**SINDHI HIGH SCHOOL, HEBBAL**

**HALF YEARLY EXAMINATION-2024-25**

**PHYSICS (042)**

**Grade: XII Max. Marks:70**

**Date:03/10/2024 Reading time: 8.10am-8.25am**

**No of sides: 7 Writing time: 8.25am-11.25am**

**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(CBQ) 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.

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| **SECTION A** | | |
| 1. | A heater coil is cut into two equal parts and only one part is now used in the heater. The heat generated will be    a) doubled b) 4 times c) 1/4th d) halved | **1** |
| 2. | Coil C carries a steady current. A second coil is placed in close proximity to coil C in different configurations as shown.  Which of the following options represents the correct order of the mutual inductance values for the pair of coils in given configurations?      a) (i) > (iii) > (iv) > (ii) b) (iv) > (iii) > (i) > (ii)  c) (ii) > (iv) > (iii) > (i) d) (iii) > (i) > (ii) > (iv) | **1** |
| 3. | The ratio of the magnitudes of the electric field and magnetic field of a plane electromagnetic wave is    a) 1 b) c) c d) | **1** |
| 4. | A lightning conductor is made of a conducting material with one of its ends earthed while the other end has several sharp metal spikes. It protects the building from lightning by either neutralizing or conducting the charge of the cloud in the sky to the ground.  Identify ONE statement from below given that DOES NOT contribute to the correct explanation of the working principle of a lightning conductor.    a) Charge density on the surface of metal spikes is inversely  proportional to the radius of curvature.  b) Charges are distributed uniformly on the surface of conductors  irrespective of their shapes.  c) The surface of a charged conductor behaves as an equipotential  surface.  d) Charges reside only on the outside of a charged conductor | **1** |
| 5. | Which of the following figures correctly depicts the Lenz’s law? The arrows show the movement of the labelled pole of a bar magnet into a closed circular loop and the arrows on the circle show the direction of the induced current. | **1** |
| 6. | A LCR series circuit is connected to an ac supply of ω=100 rad/s. Given the values as R=100Ω L=500mH , C=5μF , study the following statements carefully.  I. The given circuit (LCR) is dominantly capacitive  II. The instantaneous current in the circuit leads Vmax.  III. If ω greater than 200√10 rad/s, the circuit becomes dominantly inductive  IV. The LCR circuit can be made capacitive or inductive by simply changing  the angular frequency of the input ac supply, keeping the voltage Vmax  constant.  Identify the correct option.    a) Only statement IV is correct  b) Only statements I and II are correct  c) Only statements I and III are correct  d) All statements are correct | **1** |
| 7. | The diagrams given show regions of equipotentials. A positive charge is moved from A to B in each diagram.    a) maximum work is required to move  q in figure (c)  b) in all four cases the work done is the same  c) minimum work is required to move q in figure (a)  d) maximum work is required to move q in figure (b) | **1** |
| 8. | A capacitor is charged by connecting a battery across its plates. It stores energy U. Now the battery is disconnected and another identical capacitor is connected across it, the energy stored by both capacitors of the system will be a) U b) U c) 2U d) U | **1** |
| 9. | Three long, parallel wires, carrying current , are arranged as shown in the figure. The force experienced by a 25cm length of wire C is  a) 10-3 N b) 2.5 X 10-3 N  c) zero d) 1.5 X 10-3 N | **1** |
| 10. | A 5‐ohm resistor, a 5 mH inductor and a 5 μF capacitor, joined in series resonate with an ac source of frequency ωo. If only the resistance is changed to 10 ohm, the circuit resonates at a frequency ω1. If only the inductor is changed to 20 mH, the circuit resonates at a frequency ω2. Find the ratio ω 1/ω 2.  a) 0.5 b) 1 c) 0.25 d) 4 | **1** |
| 11. | Following plots show Magnetisation (M) vs Magnetising field (H) and Magnetic susceptibility χ vs Temperature (T) graphs    Which of the following combinations represents a diamagnetic substance? a) (A), (D) b) (B), (C) c) (B), (D) d) (A), (C) | **1** |
| 12. | Two magnets of equal magnetic moments m each are placed as shown in the figure. The resultant magnetic moment is a) m b) m c) m d) | **1** |
| **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**  **e) If Assertion is false but Reason is true** | | |
| 13. | **Assertion(A):**With the help of Gauss’ theorem, we can find electric field at any point.  **Reason (R):** Gauss’ theorem cannot be applied for any type of charge distribution | **1** |
| 14. | **Assertion(A):** Conductors having equal positive charge and volume, must also have the same potential  **Reason (R):** Potential depends only on charge and volume of the conductor | **1** |
| 15. | **Assertion(A):** A current carrying loop made of a wire of length L is placed in a magnetic field. It experiences a torque which is greater than the torque on a circular loop made of the same wire carrying the same current in the same magnetic field.  **Reason (R):** A square loop occupies more area than a circular loop, both made of wire of same length | **1** |
| 16. | **Assertion(A):** Capacitor serves as a barrier for DC and offers an easy path to AC.  **Reason (R):** Capacitive reactance is inversely proportional to frequency | **1** |
| **SECTION B** | | |
| 17. | A conductor of length ‘l’ is rotated about one of its ends at a constant speed ω in a plane perpendicular to a uniform magnetic field B. Plot graphs to show the variations of emf induced across the ends of the conductor with  (i) angular speed ω and  (ii) length of the conductor l | **2** |
| 18. | A particle having a charge +5µC, is initially at rest at the point x=30cm on the x axis. The particle begins to move due to the presence of a charge Q that is kept fixed at the origin. Find the kinetic energy of the particle at the instant it has moved 15cm from its initial position, if  (i) Q=+15µC (ii) Q=-15µC | **2** |
| 19. | (i) Draw a diagram showing a linearly polarized electromagnetic wave , propagating in the z- direction depicting E and B  (ii) The wavelength of an electromagnetic wave is 10-10m. Identify the wave and mention one of its use.  **OR**  A capacitor of capacitance C is being charged by connecting it across a DC source along with an ammeter. Will the ammeter show a momentary deflection during the process of charging? If so, how would you explain this momentary deflection and the resulting continuity of current in the circuit? Write the expression for the current inside the capacitor | **2** |
| 20. | A small magnetised needle P is placed at the origin of XY-plane with its magnetic moment pointing along the Y- axis. Another identical magnetised needle Q is placed in two positions, one by one.  Case1: at (a,0) with its magnetic moment pointing along X-axis.  Case 2: at (0,a) with its magnetic moment pointing along Y-axis.  (i) In which case is the potential energy of P and Q minimum?  (ii) In which case is P and Q not in equilibrium?  Justify your answers. | **2** |
| 21. | Plot a graph showing the variation of Coulomb force F versus , where r is the distance between the two charges of each pair of charges (1µC, 2µC) and (2µC, -3µC). Interpret the graphs obtained | **2** |
| **SECTION C** | | |
| 22. | With the help of a diagram, explain the principle of a device which changes a low voltage into a high voltage but does not violate the law of conservation of energy. Give one reason why the device may not be 100% efficiency and suggest a way to reduce the loss.  **OR**  A 2µF capacitor, 100Ω resistor and 8H inductor are connected in series with an ac source.  (i) What should be the frequency of the source such that the current drawn in the circuit is maximum? What is this frequency called?  (ii) If the peak value of emf of the source is 200V, find the maximum current.  (iii) Draw a graph showing the variation of amplitude of circuit current with changing frequency of applied voltage in a series LCR circuit for two different values of resistances R1 and R2 (R1 > R2) | **3** |
| 23. | Draw the magnetic field lines for a current carrying solenoid when a rod made of (i) copper (ii) aluminium and (iii) iron are inserted within the solenoid as shown | **3** |
| 24. | (i) A cell of emf (E) and internal resistance (r) is connected across a variable load resistance (R). Draw plots showing the variation of terminal voltage (V) with a) R and b) the current, I in the load  (ii) Three cells of emf E but internal resistance 2r,3r and 5r are connected in parallel across a resistor r. Obtain expressions for a) current flowing in the circuit and b) the terminal potential difference across the equivalent cell | **3** |
| 25. | (i) A hollow cylindrical box of length 1m and area of cross section 25cm2 is placed in a three dimensional coordinate system as shown in the figure. The electric filed in the region is given by =50 , where E is in  N/C and x is in m  Find  (a) net flux through the cylinder  (b) charge enclosed by the cylinder  (ii) A charge q is placed at the centre of a cube of side l. What is the electric flux passing through each face of the cube? | **3** |
| 26. | (i) Give reason:  (a) Why the connections between the resistors in a metre bridge are made of  thick copper strips?  (b) Why is it generally preferred to obtain the balance length near the mid-  point of the bridge wire?  (ii) Calculate the potential difference across the 4Ω resistor in the given electrical circuit, using Kirchhoff ’s rules. | **3** |
| 27. | A potential difference V is applied across a conductor of length l and uniform cross section A.  How will the (i) electric field E, (ii) drift velocity vd and (iii) current density j be affected when (a) V is doubled and (b) is halved (keeping other factors constant). | **3** |
| 28. | Using Gauss’ law, obtain the expression for the electric field due to uniformly charged spherical shell of radius R at a point outside the shell. Draw a graph showing the variation of electric field with r, for r>R and r<R | **3** |
| **SECTION D** | | |
|  | **Case study** |  |
| 29. | **Moving Coil Galvanometer**  The galvanometer is one of the most important discoveries in science and technology. It was discovered in the 19th century when scientists observed deflection in the direction of a needle in the presence of an electromagnet, indicating the flow of electric current.  Over the years, the galvanometer has been improvised and repurposed to serve many purposes. It can be used to determine the presence and direction of electric current. It can also be used to find the null point in a circuit.  Galvanometers can be repurposed to find the voltage between two circuit points. Today, galvanometers are used in a wide variety of industrial appliances like control systems, laser engraving, laser TVs, laser displays, and laser sintering, among others. They can also be used to control the status of head servos in CD/DVD players and on hard drives.  (i) Consider a galvanometer shunted with 5Ω resistance and 2% of current passes through it. What is the resistance of the given galvanometer?  a) 344 Ω b) 245 Ω c) 226 Ω d) 300 Ω  **OR**  A galvanometer coil has a resistance of 10 Ω and the meter shows full scale deflection for a current of 1mA. The shunt resistance required to convert the galvanometer into an ammeter of range 0-100mA is about  a) 10 Ω b) 1 Ω c) 0.1 Ω d) 0.01 Ω  (ii) The sensitivity of moving coil galvanometer can be increased by decreasing  a) number of turns of the coil  b) magnetic field  c) area of the coil  d) restoring couple per unit twist of suspension  (iii) Current sensitivity of a moving coil galvanometer is 5div/mA and its voltage sensitivity is 20div/V . The resistance of the galvanometer is  a) 40 Ω b) 500 Ω c) 250 Ω d) 25 Ω  (iv) A moving coil galvanometer has a coil of effective area A and number of turns N. The magnetic field B is radial. If a current I is passed through the coil, the torque acting on the coil is  a) NA2B2I b) NBAI2 c) N2ABI d) NABI | **4** |
| 30. | **Alternating Current**  An alternator is a device that can create an alternating current. This device is a type of electrical generator that generates alternating currents. Unlike direct current (DC), which is used in batteries, almost every home in the world is powered by alternating current (AC). This current is preferred over DC current due to cost, power loss and conversion difficulties from higher voltage to lower voltage. Short and medium-distance AC current moves with low power loss.  The AC is produced by rotating a magnet around stationary wire coils. The coils generate an electric wave because one end of the magnet is positive and the other is negative. This wave’s frequency varies, but most power plants emit it between 50 and 60 times per minute.  (i) The currents and voltage in AC circuit are given by I= 5 sin (100t- ) A, V=  200sin(100t)V .The power dissipated in the circuit will be  a) 20W b) 40W c) 1000W d) zero  **OR**  An ac is represented by V= 220sin(100π)t V and is applied over a resistance of 110Ω. The heat produced in 7min is  a) 11 X 103cal b) 22 X 103cal c) 33 X 103cal d) 25 X 103cal  (ii) In electric power substation in a township, large capacitor tanks are used  a) to reduce power factor b) to improve power factor  c) to decrease current d) to increase current in the circuit  (iii) In the ac circuit, the current is expressed as I=100sin 200πt. In this circuit the  current rises from zero to peak value in time  a) s b) s c) s d) s  (iv) The peak value of an alternating emf ε is given by ε= ε0cosωt is 10V and its  frequency is 50Hz. At time t= s , the instantaneous emf is  a) 1V b) 5V c) 10V d) 5 V | **4** |
|  | **SECTION E** |  |
| 31. | (i) Derive an expression for the velocity of a positive ion passing undeflected through a region where crossed and uniform electric field E and magnetic field B are simultaneously present.  (ii) Draw and justify the trajectory of identical positive ions whose velocity had a magnitude less than  (iii) A proton, a deuteron and an alpha particle having the same kinetic energy are allowed to pass through a uniform magnetic field perpendicular to their direction of motion. Compare the radii of their circular paths  **OR**  (i) Deduce the expression for the magnetic field at a point on the axis of a current loop of radius R at a distance x from the centre. Hence write the magnetic field at the centre of a loop.  (ii) Two identical circular loops P and Q each of radius r and carrying currents are kept in the parallel planes having a common axis passing through O. The direction of current in P is clockwise and in Q is anticlockwise as seen from O which is equidistant from the loops P and Q. Find the magnitude of the net magnetic field at O. | **5** |
| 32. | (i) A metallic rod of length l and resistance R is rotated with the frequency ν with one and hinged at the centre and the other end at the circumference of a circular metallic ring of radius l, about an axis passing through the centre and perpendicular to the plane of the ring. A constant and uniform magnetic field B parallel to the axis is present everywhere.  a) Derive the expression for the induced EMF and the current to the rod  b) Due to the presence of the current in the rod and the magnetic field, find the  expression for magnitude and direction of the force acting on the rod.  c) Hence obtain the expression for power required to rotate the rod  (ii) A square loop of side 20 cm initially kept 30 cm away from a region of uniform magnetic field 0.1 T as shown in the figure. It is then moved towards the right to the velocity of 10 cm per  second till it goes out of the field. Plot a graph showing the variation of  (a) magnetic flux φ through the loop with time t  (b) induced EMF ε in the loop with time t  **OR**  (i) Obtain the expression for the mutual inductance of two long co-axial solenoids S1 and S2 wound one over the other, each of length L and radii r1 and r2 (r1 < r2) and n1 and n2 be number of turns per unit length, when a current I is set up in the outer solenoid S2.  (ii) A solenoid S of radius 50 cm with 100 turns per unit length is aligned along the x‐axis carrying a current of 10 A. A coil C of radius 10 cm is coaxially placed inside the solenoid such that it can rotate about its diameter directed along the y‐axis. Refer to the diagram given.  If the coil C of 50 turns revolves with a constant angular speed of π rad/s, determine the emf generated in coil C.  (Note: The final answer may be written in terms of constants μo and π) | **5** |
| 33. | (i) Derive an expression for the capacitance of a parallel plate capacitor when a dielectric slab of dielectric constant K and thickness t= d/2 but of same area as that of the plates is inserted between the capacitor plates. (d = separation between the plates).  (ii) Three identical parallel plate air capacitors C1 ,C2 ,C3 have capacitances C each. The space between their plates is now filled with dielectrics as shown. If all the three capacitors still have equal capacitances, obtain the relation between the dielectric constants κ 1 , κ 2 , κ 3 and κ 4  **OR**  (i) Derive an expression for the electric potential at a point due to an electric  dipole.  (ii) Given are two charges, q1, a negative source charge,  and q2, a test charge. The test charge q2 is initially  positive and then changed into a negative charge of  the same magnitude.  (a) Will the potential at the position of charge q2 due to the source charge q1  (i) remain the same, (ii) increase or (iii) decrease?  (b) Will the potential energy of the q1 & q2 charge system  (i) remain the same, (ii) increase or (iii) decrease?  Give an explanation in each case | **5** |