विद्या सर्वार्थि साधिका

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PERIODIC TEST - 2

Class: XII

Subject: Physics (042) MM : 70

Date : 10-09-2025 Time: 3 Hr

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. 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.
4. 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.
5. Use of calculators is not allowed.

SECTION A

1. The line integral $\oint \vec{B} \cdot \overrightarrow{dl}$ around a closed loop is proportional to _____. (1)
   (A) magnetic flux through the surface (B) current enclosed by the loop
   (C) electric flux through the surface (D) rate of change of flux

2. In a series LCR circuit, the impedance is minimum when _____. (1)
   (A) $\omega L = \frac{1}{\omega C}$ (B) $\omega L > \frac{1}{\omega C}$ (C) $\omega L < \frac{1}{\omega C}$ (D) Resistance = 0

3. A resistor 100 ohm is connected across an AC source of 200 V, 50 Hz. Calculate the peak value of current? (1)
   (A) 2.83 A (B) 2 A (C) 100 A (D) 0.5 A

4. The power factor of a series LCR circuit at resonance is _____. (1)
   (A) 0 (B) 0.5 (C) 1 (D) Infinity

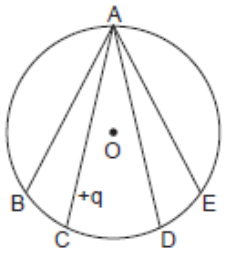
5. If copper wire is stretched to make its radius decrease by 0.1%, then the percentage change in its resistance is approximately _____. (1)
   (A) –0.4% (B) +0.8% (C) +0.4% (D) +0.2%

6. A cylindrical gaussian surface of radius R and length L is placed in a uniform electric field E parallel to the cylinder axis. The total flux passing through the surface of the cylinder is ____. (1)
   (A) $2\pi R^2 E$ (B) πR^2 (C) $\frac{\pi R^2 - \pi R}{E}$ (D) zero

7. Two charged spheres A and B having their radii in the ratio 1 : 2 are connected together with a conducting wire. The ratio of their surface charge densities will be _____. (1)
   (A) $\frac{1}{2}$ (B) 2 (C) $\frac{1}{4}$ (D) 4

8. A capacitor is charged by a battery. The battery is removed and another identical uncharged capacitor is connected in parallel. The total electrostatic energy of resulting system _____. (1)
   (A) increases by a factor of 4 (B) decreases by a factor of 2.
   (C) remains the same (D) increases by a factor of 2.

9. In the electric field of a point charge q placed at O, a certain charge is carried from point A to B, C, D and E. Then the work done _____. (1)



(A) is least along the path AB (B) is least along the path AD
(C) is zero along all the paths AB, AC, AD and AE (D) is least along AE.

10. What is the dimensional formula of magnetisation? (1)
(A) [AL] (B) $[L^{-1}A]$ (C) $[L^{-1}TA]$ $[L^{-1}A^{-1}]$

11. A circular current carrying coil produces a magnetic field B_0 at its centre. The coil is rewound so as to have number of turns three times and the same current is passed through it. The new magnetic field at the centre is _____. (1)
(A) $3B_0$ (B) $\frac{B_0}{3}$ (C) $\frac{B_0}{9}$ (D) $9B_0$

12. In a coil of self-inductance 5 H, the rate of change of current is 2 As^{-1}. Then emf induced in the coil is _____. (1)
(A) 10 V (B) – 10 V (C) 5 V (D) – 5 V

For question numbers 13 and 16, select the correct answer from the codes (A), (B), (C) and (D) as given below.
(A) Both (A) and (R) are true and (R) is the correct explanation of (A).
(B) Both (A) and (R) are true but (R) is NOT the correct explanation of (A).
(C) (A) is true but (R) is false
(D) (A) is false and (R) is true.

13. A: A current carrying coil experiences a net force and a net torque when placed in a uniform magnetic field. (1)
R: Torque arises due to equal and opposite forces acting on the parallel arms of the coil, producing a couple.

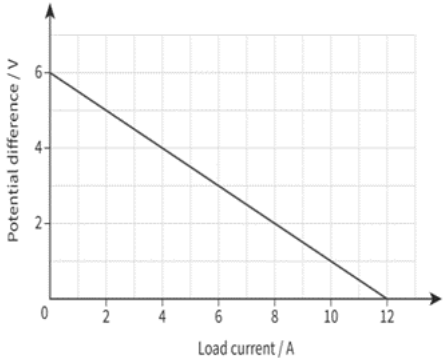
14. A: Kirchhoff's Current Law is applicable at a junction in an electric circuit. (1)
R**:** This is due to conservation of charge

15. A: If electric field at a point is equal to zero, the electric potential at that point must also be zero. (1)
R: Inside a charged conducting sphere, E = 0.

16. A: The properties of paramagnetic and ferromagnetic substances are not affected by heating. (1)
R: As temperature decreases, the alignment of molecular magnets gradually decreases.

SECTION B

17. The following graph shows the potential difference across the terminals of a cell against its load current. (2)



Find, (i) the emf of the cell and (ii) the internal resistance of the cell.

18. Show that the electric field at the surface of a charged conductor is given by $\vec{E} = \frac{\sigma}{\varepsilon_0}\hat{n}$, where σ is the surface charge density and $\hat{n}$ is a unit vector normal to the surface in the outward direction. (2)

19. A slab of material of dielectric constant K has the same area as the plates of a parallel plate capacitor but has thickness $\frac{d}{2}$, where *d* is the separation between the plates. Find the expression for the capacitance when the slab is inserted between the plates. (2)

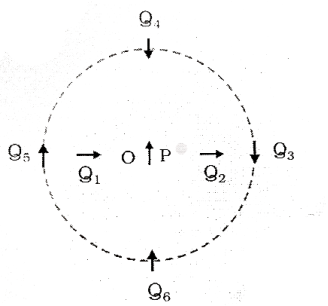
20. 

Figure shows a small magnetised needle P placed at a point O. The arrow shows the direction of its magnetic moment. The other arrows show different positions (and orientations of the magnetic moment) of another identical magnetised needle Q. (2)
(a) In which configuration the system is not in equilibrium?
(b) In which configuration is the system in (i) stable and (ii) unstable equilibrium (write one each)?

21. Four point-charges of 1μC, -2μC, 1μC and -2μC are placed at the corners A, B, C and D respectively of a square of side 30 cm. Find the electrostatic force acting on a charge 4μC placed at the centre of square. (2)

OR

Three point-charges 1 pC each are kept at the vertices of a equilateral triangle of side 10 cm. Find the net electric field at the centroid of the triangle.

SECTION C

22. When a circuit element X is connected across an AC source, a current of √2A flows through it and this current is in phase with the applied voltage. When another element Y is connected across the same AC source, the same current flows in the circuit but it leads the voltage by π/2 radians. (3)
(a) Identify the elements X and Y.
(b) Find the current in the circuit when the series combination of X and Y is connected across the same AC voltage.

23. Draw the Wheatstone bridge circuit. Obtain the balance condition of Wheatstone bridge. (3)

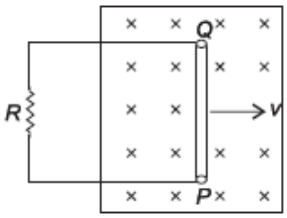
24. (a) The electric field induced in a dielectric when placed in an external field is $\frac{1}{10}$ times the external field. Calculate relative permittivity of the dielectric. (3)
(b) The sum of two point-charges is 7 μC. They repel each other with a force of 1 N when kept 30 cm apart in free space. Calculate the value of each charge.

25. (a) Show diagrammatically the orientation of the dipole in the field for which the torque is (i) maximum and (ii) half the maximum value. (3)
(b) An electric dipole is free to move in a uniform electric field. Explain its motion when it is placed (i) parallel to the field, and (ii) perpendicular to the field.

26. (a) Depict the equipotential surfaces for a system of two identical positive point charges placed at a distance *d* apart. (3)
(b) Deduce the expression for the potential energy of a system of two point-charges q_1 and q_2 brought from infinity to the points r_1 and r_2 respectively in the presence of external electric field $\vec{E}$.

27. Two long straight thin wires AB and CD have linear charge densities 10 μC/m and -20μC/m respectively. They are kept parallel to each other at a distance of 1 m. Find the magnitude and direction of net electric field at a point midway between them. (3)

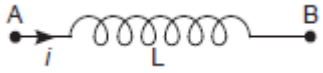
28. A conducting rod, PQ, of length l, connected to a resistor R, is moved at a uniform speed, v, normal to a uniform magnetic field, B, as shown in the figure.



(i) Deduce the expression for the emf induced in the conductor. (3)
(ii) Find the force required to move the rod in the magnetic field.
(iii) Mark the direction of induced current in the conductor.

SECTION D

29. An inductor is simply a coil or a solenoid that has a fixed inductance. It is referred to as a choke. The usual circuit notation for an inductor is as shown. (4)



Let the current '*i*' flows through the inductor from A to B. Whenever electric current changes through it, a back emf is generated. If the resistance of inductor is assumed to be zero (ideal inductor) then induced emf in it is given by

$$e = V_B - V_A = -L\frac{dI}{dt}$$

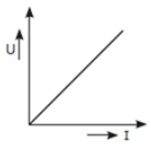
Thus, potential drops across an inductor as we move in the direction of current. But potential also drops across a pure resistor when we move in the direction of the current.
The main difference between a resistor and an inductor is that while a resistor opposes the current through it, an inductor opposes the change in current through it.
Now, answer the following questions:

(i) How does the inductor behave when a steady current flow through it?
(A) It behaves like a perfect conductor. (B) It behaves like an insulator.
(C) It behaves like a semiconductor. (D) It behaves like a capacitor

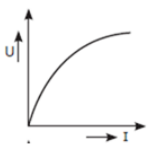
(ii) If the current through the solenoid decreases, then
(A) emf induced is equal to zero.
(B) current induced is in the direction from B to A.
(C) current is induced in the direction A to B.
(D) current remains constant

(iii) If the number of turns of the solenoid is doubled, then self-inductance of solenoid becomes _____ times.
(A) 4 (B) 2 (C) ½ (D) ¼

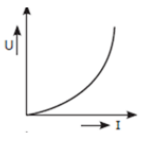
(iv) (A) If an electric current I flows through the solenoid, then the magnetic energy stored in it varies with current as _____.



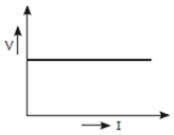
(A)



(B)



(C)



(D)

OR

(iv) (B) If a soft iron core is inserted in the solenoid, which is connected to an AC source, then the energy stored in solenoid _____.
(A) increases (B) decreases (C) remains constant (D) becomes zero

30. A moving coil galvanometer is used to detect a very small current in a circuit. The galvanometer consists of a coil, with many turns, free to rotate about a fixed axis, in a uniform radial magnetic field. There is a cylindrical soft iron core which not only makes the field radial but also increases the strength of the magnetic field. (4)

The current sensitivity of the galvanometer is given by the expression $\frac{\phi}{I} = \frac{NAB}{k}$.

The galvanometer is not used for measuring current. To measure current, we have to convert the galvanometer to withstand high current. We can also convert galvanometer into a voltmeter.

(i) Define voltage sensitivity of a galvanometer.

(ii) How can a galvanometer be converted into an ammeter?

(iii) (a) A galvanometer has resistance 50 Ω and gives full-scale deflection for Ig = 2 mA. How can it be converted into an ammeter of range 5 A?

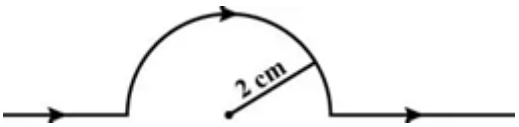
OR

(iii) (b) The current sensitivity of a galvanometer is increased by increasing the number of turns of the coil. Will the voltage sensitivity also increase? Explain.

SECTION E

31. State Biot – Savart Law. A circular coil of radius R and of N turns is carrying a current I. Derive the expression for the magnetic field at its centre. (5)

A straight wire carrying a current of 12 A is bent into a semi-circular arc of radius 2.0 cm as shown in figure. Calculate the magnetic field B at the centre of the arc.



OR

(a) State Lorentz force in magnetism.

(b) Describe the motion of a charged particle in a uniform magnetic field if:

(i) velocity is perpendicular to the field,

(ii) velocity is parallel to the field,

(iii) velocity is at an angle θ to the field where $0 < \theta < 90°$

(c) Derive the expression for the radius of the circular path of a charge q moving perpendicular to a magnetic field B with a velocity v.

32. (a) Draw the phasor diagram of a series LCR ac circuit. (5)

(b) From the phasor diagram obtain the impedance and phase difference between current and voltage in the circuit

(c) A series LCR circuit has L=2 H, C=50 μF, R=20 Ω
Find: (i) resonant frequency ω_0 and (ii) impedance at resonance.

OR

(a) State the underlying principle of a transformer.

(b) Obtain the expression for the ratio of secondary to primary voltage in terms of the number of secondary and primary windings and primary and secondary currents.

(c) What are the causes for energy loss in an actual transformer?

33. (a) What is drift velocity? Give the relation between the current through a wire and the drift velocity. Obtain the expression for the resistivity using the concept of drift velocity? (5)

(b) A copper wire of cross-sectional area 1 mm^2 carries a current of 3A. If number density of electrons in copper is $8.5 \times 10^{28}\ m^{-3}$, calculate the drift velocity. (Take e = 1.6×10^{-19} C).

(c) Explain why electrons, though moving very slowly (mm/s), can make an electric bulb glow almost instantly when the switch is turned on.

OR

(a) Obtain the electric potential due to a small electric dipole at points making an angle θ with its dipole moment $\vec{p}$.

(b) Charges (+q) and (–q) are placed at the points A and B respectively which are a distance 2L apart. C is the midpoint between A and B. What is the work done in moving a charge +Q along the semicircle CRD?