kept 2 m apart carry 3A current each, in the same direction. The force per unit length on one wire due to the other is

(a) $4.5 \times 10^{-5}\ Nm^{-1}$, attractive (b) $4.5 \times 10^{-7}\ Nm^{-1}$, repulsive
(c) $9 \times 10^{-7}\ Nm^{-1}$, repulsive (d) $9 \times 10^{-7}\ Nm^{-1}$, attractive

12. The magnetic susceptibility for a diamagnetic material is

(a) small and negative. (b) small and positive.
(c) large and negative. (d) large and positive.

**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) If both Assertion and Reason are true and Reason is correct explanation of Assertion.**
**(B) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.**
**(C) If Assertion is true but Reason is false.**
**(D) If both Assertion and Reason are false.**

13. **Assertion (A):** The internal resistance of a cell is constant.
**Reason (R):** Ionic concentration of the electrolyte remains same during the use of a cell.

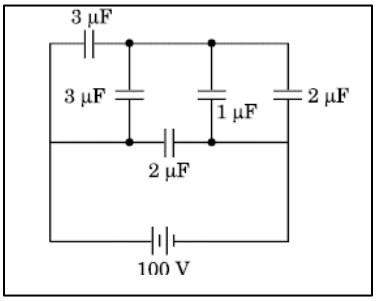
14. **Assertion (A):** When a bar of copper is placed in an external magnetic field, the field lines get concentrated inside the bar.
**Reason (R):** Copper is a paramagnetic substance.

15. **Assertion (A):** The mutual inductance between two coils is maximum when the coils are wound on each other.
**Reason (R):** The flux linkage between two coils is maximum when they are wound on each other.

16. **Assertion(A):** A transformer cannot work on direct current supply.
**Reason(R):** Direct current changes neither in magnitude nor in direction.

## SECTION B (5 × 2 = 10)

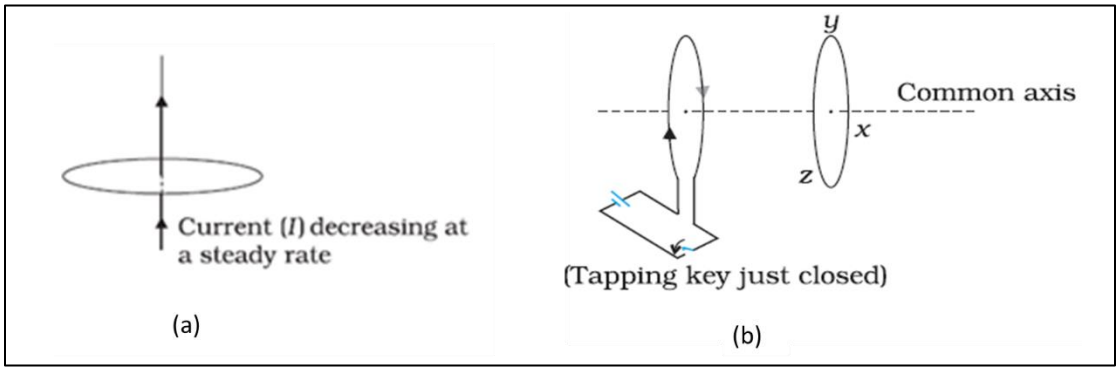
17. The figure shows a network of five capacitors connected to a 100 V supply. Calculate the total energy stored in the network.




18. Define the term 'mobility' of charge carriers in a current carrying conductor. Obtain the relation for mobility in terms of relaxation time.

19. Define magnetic permeability and magnetic susceptibility. Hence, write the relation between the two.

20. Predict the direction of induced current in the situations described by the following figures.



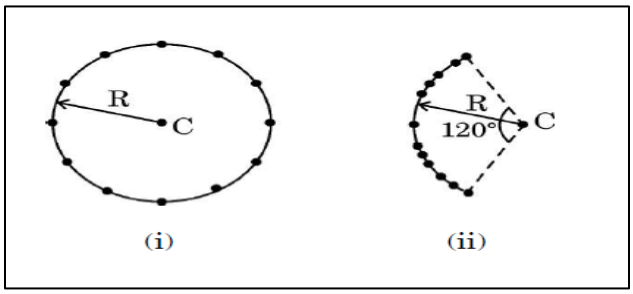
**OR**

Current in a circuit falls from 5.0 A to 0.0 A in 0.1 s. If an average emf of 200 V is induced, give an estimate of the self-inductance of the circuit.

21. A charged 30 μF capacitor is connected to a 27 mH inductor. What is the angular frequency of free oscillations of the circuit?

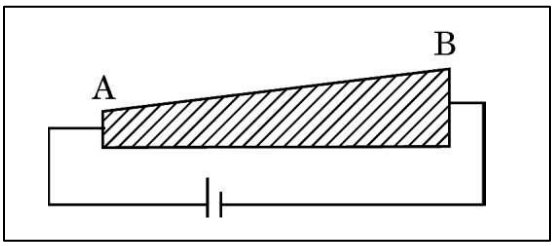
**SECTION C (7 × 3 = 21)**

22. (a) Twelve negative charges of same magnitude 'q' are equally spaced and fixed on the circumference of a circle of radius R as shown in Fig. (i). Relative to potential being zero at infinity, find the electric potential and electric field at the centre C of the circle.




(b) If the charges are unequally spaced and fixed on an arc of 120° of radius R as shown in Fig. (ii), find electric potential at the centre C.

23. (i) Define drift velocity of an electron across a conductor.
(ii) A steady current flow through a wire AB, as shown in the figure. What happens to the electric field and the drift velocity along the wire? Justify your answer.




24. (i) Define voltage sensitivity of a galvanometer.
(ii) A galvanometer of resistance 16 Ω shows full scale deflection for a current of 4 mA. How will you convert it into a voltmeter to measure a voltage up to 3 V?

25. Define self-inductance of a coil. Write SI unit and dimension of co-efficient of self-induction. Depict expression for self-inductance of a long solenoid.

**OR**

A rectangular wire loop of sides 8 cm and 2 cm with a small cut is moving out of a region of uniform magnetic field of magnitude 0.3 T directed normal to the loop. What is the emf developed across the cut if the velocity of the loop is 1 cm $s^{-1}$ in a direction normal to the (a) longer side, (b) shorter side of the loop? For how long does the induced voltage last in each case?

26. A circular loop of radius R carries a current I. Obtain an expression for the magnetic field at a point on its axis at a distance 'x' from its centre.

27. (i) You are given three circuit elements, X, Y and Z. They are connected one by one across a given ac source. It is found that V and I are in same phase for element X. V leads I by ( Π/4 ) for element Y, while I leads V by ( Π/4) for element Z, identify elements X, Y and Z.
(ii) What is wattless current?

28. What is a transformer? Discuss the four main causes of energy loss in a real transformer and write the way to minimise these losses.

**SECTION D (2 × 4 = 8 marks)**

29. When a current 'I' flows through a coil, flux linked with it is φ = LI, where L is a constant known as self-inductance of the coil. Any change in current sets up an induced emf in the coil. Thus, self-inductance of a coil is the induced emf set up in it when the current passing through it changes at the unit rate. It is a measure of the opposition to the growth or the decay of current flowing through the coil. Also, value of self-inductance depends on the number of turns in the solenoid, its area of cross-section and the permeability of its core material.

**Answer the following questions.**

(i) The inductance in a coil plays the same role as
(a) inertia in mechanics. (b) energy in mechanics.
(c) momentum in mechanics. (d) force in mechanics.

(ii) A current of 2.5 A flows through a coil of inductance 5 H. The magnetic flux linked with the coil is
(a) 0.5 Wb (b) 12.5 Wb (c) zero (d) 2 Wb

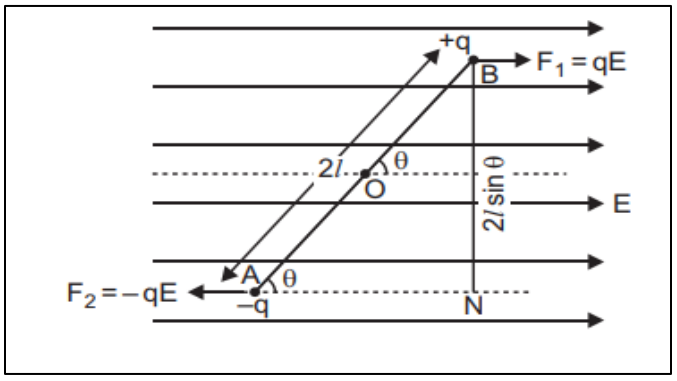
(iii) The inductance L of a solenoid depends upon its radius R as
(a) $L \propto R$ (b) $L \propto 1/R$ (c) $L \propto R^2$ (d) $L \propto R^3$

(iv) The unit of self-inductance is
(a) Weber ampere (b) $Weber^{-1}$ ampere (c) Ohm second (d) Farad

**OR**

(iv) The induced emf in a coil of 10 Henry inductance in which current varies from 9 A to 4 A in 0.2 second is
(a) 200 V (b) 250 V (c) 300 V (d) 350 V

30. When electric dipole is placed in uniform electric field, its two charges experience equal and opposite forces, which cancel each other and hence net force on electric dipole in uniform electric field is zero. However, these forces are not collinear, so they give rise to some torque on the dipole. Since net force on electric dipole in uniform electric field is zero, no work is done in moving the electric dipole in uniform electric field. However, some work is done in rotating the dipole against the torque acting on it.



**Answer the following questions.**

(i) The dipole moment of a dipole in a uniform external field is $\vec{E}$ is $\vec{p}$. Then the torque τ acting on the dipole is

(a) $\tau = \vec{p} \times \vec{E}$ (b) $\tau = \vec{p} \cdot \vec{E}$ (c) $\tau = 2(\vec{p} + \vec{E})$ (d) $\tau = (\vec{p} + \vec{E})$

(ii) An electric dipole consists of two opposite charges, each of magnitude 1.0 μC separated by a distance of 2.0 cm. The dipole is placed in an external field of $10^5$ $NC^{-1}$. The maximum torque on the dipole is

(a) $0.2 \times 10^{-3}$ Nm (b) $1 \times 10^{-3}$ Nm (c) $2 \times 10^{-3}$ Nm (d) $4 \times 10^{-3}$ Nm

(iii) Torque on a dipole in uniform electric field is minimum when θ is equal to

(a) 0° (b) 90° (c) 180° (d) Both (a) and (c)

(iv) When an electric dipole is held at an angle in a uniform electric field, the net force F and torque τ on the dipole are

(a) F= 0, τ = 0 (b) F≠0, τ≠0 (c) F=0, τ ≠ 0 (d) F≠0, τ=0

**OR**

(iv) Which of the following properties is not satisfied by an electric charge?

(a) Total charge conservation. (b) Quantization of charge.
(c) Two types of charge. (d) Decay of charge.

**SECTION E (3 × 5 = 15)**

31. (i) Derive the expression for the torque acting on the rectangular current carrying coil placed in a magnetic field.

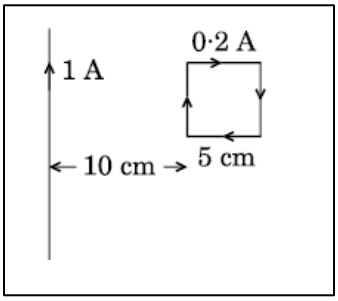
(ii) Why is the magnetic field made radial in a galvanometer?

(iii) A square coil of side 10 cm consists of 20 turns and carries a current of 12 A. The coil is suspended vertically and the normal to the plane of the coil makes an angle of 30° with the direction of a uniform horizontal magnetic field of magnitude 0.80 T. What is the magnitude of torque experienced by the coil?

**OR**

(i) Derive the expression for the force acting between two long parallel current carrying conductors. Hence, define 1 A current.

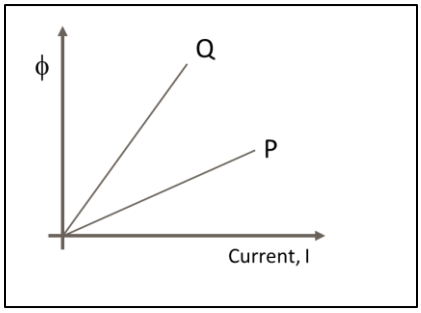
(ii) A square loop of sides 5 cm carrying a current of 0.2 A in the clockwise direction is placed at a distance of 10 cm from an infinitely long wire carrying a current of 1 A as shown. Calculate (a) the resultant magnetic force, and (b) the torque, if any, acting on the loop.



32. (i) Define mutual inductance and write its SI unit.

(ii) Derive an expression for the mutual inductance of two long co-axial solenoids of same length wound one over the other.

(iii) The given graph shows a plot of magnetic flux(φ) and the electric current(I) following through two inductors P and Q. Which of the two inductors has smaller value of self-inductance?




**OR**

(i) What is impedance?

(ii) In a series LCR circuit with an ac source of effective voltage 50 V, frequency $\nu = 50/\pi$ Hz, R = 300 Ω, C = 20 μF and L = 1.0 H. Find the rms current in the circuit.

(iii) A series LCR circuit is connected to an ac source having voltage $V = V_0 \sin\omega t$. Find the expression for resonant frequency.

33. (i) State Faraday's both laws of electromagnetic induction.

(ii) Explain, with the help of a suitable example, that Lenz's law is consequence of the principle of conservation of energy.

(iii) A circular coil of radius 8.0 cm and 20 turns is rotated about its vertical diameter with an angular speed of 50 rad $s^{-1}$ in a uniform horizontal magnetic field of magnitude $3.0 \times 10^{-2}$ T. Obtain the maximum and average emf induced in the coil. If the coil forms a closed loop of resistance 10 Ω, calculate the maximum value of current in the coil. Calculate the average power loss due to Joule heating. Where does this power come from?

**OR**

(i) Describe briefly with the help of a labelled diagram the basic elements of an AC generator. State its underlying principle.

(ii) The magnetic field through a circular loop of wire 12 cm in radius and 8.5 Ω resistance, changes with time as shown in the figure. The magnetic field is perpendicular to the plane of the loop. Calculate the induced current in the loop and plot it as a function of time.