विद्या सर्वार्थि साधिका

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PERIODIC TEST -2

Class: XII

Subject: Physics (042) MM : 70

Date : 30-09-2024 Time: 3 Hrs

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 consists of sixteen MCQs of 1 mark each, Section B consists of five very short answer type questions of 2 marks each, Section C consists of seven short answer type questions of 3 marks each, Section D consists of three long answer type questions of 5 marks each and Section E consists two case study-based questions of 4 marks each.
4. There is no overall choice. However, an internal choice has been provided in section D and E. You have to attempt only one of the choices in such questions.
5. Use of calculators is not allowed.

SECTION A

1. A body contains n_1 electrons and n_2 protons, the total amount of charge on the body is _____. (1)
   (A) $(n_1+ n_2)$ e (B) $(n_1- n_2)$ e (C) $(n_2 - n_1)$ e (D) $(n_1 \times n_2)$ e

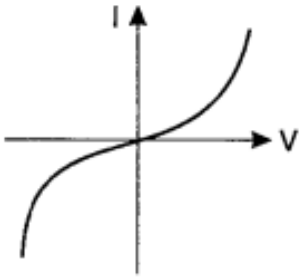
2. Calculate the potential at a point P due to a charge of 4×10^{-7}C located 9 cm away. (1)
   (A) $4 \times 10^4 V$ (B) $3.6 \times 10^4\ V$ (C) $2.5 \times 10^4\ V$ (D) 4×10^3 V

3. A small electric dipole has a dipole moment p. What will be the ratio between the potential at a point along the equatorial line at a distance *x* and that on the axial line at the same distance? (1)
   (A) 2 (B) -2 (C) zero (D) ½

4. An electron is accelerated through a potential difference of 100 V. What will be the change in its kinetic energy? (The charge on an electron = 1.6×10^{-19} C) (1)
   (A) 100 eV (B) 1.6×10^{-17} eV (C) 1.6×10^{-19} J (D) 100 J

5. In a Wheatstone bridge if the battery and galvanometer are interchanged, then the deflection in galvanometer will _____. (1)
   (A) change in previous direction (B) not change
   (C) change in opposite direction (D) be more than the previous value

6. The I-V characteristics shown in figure represents _____. (1)



   (A) ohmic conductors
   (B) non-ohmic conductors
   (C) insulators
   (D) superconductors

7. Two concentric and coplanar circular loops P and Q have their radii in the ratio 2:3. Loop Q carries a current 9A in the anticlockwise direction. For the magnetic field to be zero at the common centre, loop P must carry _____. (1)
   (A) 3A in clockwise direction (B) 9A in clockwise direction
   (C) 6A in anti-clockwise direction (D) 6A in the clockwise direction.

8. Susceptibility is positive for _____. (1)
(A) Ferromagnetic material (B) Paramagnetic material
(C) Diamagnetic material (D) Option (a) and (b)

9. Which of the following factors is the self inductance associated with a coil independent of? (1)
(A) Number of turns (B) Current (C) Area (D) Nature of core

10. A circular coil expands radially in a region of magnetic field and no electromotive force is produced in the coil. This can be because _____. (1)
(A) the magnetic field is constant.
(B) the magnetic field is in the same plane as the circular coil and it may or may not vary.
(C) the magnetic field is decreasing and is perpendicular (to the plane of the coil).
(D) there is a constant magnetic field in the perpendicular (to the plane of the coil) direction

11. In an alternating current circuit consisting of elements in series, the current increases on increasing the frequency of supply. Which of the following elements are likely to constitute the circuit? (1)
(A) Only resistor. (B) Resistor and an inductor.
(C) Resistor and a capacitor. (D) Only an inductor.

12. The output of a step-down transformer is measured to be 24 V when connected to a 12-watt light bulb. The value of the peak current is _____. (1)
(A) $\frac{1}{\sqrt{2}}$ A (B) $\sqrt{2}$ A (C) 2 A (D) $2\sqrt{2}$ A

For question numbers 13to 16, select the correct answer to these questions of Assertion (A) and Reason (R) 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 also false.

13. (A): Two electric field lines would never cross each other. (1)
(R): Electric field is a vector quantity and net electric field at a point is the vector addition of electric fields due to all charges.

14. (A): The path of a charged particle moving perpendicular to a uniform magnetic field is a helical path. (1)
(R): The Lorentz force acting a charged particle in a magnetic field is always parallel to its velocity.

15. (A): Magnetic field lines inside a bar magnet travel from the south pole to the north pole. (1)
(R): Magnetic field lines always form closed loops and have a direction from the north pole to the south pole outside the magnet.

16. (A): A step up transformer works on the principle of mutual induction. (1)
(R): Transformer works with any current, AC or DC, as long as the magnetic field is linked with the coils.

SECTION B

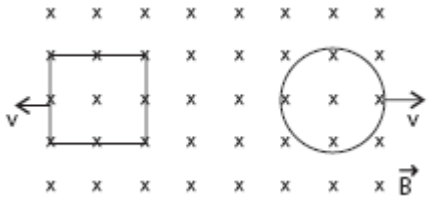
17. (a) Define the term 'electric flux'. Write its SI units. (2)
(b) What is the electric flux due to electric field $\vec{E} = 3 \times 10^3 \hat{\imath}$ N/C through a square of side 10 cm, when it is held normal to$\vec{E}$?

18 Derive the equation of the balanced state in a Wheatstone bridge using Kirchhoff's laws. (2)

19. Write the expression for the equivalent magnetic moment of a planar current loop of area A, having N turns and carrying a current I. Use the expression to find the magnetic dipole moment of a revolving electron. (2)

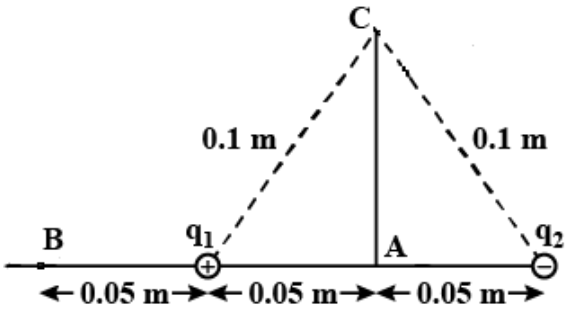
20. Show diagrammatically the behaviour of magnetic field lines in the presence of (i) paramagnetic and (ii) diamagnetic substances. How does one explain this distinguishing feature? (2)

21. A rectangular loop and a circular loop are moving out of a uniform magnetic field to a field-free region with a constant velocity v as shown in the figure. Explain in which loop do you expect the induced emf to be constant during the passage out of the field region. Also write the direction of induced current in each case. The magnetic field is normal to the loops. (2)



SECTION C

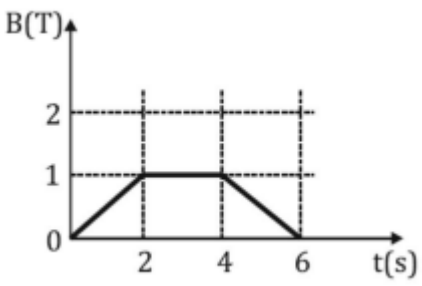
22. Two point charges q_1 and q_2, of magnitude $+10^{-8}$ C and -10^{-8} C, respectively, are placed 0.1 m apart. Calculate the electric fields at points A, B and C shown in the figure. (3)



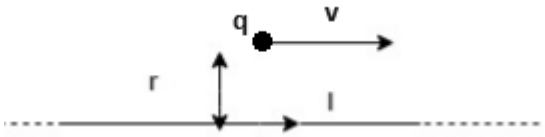
23. An electric dipole of dipole moment $\vec{p}$ is placed in a uniform electric field $\vec{E}$ at an angle θ with the electric field. Show that the potential energy of the electric dipole $U = -pE\cos\theta$. (3)

24. A conducting sphere of radius 10cm is charged to 5μC. Answer the following questions giving reasons. (3)
(a) What is the electric field inside the conductor at a distance of 5cm from the centre?
(b) What is the magnitude and direction the electric field on the surface of the sphere?
(c) What is the potential at a point inside the sphere?

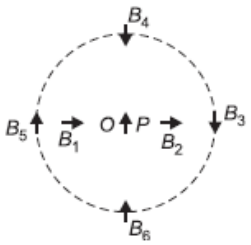
25. The magnetic field through a circular loop of wire, 12cm in radius and 8.5Ω resistance, changes with time as shown in the figure. The magnetic field is perpendicular to the plane of the loop. Calculate the current induced in the loop and plot a graph showing induced current as a function of time. (3)



26. A particle of mass m and positive charge q is in motion at speed v parallel to a long straight conductor carrying current I as shown below. Find magnitude and direction of electric field required so that the particle goes undeflected. (3)



27. The given 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 magentised needle *B*. (3)



(a) In which configuration the system is not in equilibrium?
(b) In which configuration is the system in (i) stable, and (ii) unstable equilibrium?
(c) Which configuration corresponds to the lowest potential energy among all the configurations shown?

28. A series *LCR* circuit is connected to an AC source. Using the phasor diagram, derive the expressions for the impedance of the circuit and phase difference between current and voltage. Plot a graph to show the variation of current with frequency of the source. (3)

SECTION D

29. (a) State Gauss law in electrostatics. (5)
(b) Derive the expression for the electric field at a point due to an infinitely long line charge of linear charge density λ.
(b) An infinitely long line charge with charge density 10^{-6} C/m is enclosed with a cylindrical gaussian surface of radius 10 cm and height 0.5 m. Calculate the electric flux passing through the cylindrical surface.

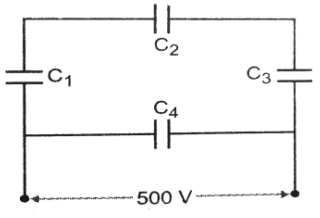
OR

(a) Define electric dipole moment. What is the direction of electric dipole moment?
(b) An electric dipole has charges ±Q separated by a distance 2d. Obtain the electric field at a point on the equatorial plane of the electric dipole. Express the same for a small dipole of dipole moment $\vec{p}$.

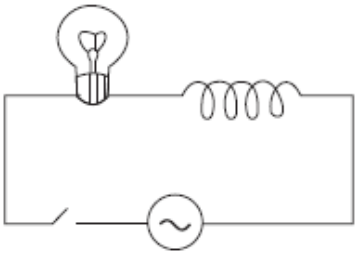
30. (a) Define capacitance. (5)
(b) A parallel plate capacitor has plate area A and the distance between them is d. Derive the expression for the capacitance of the parallel plate capacitor.
(c) A parallel plate capacitor has distance between the plates as 1 cm. Estimate the area of the plates if the capacitance is 1 F. Compare this area with a rectangle of length 40 km and breadth 30 km. Take ε_0 as 8.0×10^{-12} $C^2N^{-1}m^{-2}$.

OR

(a) Derive the equivalent capacitance of three capacitors C_1, C_2 and C_3 are connected in series when they are connected in series.
(b) A network of four 10μF capacitors is connected to a 500 V supply, as shown in figure. Determine (a) the equivalent capacitance of the network and (b) the charge on each capacitor.



31. (a) A light bulb and an open coil inductor are connected to an AC source through a key as shown in the figure. The switch is closed and after sometime, an iron rod is inserted into the interior of the inductor. What changes would be observed in the glow of the light bulb as the iron rod is inserted. Give your answer with reason. What will be your answer if AC source is replaced by a DC source? (5)



(b) A voltage $V = V_0 \sin \omega t$ is applied to a series *LCR* circuit. Derive the expression for the average power dissipated over a cycle. Under what condition is (i) no power dissipated even though the current flows through the circuit, (ii) maximum power dissipated in the circuit?

OR

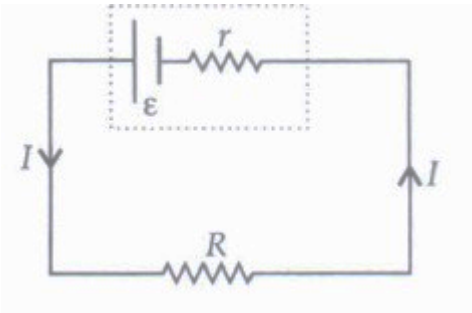
(a) A coil of N turns and area A is rotated in a uniform electric field B with an angular speed of ω. Derive the instantaneous value of induced emf in the coil.

(b) A circular coil of radius 8.0 cm and 20 turns is rotated about its vertical diameter with an angular speed of 50rad/s in a uniform horizontal magnetic field of magnitude 3.0×10^{-2} T. Obtain the maximum and average induced emf in the coil. If the coil forms a closed loop of resistance 10 ohm, calculate the maximum value of the current in the coil.

SECTION E

Question nos 32 and 33 are case study-based questions.

32. Emf of a cell is the maximum potential difference between two electrodes of the cell when no current is drawn from the cell. Internal resistance is the resistance offered by the electrolyte of a cell when the electric current flows through it. The internal resistance of a cell depends upon the factors such as distance between the electrodes, nature and temperature of the electrolyte, nature of electrodes and area of electrodes



For a freshly prepared cell, the value of internal resistance is generally low and goes on increasing as the cell is put to more and more use. The potential difference between the two electrodes of a cell in a closed circuit is called terminal potential difference and its value is always less than the emf of the cell in a closed circuit. It can be written as V = E – Ir.

(i) The terminal potential difference of two electrodes of a cell is equal to emf of the cell when _____. (1)

(A) I≠0 (B) I=0 (C) both (a) and (b) (D) neither (a) nor (b)

(ii) Choose the wrong statement**.** (1)

(A) Potential difference across the terminals of a cell in a closed circuit is always less than its emf.

(B) Internal resistance of a cell decreases with the decrease in temperature of the electrolyte.

(C) Potential difference versus current graph for a cell is a straight line with a -ve slope.

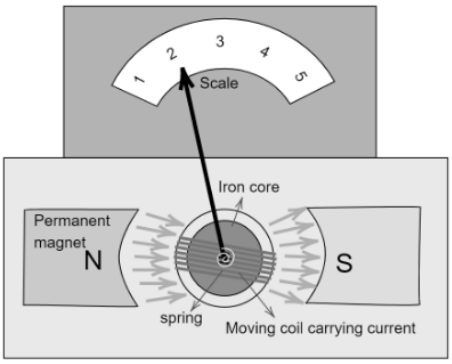
(D) Terminal potential difference of the cell when it is being charged is given as V = E + Ir.

(iii) IF external resistance connected to a cell has been increased to 5 times, the potential difference across the terminals of the cell increases from 10 V to 30 V. Find the emf of the cell. (2)

OR

(iii) A cell of emf E and internal resistance r gives a current of 0.5 A with an external resistance of 12Ω and a current of 0.25 A with an external resistance of 25 Ω. What is the value of the internal resistance of the cell?

33. Moving coil galvanometer operates on Permanent Magnet Moving Coll (PMMC) mechanism and was designed by the scientist Darsonval.
Moving coil galvanometers are of two types:
(i) Suspended coil
(ii) Pivoted coil type or tangent galvanometer.
Its working is based on the fact that when a current carrying coil is placed in a magnetic field, it experiences a torque.



Front view of a Moving Coil Galvanometer

This torque tends to rotate the coil about its axis of suspension in such a way that the magnetic flux passing through the coil is maximum.

(i) A moving coil galvanometer is an instrument which _____. (1)
(A) is used to measure emf
(B) is used to measure potential difference
(C) is used to measure resistance
(D) gives a deflection when a current flows through its coil

(ii) To make the field radial in a moving coil galvanometer _____. (1)
(A) number of turns of coil is kept small
(B) magnet is taken in the form of horse-shoe
(C) poles are of very strong magnets
(D) poles are cylindrically cut

(iii) The deflection in a moving coil galvanometer is _____. (1)
(A) directly proportional to torsional constant of spring
(B) directly proportional to the number of turns in the coil
(C) inversely proportional to the area of the coil
(D) inversely proportional to the current in the coil

(iv) A moving coil galvanometer, having a coil of N-turns of area A and carrying current I, is placed in a radial field of strength B. The torque acting on the coil is _____. (1)
(A) NA^2B^2I (B) NABI (C) N^2ABI (D) $NABI^2$

OR

(iv) To increase the current sensitivity of a moving coil galvanometer, we should decrease __.
(A) strength of magnet (B) torsional constant of spring
(C) number of turns in coil (D) area of coil