B.K. BIRLA CENTRE FOR EDUCATION

SARALA BIRLA GROUP OF SCHOOLS
A CBSE DAY-CUM-BOYS' RESIDENTIAL SCHOOL

TERM-1 EXAMINATION (2025-26)

PHYSICS (042)

Class: XII **Time: 3hrs**
Date: 03.09.25 **Max Marks: 70**
Admission no: **Roll no:**

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 where ever 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. $\varepsilon_0 = 8.854 \times 10^{-12}$ $C^2N^{-1}m^{-2}$ vii. Avogadro's number = 6.023×10^{23} per gram mole

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SECTION-A (16 Q X 1 M= 16 M)

1. The unit of electric field is:
   (a) N/C (b) V/m (c) J/C (d) Both a and b

2. The potential at a point due to a point charge is inversely proportional to:
   (a) Distance (b) Square of distance (c) Charge (d) Capacitance

3. Capacitance of a parallel plate capacitor increases with:
   (a) Increase in separation (b) Increase in plate area
   (c) Decrease in dielectric constant (d) None of these

4. Ohm's law is valid only when:
   (a) Temperature remains constant (b) Current is zero
   (c) Resistance is infinite (d) Voltage is zero

5. Magnetic field due to a long straight current-carrying wire is:
   (a) Zero (b) Radial (c) Uniform (d) Circular

6. The direction of magnetic force on a moving charge is given by:
   (a) Lorentz force (b) Right-hand thumb rule (c) Fleming's left-hand rule (d) Ampere's law

7. Lenz's law is a consequence of:
   (a) Conservation of energy (b) Conservation of charge
   (c) Newton's third law (d) Coulomb's law

8. The average value of AC over one complete cycle is:
   (a) Maximum (b) Zero (c) RMS value (d) Peak value

9. In an AC circuit containing only a capacitor, the current:
   (a) Is zero (b) Lags the voltage (c) Is in phase with voltage (d) Leads the voltage

10. Electromagnetic waves are:
    (a) Longitudinal (b) Transverse (c) Both (d) Neither

11. Which of the following has the highest frequency?
    (a) Radio waves (b) X-rays (c) Infrared (d) Microwaves

12. The speed of electromagnetic waves in vacuum is:
    (a) 3×10^8 m/s (b) 1.5×10^8 m/s (c) 3×10^6 m/s (d) 1.5×10^6 m/s

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 Reason is true but Assertion is false.

13. **Assertion:** Electric lines of force never cross each other.
    Reason: At any point, electric field has a unique direction.
14. **Assertion:** Ohm's law is applicable for all conducting elements.
    Reason: Ohm's law is a fundamental law.
15. **Assertion:** Magnetic field inside a bar magnet flows from south to north.
    Reason: Magnetic field lines are closed loops.
16. **Assertion:** Induced current opposes the cause producing it.
    Reason: This is in accordance with Lenz's law.

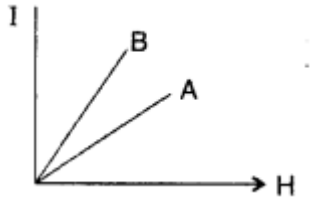
SECTION-B (5Q X 2 M= 10 M)

17. What will the force between two small spheres that have 2 X 10^{-7} C and 3 X 10^{-7}C be, if they are suspended in the air and have 30 cm of distance between them? 2

18. Derive the expression for energy stored in a capacitor. 2

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

20. The figure shows the variation of intensity of magnetisation versus the applied magnetic field intensity, H, for two magnetic materials A and B: 2

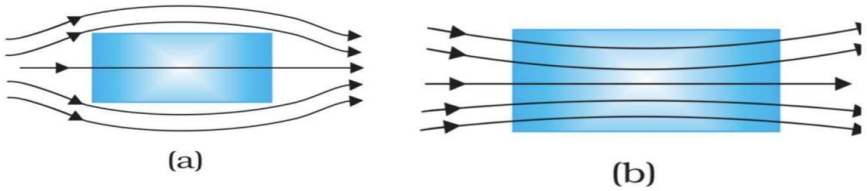


(a) Identify the materials A and B.

(b) Why does the material B, has a larger susceptibility than A, for a given field at constant temperature?

OR

A uniform magnetic field gets modified as shown in figure when two specimens A and B are placed in it.



(a) Identify the specimen A and B.

(b) How is the magnetic susceptibility of specimen 'A' different from that of specimen 'B'?

21. Write any two properties of electromagnetic waves. 2

SECTION-C (7Q X 3 M= 21 M)

22. Derive the expression for electric field due to a point charge. 3

OR

State Gauss' law in electrostatics. Use this law to derive an expression for the electric field due to an infinitely long straight wire of linear charge density λ cm^{-1}.

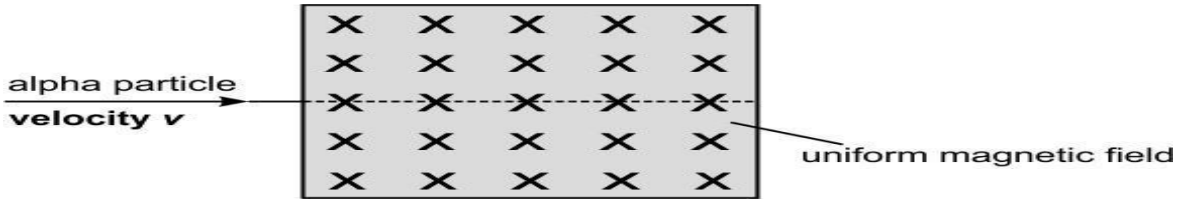
23. Three resistors of 2 Ω, 3 Ω, and 6 Ω are connected in parallel. This combination is connected to a battery of 12 V. Calculate: 3

(a) The equivalent resistance of the circuit

(b) The total current drawn from the battery

(c) The power dissipated in the circuit

24. An alpha particle is moving with a velocity v. It enters a magnetic field (B) as shown below. The magnetic field is perpendicular and into the plane of paper. 3



A uniform electric field is applied in the same region as the magnetic field so that the alpha particle passes un-deviated through the combined fields.

(a) What should be the direction of the electric field?

(b) Without any change in the electric and magnetic field, the alpha particle is replaced by the following particles:

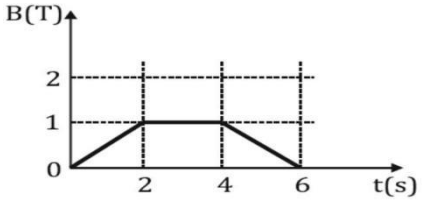
(i) proton moving with a velocity v

(ii) electron moving with a velocity v/2

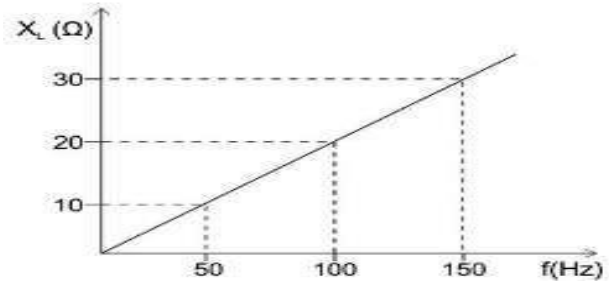
Will there be any change a deviation in the path of the particles? Give a reason for your answer.

25. A small compass needle of magnetic moment 'm' is free to turn about an axis perpendicular to the direction of uniform magnetic field 'B'. The moment of inertia of the needle about the axis is 'I'. The needle is slightly disturbed from its stable position and then released. Prove that it executes simple harmonic motion. Hence deduce the expression for its time period. 3

26. 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



27. An inductor of inductance 'L' is connected to an AC source, V = 100 sin ωt. The graph below represents the variation of inductive reactance (X_L) of the inductor with the frequency of an alternating source. 3



(a) What is the self-inductance of the inductor?

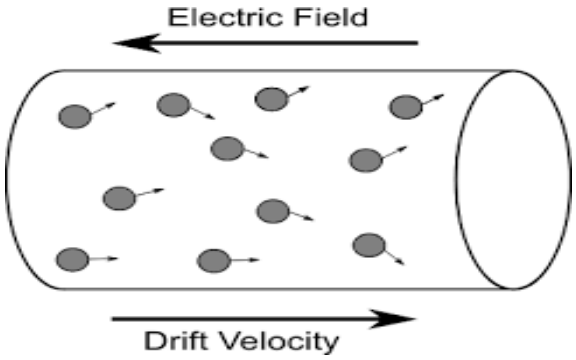
(b) If the ac source is replaced by a battery such that V = 100 V, then what is the inductive reactance of the inductor? Give reason.

(c) When the frequency is 50 Hz, what is the average power dissipated by the inductor over a complete cycle in the circuit? Justify your answer.

28. Write Maxwell's equations in integral form and explain their significance. 3

SECTION-D (Case Study Based Questions) (2 Q X 4 M= 8 M)

29. Drift velocity is the average velocity of electrons in a conductor material due to an electric field. In a conducting material, it is also proportional to the magnitude of an external electric field. 4



(i) The drift velocity of electrons in a conductor is 0.8 mm/s. The potential difference across a conducting wire is doubled keeping other factors constant. What is the value of new drift velocity? 1

(a) 0.4mm/s (b) 0.64 mm/s (c) 1.6 mm/s (d) 0.2 mm/s

(ii) How would be the current density of a conductor get affected when the potential difference is tripled keeping other factors constant. 1

(a)Doubled (b) halved (c) no change (d) tripled

(iii) Two conducting wires of the same material, radii in the ratio 1:2 and lengths in the ratio 2:3 are connected in series to a battery of emf 5V. What is the ratio of the drift velocities of electrons in the two wires? 1

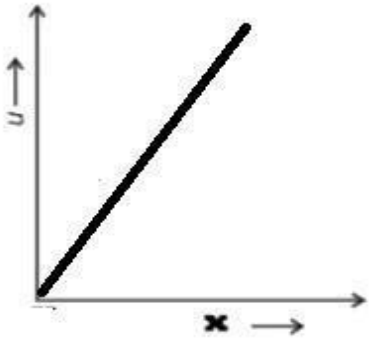
(a) 4:1 (b) 1:3 (c)2:3 (d) 4:3

(iv) A current of 3.2 A, flows through a conducting wire of number density 10^{28} m^{-3} and cross sectional area 10^{-6} m^2. The drift velocity of electrons in the wire is 1

(a) 4 mm/s (b) 2 mm/s (c) 1mm/s (d) 0.5 mm/s

Or

(v) The following is the graph between a drift velocity of electrons in a conductor and a physical quantity X. Identify the quantity.



(a) Current (b) Area of cross section (c) number density (d) length of conductor

30. Read the para given below and answer the questions that follow: 4

Dr. Meera is a radiologist working in a modern diagnostic center. She frequently uses advanced imaging techniques to examine patients. For soft tissue imaging, she relies on MRI scans, which use specific electromagnetic waves. Meanwhile, her colleague in the communication department is working on improving wireless data transmission using EM waves. Both professionals understand that these waves travel at the same speed in vacuum, but differ greatly in frequency and energy.

Answer the following:

(i) Identify one medical and one communication application of electromagnetic waves mentioned in the passage. 2

(ii) Which type of electromagnetic wave is used in MRI scans? 1

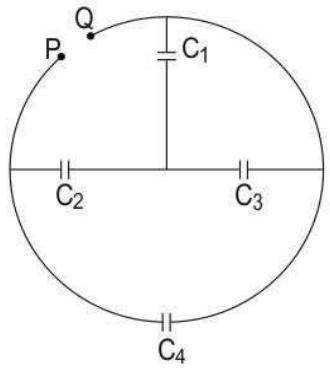
(iii) Mention one key difference between X-rays and radio waves based on their properties. 1

SECTION-E (3 Q X 5 M= 15 M)

31. Derive the expression for potential due to a uniformly charged spherical shell (i) outside the surface of the shell, (ii) at the surface of the shell, (iii) inside the shell. Draw the potential, distance graph. 5

Or

(a) Find the effective capacitance between points P and Q, if each capacitor has a capacitance of 6μF.



(b) Find the ratio of charges on capacitors C_1 and C_4, if the potential difference between points P and Q is 10 V.

32.

(a) Draw graphs showing the variations of inductive reactance and capacitive reactance with frequency of applied ac source. 5

(b) Draw the phasor diagram for a series LRC circuit connected to an AC source.

(c) When an alternating voltage of 220V is applied across a device X, current of 0.25A flows which lags behind the applied voltage in phase by $\pi/2$ radian. If the same voltage is applied across another device Y, the same current flows but now it is in phase with the applied voltage.

(i) Name the devices X and Y.

(ii) Calculate the current flowing in the circuit when the same voltage is applied across the series combination of X and Y.

Or

(a) A series LCR circuit is connected to an ac source. Using the phasor diagram, derive the expression for the impedance of the circuit.

(b) Plot a graph to show the variation of current with frequency of the ac source, explaining the nature of its variation for two different resistances R_1 and R_2 ($R_1 < R_2$) at resonance.

33. (a) Using Ampere's circuital law, obtain an expression for the magnetic field along the axis of a current carrying solenoid of length **l** and having **N** number of turns. 5

(b) How is the magnetic field, inside a given solenoid made strong?

Or

For a circular coil of radius ***R*** and ***N*** turns carrying current ***I***, the magnitude of the magnetic field at a point on its axis at a distance ***x*** from its centre is given by,

$$B = \frac{\mu_0 I R^2 N}{2\left(x^2 + R^2\right)^{\frac{3}{2}}}$$

(a) Show that this reduces to the familiar result for field at the centre of the coil.

(b) Consider two parallel co-axial circular coils of equal radius ***R***, and number of turns ***N***, carrying equal currents in the same direction, and separated by a distance ***R***. Show that the field on the axis around the mid-point between the coils is uniform over a distance that is small as compared to ***R***, and is given by, **B= 0.72 -** $\frac{\mu oBNI}{R}$, approximately.

----------**ALL THE BEST**----------