BK BIRLA CENTRE FOR EDUCATION

SARALA BIRLA GROUP OF SCHOOLS
SENIOR SECONDARY CO-ED DAY CUM BOYS' RESIDENTIAL SCHOOL

MID-TERM EXAMINATION 2024-25

PHYSICS (042)

Class : XII
Date : 14/09/2024
Name :

Duration: 3 Hrs
Max. Marks: 70
Exam 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 one mark each.
5) **Section B** contains five questions of two marks each.
6) **Section C** contains seven questions of three marks each.
7) **Section D** contains two case study based questions of four marks each.
8) **Section E** contains three long answer questions of five marks each.
9) 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 **Case Based Question** in **Section D** and all three questions in **Section E**. You have to attempt only one of the choices in such questions.
10) Use of calculators is not allowed.
11) 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. $\mu_0 = 4\pi \times 10^{-7}$ Tm$\boldsymbol{A^{-1}}$
    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} $gram^{-1}$ $mole^{-1}$

SECTION-A

1. Number of electrons required to transfer for 1 Coulomb charge; 1
   (a) 6.25×10^{16} (b) 6.25×10^{17} (c) 6.25×10^{18} (d) 6.25×10^{19}
2. The electrostatic potential on the perpendicular bisector due to an electric dipole is; 1
   (a) Zero (b) 1 (c) Infinite (d) Negative
3. The nature of parallel and anti-parallel currents are; 1
   (a) Parallel currents repel and anti-parallel currents attract.
   (b) Parallel currents attract and anti-parallel currents repel.
   (c) Both currents attract.
   (d) Both currents repel.
4. An electron is projected with uniform velocity along the axis of a current carrying long solenoid. Which of the following is true? 1
   (a) The electron will be accelerated along the axis.
   (b) The electron path will be circular about the axis.

(c) The electron will experience a force at 45° to the axis and hence execute a helical path.
(d) The electron will continue to move with uniform velocity along the axis of the solenoid.

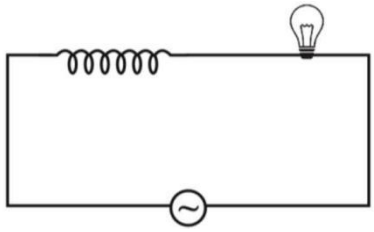
5. If a charged particle moves through a magnetic field, perpendicular to it. 1
(a) Both momentum and energy of particle change.
(b) Momentum as well as energy are constant.
(c) Energy is constant but momentum changes.
(d) Momentum is constant but energy changes.

6. S.I. unit of flux is: 1
(a) Ohm (b) Weber (c) Tesla (d) None

7. An induced e.m.f. is produced when a magnet is plunged into a coil. The strength of the induced e.m.f. is independent of; 1
(a) the strength of the magnet (b) number of turns of coil
(c) the resistivity of the wire of the coil (d) speed with which the magnet is moved

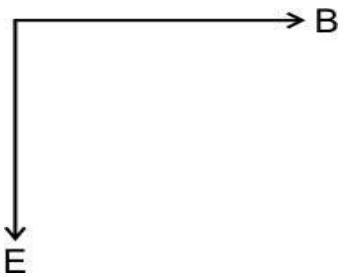
8. The large scale transmission of electrical energy over long distances is done with the use of transformers. The voltage output of the generator is stepped-up because of; 1
(a) reduction of current (b) reduction of current and voltage both
(c) Power loss is cut down (d) (a) and (c) both

9. An iron cored coil is connected in series with an electric bulb with an AC source as shown in figure. When iron piece is taken out of the coil, the brightness of the bulb will; 1



(a) decrease (b) increase (c) remain unaffected (d) fluctuate

10. The diagram below shows the electric field (E) and magnetic field (B) components of an electromagnetic wave at a certain time and location.



What is the direction of propagation of the em wave? 1
(a) perpendicular to E and B and out of the plane of the paper
(b) perpendicular to E and B and into the plane of the paper
(c) parallel and in the same direction as E
(d) parallel and in the same direction as B

11. For a total internal reflection, which of the following is correct? 1
(a) Light travels from rarer to denser medium.

(b) Light travels from denser to rarer medium.
(c) Light travels in air only.
(d) Light travels in water only.

12. Two lenses of focal lengths 20 cm and – 40 cm are held in contact. The image of an object at infinity will be formed by the combination at; 1
(a) 10 cm (b) 20 cm (c) 40 cm (d) infinity

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: In a cavity within a conductor, the electric field is zero. 1
Reason: Charges in a conductor reside only at its surface.
14. Assertion: Ohm's law is applicable for all conducting elements. 1
Reason: Ohm's law is a fundamental law.
15. Assertion: Ferro-magnetic substances become paramagnetic above Curie temp. 1
Reason: Domains are destroyed at high temperature.
16. Assertion: An induced emf appears in any coil in which the current is changing. 1
Reason: Self-induction phenomenon obeys Faraday's law of induction.

SECTION-B

17. State Coulomb's law. Derive the expression of electrostatic force between two charges in vector form. 2
18. Two charges 3×10^{-8} C and -2×10^{-8} C are located 15 cm apart. At what point on the line joining the two charges is the electric potential zero? Take the potential at infinity to be zero. 2
19. Derive the equation of the balanced state in a Wheatstone bridge using Kirchhoff's laws. 2
20. Identify the part of the electromagnetic spectrum which: 2

(a) Produces heating effect,
(b) is absorbed by the ozone layer in the atmosphere,

Write any one method of the production of each of the above radiations.

21. State and explain laws of refraction. 2

Or

Define absolute refractive index of a material. Write its SI unit. 2

SECTION-C

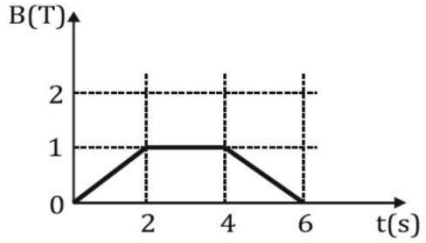
22. Derive an expression for the torque experienced by an electric dipole kept in a uniform electric field. 3

Or

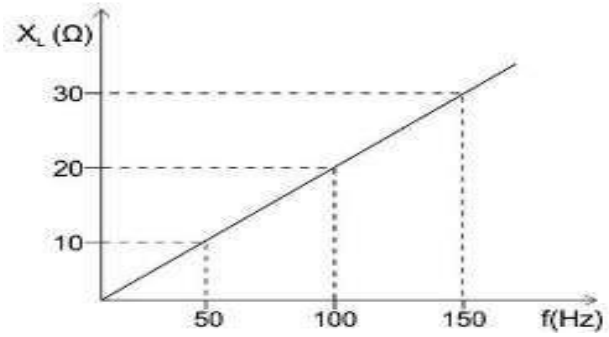
State Gauss' law in electrostatics. Use this law to derive an expression for the electric field due to a charged thin sheet of surface charge density **σ** Cm^{-2}. 3

23. 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. 3
24. Define different types of magnetic materials. Also write one example of each type. 3

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. 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.

27. (a) How does oscillating charge produce electromagnetic waves? 3
(b) Sketch a schematic diagram depicting oscillating electric and magnetic fields of an em wave propagating along + z-direction.

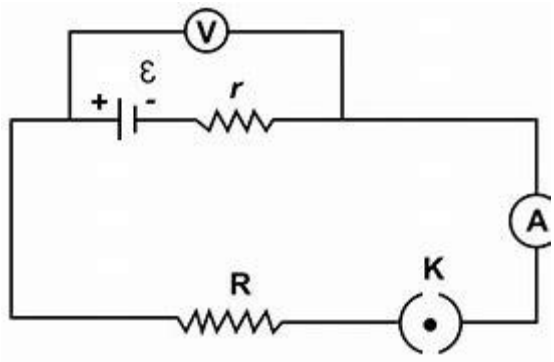
28. Derive Lens maker's formula and hence find expression of lens equation. 3

SECTION-D (Case Study Based Questions)

29. Read the following paragraph and answer the questions that follow. (4x1=4)
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

following factors;

(i) distance between the electrodes (ii) nature and temperature of the electrolyte, (iii) nature of electrodes, (iv)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;

(a) I≠0 (b) I=0 (c) both (a) and (b) (d) neither (a) nor (b)

(ii) 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?

(a) 7Ω (b) 5Ω (c) 3Ω (d)1Ω

(iii) Choose the wrong statement.

(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 decrease 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.

(iv) An external resistance R is connected to a cell of internal resistance r, the maximum current flows in the external resistance, when

(a) R=r (b) R> r (c) R< r (d) R=1/r

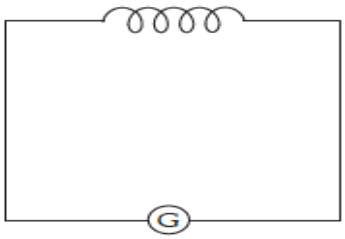
Or

(iv) 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. Then, the emf of the cell is;

(a) 30V (b) 40V (c) 50V (d) 60V

30. Read the para given below and answer the questions that follow: (4x1=4)

When a current I flows through a coil, flux linked with it is φ = LI, where L is a constant known as self-inductance of the coil.



Any charge in current sets up an induced emf in the coil. Thus, self-inductance of a coil is the induced emf set up in it when the current passing through it changes at the unit rate. It is a measure of the opposition to the growth or the decay of current flowing through the coil. Also, value of self-inductance depends on the number of turns in the solenoid, its area of cross-section and the permeability of its core material.

(i) The inductance in a coil plays the same role as;
(a) inertia in mechanics (b) energy in mechanics
(c) momentum in mechanics (d) force in mechanics

(ii) A current of 2.5 A flows through a coil of inductance 5 H. The magnetic flux linked with the coil is;
(a) 0.5 Wb (b) 12.5 Wb (c) zero (d) 2 Wb

(iii) The inductance L of a solenoid depends upon its radius R as
(a) $L \propto R$ (b) $L \propto 1/R$ (c) $L \propto R^2$ (d) $L \propto R^3$

(iv) The unit of self-inductance is
(a) Weber ampere^{-1} (b) Weber^{-1} ampere (c) Ohm second (d) Farad

Or

(iv) The induced emf in a coil of 10 henry inductance in which current varies from 9A to 4A in 0.2 second is;
(a) 200 V (b) 250 V (c) 300 V (d) 350 V

SECTION-E

31. (a) Establish relation between electric field and electrostatic potential. 3

(b) A molecule of a substance has a permanent electric dipole moment of magnitude 10^{-29} C m. A mole of this substance is polarised (at low temperature) by applying a strong electrostatic field of magnitude 10^6 V m^{-1}. The direction of the field is suddenly changed by an angle of 60º. Estimate the heat released by the substance in aligning its dipoles along the new direction of the field. For simplicity, assume 100% polarisation of the sample. 2

Or

(a) In a parallel plate capacitor with air between the plates, each plate has an area of 6×10^{-3} m^2 and the distance between the plates is 3 mm. Calculate the capacitance of the capacitor. If this capacitor is connected to a 100 V supply, what is the charge on each plate of the capacitor? 3

(b) Find the capacitance and charges on plates of capacitor in part 'a', if a dielectric material of dielectric constant 40 filled between the plates of the capacitor. 2

32. (a) Draw the phasor diagram for a series LRC circuit connected to an AC source. 2

(b) When an alternating voltage of 220V is applied across a device X, a 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. 1

(ii) Calculate the current flowing in the circuit when the same voltage is applied across the series combination of X and Y. 2

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. 3

(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. 2

33. (a) Define the current sensitivity and voltage sensitivity of a galvanometer. 2

(b) The coil area of a galvanometer is 16×10^{-4} m^2. It consists of 200 turns of a wire and is in a magnetic field of 0.2 T. The restoring torque constant of the suspension fibre is 10^{-6} Nm per degree. Assuming the magnetic field to be radial, calculate the maximum current that can be measured by the galvanometer if the scale can accommodate 30° deflection. 3

Or

(a) Derive the expression of magnetic field at the centre of a current carrying coil. 2½

(b) What is the radius of the path of an electron (mass 9×10^{-31} kg and charge 1.6×10^{-19} C) moving at a speed of 3×10^7 m/s in a magnetic field of 6×10^{-4} T perpendicular to it? What is its frequency? Calculate its energy in keV. (1 eV = 1.6×10^{-19} J). 2½

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