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INDIAN SCHOOL SALALAH

FIRST TERM EXAMINATION - SEPTEMBER 2024

PHYSICS (042)

Class: XII **Date: 18/09/2024**

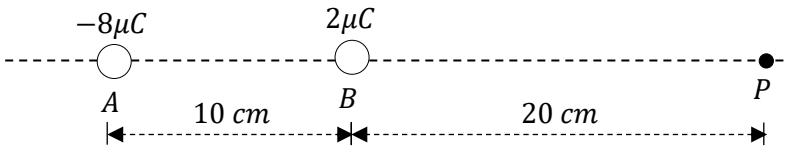
Time: 3h **Maximum Marks: 70**

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 must 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.
   (i) $c = 3 \times 10^8$ m/s
   (ii) $m_e = 9.1 \times 10^{-31}\ kg$
   (iii) $e = 1.6 \times 10^{-19}\ C$
   (iv) $\mu_0 = 4\pi \times 10^{-7}\ TmA^{-1}$
   (v) $h = 6.63 \times 10^{-34}\ Js$
   (vi) $\varepsilon_0 = 8.854 \times 10^{-12}\ C^2\ N^{-1}m^{-2}$

SECTION A

1. In the following figure, two point charges are fixed at points A and B on x - axis. If a small positive test charge is released at point P, then it will **1**



(A) get accelerated to the left side with increasing acceleration till it reaches B.

(B) get accelerated towards the left with decreasing acceleration till it reaches B.

(C) execute oscillation about some point to the right of B.

(D) get accelerated towards right with decreasing acceleration.

2. Study the following cases and choose the correct option. **1**

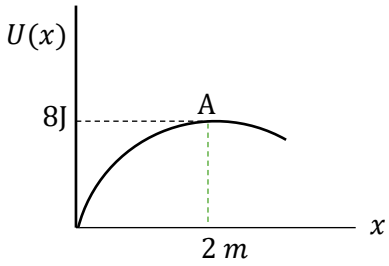
Case I: A point charge is placed at the centre of a thin spherical conducting shell of radius R. Field at a distance r (r<R) is E_1 .

Case II: Same point charge in case I is placed at the centre of a thin non conducting shell of radius R. Field at a distance r (r<R) is E_2.

(A) $E_1 = 0$, $E_2 \neq 0$ (B) $E_1 = 0$, $E_2\ \alpha\ \frac{1}{r}$

(C) $E_1\ \alpha\ \frac{1}{r^2}$, $E_2\ \alpha\ r$ (D) $E_1 \alpha\ \frac{1}{r^2}$, $E_2\ \alpha\ \frac{1}{r^2}$

3. Electrostatic potential energy of a particle varies with distance as shown in figure. The strength of the electric field corresponding to the point A is: **1**



(A) zero (B) $4 \times 10^{-2} N/C\ \hat{\imath}$ (C) $-4 \times 10^{-2} N/C\ \hat{\imath}$ (D) $-8 \times 10^{-2} N/C\ \hat{\imath}$

4. A parallel plate capacitor is connected to a cell. If a dielectric slab is inserted between the plates with cell connected to the capacitor. Choose the quantities which are not affected due to the insertion of dielectric slab. **1**

(A) charge, capacitance, electric field inside, energy density.

(B) Energy, voltage across the capacitor, electric field inside.

(C) voltage across the capacitor, electric field inside.

(D) Only voltage.

5. The Wheatstone bridge shown in the figure -1 is a balanced bridge and current drawn from the supply is I_1. If resistors R and Q are interchanged as shown in the figure – 2, then, **1**

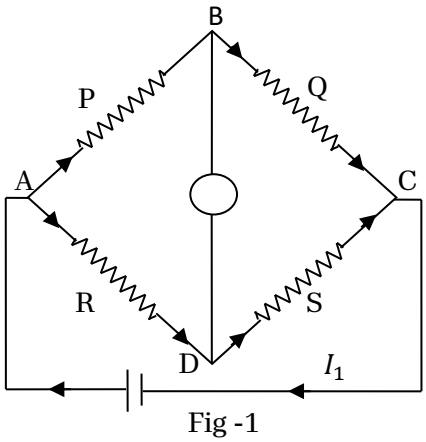


Fig -1

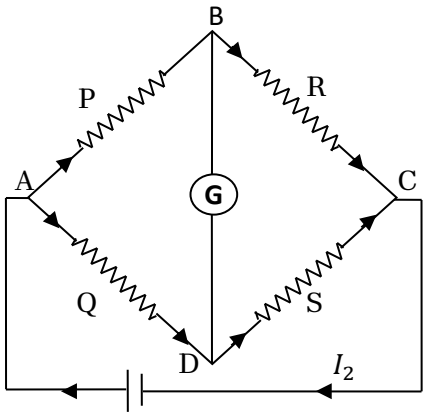


Fig -2

(A) $V_B \neq V_D$ in figure -2 and $I_1 > I_2$ if $Q > R$ and $P < R$

(B) $V_B \neq V_D$ in figure -2 and $I_1 < I_2$ if $Q > R$ and $P < R$

(C) $V_B = V_D$ in figure -2 and $I_1 > I_2$ if $Q > R$ and $P < R$

(D) $V_B = V_D$ in figure -2 and $I_1 < I_2$ if $Q > R$ and $P < R$

6. A charged particle will never continue to move with a constant velocity in a region wherein, **1**

(A) E = 0, B ≠ 0 (B) E ≠ 0, B ≠ 0. (C) E ≠0, B = 0. (D) E = 0, B = 0.

7. Choose correct statement **1**

(A) Gold and platinum are diamagnetic, silver and lithium are paramagnetic.

(B) silver and lithium are diamagnetic, Gold and platinum are paramagnetic.

(C) Platinum and lithium are diamagnetic, Gold and silver are paramagnetic.

(D) Gold and silver are diamagnetic, Platinum and lithium are paramagnetic.

8. Choose **incorrect** statement **1**

(A) electrostatic field lines can end on charges and conductors have free charges.

(B) Magnetic field lines can also end but conductors cannot end them.

(C) Magnetic field lines cannot end on any material and perfect shielding is not possible.

(D) shells of high permeability materials can be used to divert magnetic fieldlines from the interior region.

9. Two identical rectangular loops - ABCD, are pulled out of a uniform magnetic field (perpendicular to the plane and inward) with uniform velocity v as shown in the figures. Choose correct statement about net force on free electrons present in arm BC in Fig-1 and net force on free electrons present in arm AD in Fig – 2. **1**

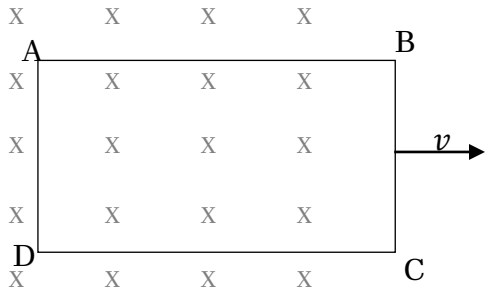


Fig -1

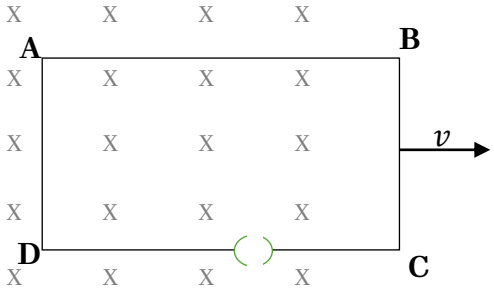


Fig -2

(A) Net force is not zero in Fig - 1, but net force is zero in Fig -2.

(B) Net force is zero in Fig - 1, but net force is not zero in Fig -2.

(C) Net force is zero in Fig-1 and Fig – 2.

(D) Net force is not zero in Fig-1 and Fig – 2.

10. The phase difference between the current and voltage in a series L-R circuit (Inductor – resistor) circuit is $\pi/6$ rad. If current in the circuit is 2A, then wattless current is: **1**

(A) 1A (B) 1.5A (C) $\sqrt{2}$ A (D) 0.5 A

11. Electric field component of an electromagnetic wave at an instant is given by the equation $\vec{E} = E_o \sin(6.28x + 18.8 \times 10^8 t)\ N/C\ \hat{\mathbf{j}}$. The magnetic field at that instant is given by the equation: **1**

(A) $\vec{B} = B_o \sin(6.28x - 18.8 \times 10^8 t)\ N/C\ \hat{\mathbf{k}}$.

(B) $\vec{B} = -B_o \sin(6.28x - 18.8 \times 10^8 t)\ N/C\ \hat{\mathbf{k}}$.

(C) $\vec{B} = B_o \sin(6.28x + 18.8 \times 10^8 t)\ N/C\ \hat{\mathbf{k}}$.

(D) $\vec{B} = -B_o \sin(6.28x + 18.8 \times 10^8 t)\ N/C\ \hat{\mathbf{k}}$.

12. A convex lens forms virtual magnified image of an object when placed in between optical centre and its focus. If object is moved towards the lens, then: **1**

(A) Linear magnification decreases but magnifying power increases.

(B) Linear magnification increases but magnifying power decreases.

(C) Both linear and angular magnification increases.

(D) Both linear and angular magnification decreases.

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):** Electric field lines never cross each other. **1**

Reason (R): The direction of the electric field is unique at every point.

14. **Assertion (A):** When two charged spheres of different radii and charged to different amount of charge are connected to each other with a wire, there is **always** some loss of electric energy. **1**

Reason (R): The only cause of energy loss is heat energy produced in the connecting wire due to the current.

15. **Assertion (A):** Resistivity of a semiconductor increases with temperature. **1**

Reason (R): The atoms of a semiconductor vibrate with larger amplitude at higher temperatures thereby increasing its resistivity.

16. **Assertion (A):** Apparent depth(height) of an object which is placed in rarer medium with respect to denser medium is more than real depth(height). **1**

Reason (R): Ratio of real depth to apparent depth is always equal to refractive index of denser medium with respect to rarer medium.

SECTION B

17. (i) Define the quantity electric dipole moment and give its direction. **2**

(ii) Dipole field vanishes faster than field due to a point charge as distance increases. Justify this statement with suitable expressions.

18. (i) State Ohm's law. **2**

(ii) Ohm's law is not a universal law. Justify this statement by drawing any two V – I graphs and corresponding explanation.

19. Current flowing through a conductor is directly proportional to the drift velocity of electrons in the conductor. Write an expression to support this statement. Using this equation obtain an expression for resistivity of material of the conductor. **2**

20. A loop, made of straight edges has six corners at A(0,0,0), B(L,O,0) C(L,L,0), D(0,L,0) E(0,L,L) and F(0,0,L) where L is 2 cm. A magnetic field $\vec{B} = 4(t\hat{\imath} + t^2\hat{k})$is present in the region. Calculate the flux passing and induced emf (if any) through the loop ABCDEFA (in that order) at $t = 2$s. **2**

21. (i) How are electromagnetic waves produced by oscillating charges? **2**

(ii) Why are microwaves found useful for the radar systems in aircraft navigation?

OR

(i) What do you mean by displacement current? **2**

(ii) A capacitor is connected to a power supply. Show that displacement current is equal to conduction current in the circuit.

SECTION C

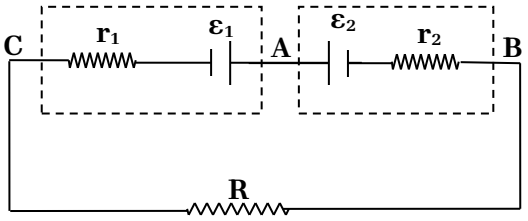
22. (i) Sate Gauss' theorem. Using this theorem obtain an expression for field due to a plane sheet of infinite area which is uniformly charged to charge density σ. **3**

(ii) We can use the expression obtained in question (i) to calculate field at a point lying at a distance 2 μm from the centre of a small plane square sheet of side 5 cm. Justify this statement

23. (i) Derive an expression for potential energy of dipole placed in uniform electric field. **3**

(ii) Write the expression for potential energy of dipole in the absence of external electric field.

24. In the given circuit diagram ε_1 and ε_2 are 2.V and 4 V respectively and resistances r_1, r_2 and R are 1 Ω, 2 Ω, and 5 Ω respectively. Calculate the value of current and indicate its direction. Also calculate the potential difference between the points (i) B and A and (ii) A and C. **3**



25. Give reason: **3**

(i) A freely suspended flexible current-carrying loop of irregular shape changes into a circular shape when placed in an external magnetic field.

(ii) The length of a solenoid made of delicate wire decreases when current flows through it.

(iii) It is impossible to continuously rotate a current loop about an axis passing through its center and perpendicular to its plane using only an external magnetic field.

26. (i) Derive a relation between magnetic susceptibility and relative permeability of a magnetic material. **3**

(ii) Classify para, dia and ferro magnetic materials in terms of their susceptibility, relative permeability.

27. An inductor of inductive reactance X_L is connected in series with a bulb B and an ac source. How would brightness of the bulb change when (i) number of turn in the inductor is reduced, (ii) an iron rod is inserted in the inductor and (iii) a capacitor of reactance $X_C = X_L$ is inserted in series in the circuit. Justify your answer in each case. **3**

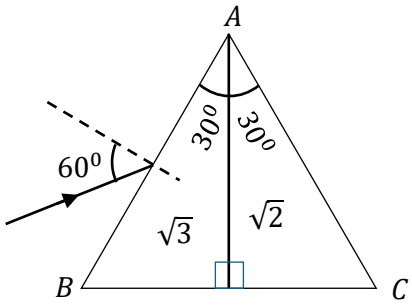
OR

(i) You are given three circuit elements X, Y and Z. When the element X is connected across an a.c. source of a given voltage, the current and the voltage are in the same phase. When the element Y is connected in series with X across the source, voltage is ahead of the current in phase by π /4. But the current is ahead of the voltage in phase by $\pi/4$ when Z is connected in series with X across the source. Identify the circuit elements X, Y and Z. **3**

(ii) When all the three elements are connected in series across the same source, determine the impedance of the circuit.

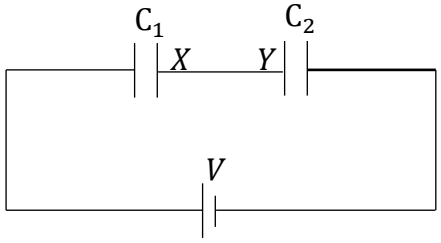
(iii) Draw a plot of the current versus the frequency of applied source and mention the significance of this plot.

28. A composite prism ABC is made up of two identical right-angled prisms ABD and ADC made up of different materials of refractive indices $\sqrt{3}$ and $\sqrt{2}$ respectively. A ray of light is incident on face AB of this prism at 60^0 as shown in the figure. Find the angle of emergence. **3**



SECTION D

29. Two parallel plate capacitors C_1 and C_2 of capacitances $2F$ and $6F$ are connected in series to a cell as shown in figure. These capacitors have same plate area A and same plate separation d but space between the plate is filled with materials with different dielectric constant. **4**



(i) Assume that these two capacitors are going to be replaced with a single capacitor to store same amount of charge as these two capacitors stored. What should be the plate of the plate area of that new capacitor if plate separation is d and space is filled with same material which is present in capacitor C_1.

(A) $3A$ (B) 3A/4 (C) A/2 (D) A/4

(ii) What is the ratio of energy density of these two capacitors?

(A) 1:1 (B) 4:9 (C) 3:1 (D) 9:1

OR

(ii) Capacitors are disconnected from the cell and reconnected to the same cell but connected parallel to the cell. If 1300 J of energy is additionally drawn from the cell, then the battery voltage is: [Assume there is no loss of energy]

(A) 5 V (B) 8 V (C) 20 V (D) 24 V

(iii) What is the potential difference between X and Y shown in the figure when capacitors are fully charged and potential difference across C_1 is 3V.

(A) zero (B) 3V (C) 4V (D) 6V

(iv) Choose correct shape of equipotential surfaces between the plates of the capacitors

(A) plane surfaces perpendicular to the plates.

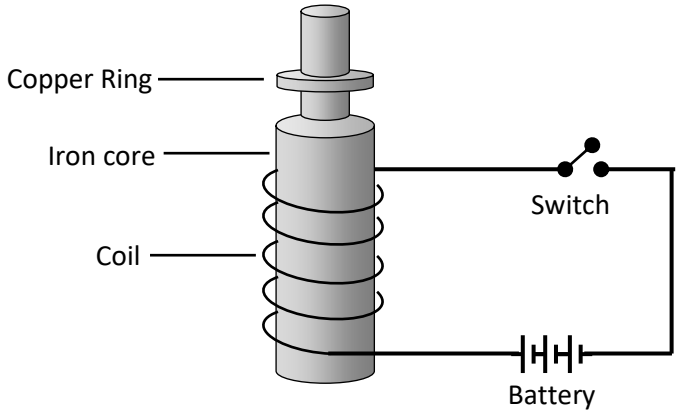
(B) Plane surfaces parallel to the plates.

(C) Surfaces which are neither parallel nor perpendicular to the plates.

(D) No equipotential surface exists in between the plates as field is uniform.

30. Consider the experimental set up shown in the figure. This jumping ring experiment is an outstanding demonstration of some simple laws of Physics. A conducting non-magnetic ring is placed over the vertical core of a solenoid. When current is passed through the solenoid, the ring is thrown off. **4**

In a lab demonstration, a solenoid is connected to a DC power supply. A non-magnetic, conducting ring is placed over the vertical core of the solenoid. When switch is closed a current flow through the solenoid and the ring suddenly jumps off the core. One can study this by varying number of turns in the coil, using strong battery, changing polarity of the terminals of the coil and using a non-conduction ring.



(i) Which law is primarily responsible for the ring being lifted off the solenoid?

(A) Ohm's Law (B) Faraday's Law of Electromagnetic Induction

(C) Coulomb's Law (D)Lenz's Law

(ii) What happens if a non-conducting ring is used instead of a conducting ring in the experiment?

(A) The ring will be lifted higher.

(B) The ring will remain stationary.

(C) The ring will spin in place.

(D) The ring will experience a force pulling it downward.

(iii) Which of the following factors increases the height to which the ring is lifted?

(A) Decreasing the number of turns in the solenoid.

(B) Using a ring made of a non-conducting material.

(C) Increasing the current passing through the solenoid.

(D) Using a ring with a larger diameter.

(iv) If mutual inductance of the coil and ring is 4H, what is the flux passing through the ring when current in the coil is 2 A.

(A) 16 Wb (B) 8 Wb (C) 0.5 Wb (D) 0.25 Wb

OR

(iv) What is the magnitude of induced emf developed in the solenoid with a self inductance 1.5 mH if current in the solenoid increases from 0 to 2 A in 2 ms.

(A) 1 V (B) 1.5 V (C) 2 V (D)2.5 V

SECTION E

31. (i) With the help of neat, labelled diagram, explain the underlying principle and working of a moving coil galvanometer and show that deflection in galvanometer is directly proportional to the current through galvanometer. **5**

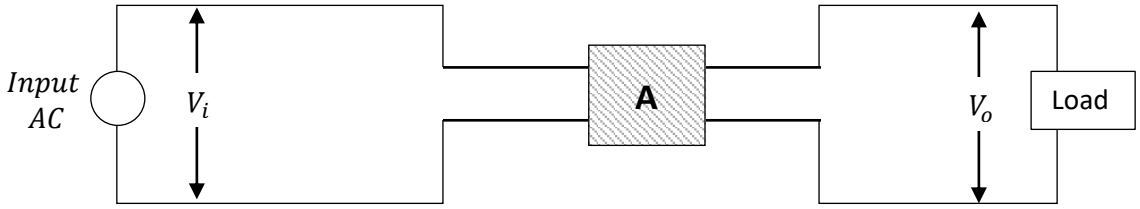
(ii) A galvanometer with resistance 20 Ω shows 30 div deflection when potential difference across it is 50mV. This galvanometer is modified by using a shunt resistance of 2Ω (connected parallel) and used in another circuit. If the galvanometer shows 20 div deflection, then calculate the current flows in the circuit.

OR

(i) With the help of neat diagram, show that a positive charge $\boldsymbol{q}$ that moves with velocity $v_x\hat{\boldsymbol{\imath}} + v_y\hat{\boldsymbol{\jmath}}$ that enters in a uniform magnetic field $B\,\hat{\jmath}$ follows a helical path along positive y – axis. Also obtain expression for pitch of the path. **5**

(ii) Assume that the charge mentioned in the above question moves along a helical path with pitch 33/7 m and radius 1m in a uniform magnetic field of strength 2T. Calculate its speed by assuming that the charge to mass ratio of the particle is 2 C/kg.

32. 'Box' A, in the set up shown below, represents an electric device often used/needed to supply, electric power from the (ac) mains, to a load. It is known that Vo < Vi. **5**



(i) Identify the device A and draw its symbol.

(ii) Draw a schematic diagram of this electric device. Explain its principle and working. Obtain an expression for the ratio between its output and input voltages.

(iii) Write any two causes of energy loss in device.

OR

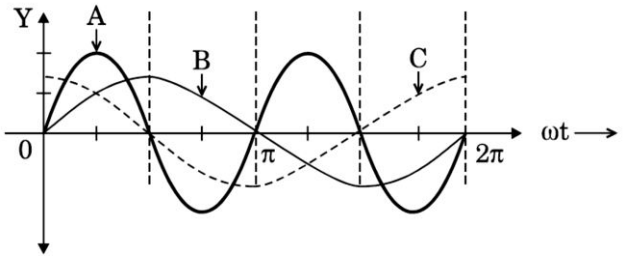
A device 'X' is connected to an ac source $I = I_0 \sin\omega t$ The variation of voltage, current and power in is shown in the following graph: **5**

(i) Identify the device 'X'.

(ii) Which of the curves A, B and C represent the voltage, current and the power consumed in the circuit? Justify your answer.

(iii) How does its impedance vary with frequency of the ac source? Show graphically.

(iv) Obtain an expression for the current in the circuit and its phase relation with ac voltage.



33. (i) Draw a ray diagram for final image formed at distance of distinct vision (D) by a compound microscope and write expression for its magnifying power. **5**

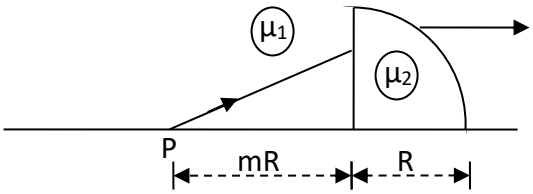
(ii) An angular magnification (magnifying power) of 54X is desired for a compound microscope using as objective of focal length 1.8cm and eye piece of focal length 5cm. Calculate the position of the specimen?

OR

(i) A concave lens made up of glass is immersed in water, What change do you expect in its focal length as compared to its value in air? Why? **5**

(ii) A concave lens made of glass is immersed in a transparent medium with a refractive index greater than that of glass. Describe and trace the path of a light beam that enters the lens parallel to its principal axis.

(iii) A quarter cylinder of radius R and refractive index 1.5 is placed on a table. A point object P is kept at a distance of mR from it. Find the value of m for which a ray from P will emerge parallel to the table as shown in the figure



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