No. of pages - 24

MID-TERM EXAMINATION (2024-25)
CLASS : XII
SUBJECT: PHYSICS (042)

समय : 3 घंटे
Time Allowed : 3 hours

अधिकतम अंक - 70
Maximum Marks : 70

सामान्य निर्देश:

1. इस प्रश्न पत्र में कुल 33 प्रश्न हैं। सभी प्रश्न अनिवार्य हैं।
2. प्रश्न प्रश्न पत्र में पांच खंड हैं। खंड-क, खंड-ख, खंड-ग, खंड-घ एवं खंड ङ।
3. खंड क में प्रश्न संख्या 1 से 16 तक बहुविकल्पीय प्रकार के एक-एक अंक के प्रश्न हैं।
4. खंड ख में प्रश्न संख्या 17 से 22 तक अतिलघु उत्तरीय प्रकार के दो-दो अंकों के प्रश्न हैं।
5. खंड ग में प्रश्न संख्या 23 से 28 तक अतिलघु उत्तरीय प्रकार के तीन-तीन अंकों के प्रश्न हैं।
6. खंड घ में प्रश्न संख्या 29 तथा 30 तक केस आधारित चार-चार अंकों के प्रश्न हैं।
7. खंड ङ में प्रश्न संख्या 31 तथा 33 तक दीर्घउत्तरीय प्रकार के पाँच-पाँच अंकों के प्रश्न हैं।
8. प्रश्न पत्र में कोई समग्र विकल्प नहीं है। यद्यपि खंड ख के एक प्रश्न में खंड ग में दो प्रश्नों में, खंड घ के दो प्रश्नों में और खंड ङ के तीनों प्रश्नों में आंतरिक विकल्प का प्रावधान दिया गया है।
9. कैलकूलेटर का प्रयोग वर्जित है।

GENERAL INSTRUCTIONS:

1. This question paper contains 33 questions in all. All questions are compulsory.
2. This question paper is divided into five sections - Section A, Section B, Section C, Section D and Section E.
3. In Section A question number 1 to 16 are MCQ type questions carrying 1 mark each.
4. In Section B question number 17 to 21 are SA-1 type questions carrying 2 marks each.
5. In Section C question number 22 to 28 are SA-2 type questions carrying 3 marks each.
6. In Section D question number 29 to 30 are case based questions carrying 4 marks each.
7. In Section E question number 31 to 33 are long answer type questions carrying 5 marks each.
8. There is no over all choice. However an internal choice has been given in one question in Section B, two questions in Section C, one question in each CBQ in Section D and all three questions in Section E.
9. Use of calculator is NOT permitted.

$c = 3 \times 10^8$ m/s

$e = 1.6 \times 10^{-19}$ C

$\mu_0 = 4\pi \times 10^{-7}$ Tm A^{-1}

$\epsilon_0 = 8.85 \times 10^{-12}$ C^2 N^{-1} m^{-2}

$\frac{1}{4\pi\epsilon_0} = 9 \times 10^9$ Nm^{2}C^{-2}

SECTION-A

1. Which of the following is a non-ohmic conductor? 1

(a) Aluminium (b) Copper

(c) Iron (d) Silicon

2. Two long, straight, parallel conductors carrying same steady current 'I', are kept in vacuum at a distance of 1m, experience a force of 2×10^{-7} N per metre of their length. The value of I is : 1

(a) 1A (b) 0.1A

(c) 2A (d) 0.2A

3. SI unit of the pole strength of a magnet is : 1

(a) Ampere-(metre)$^{-1}$ (b) Ampere-(metre)^{2}

(c) Ampere-metre (d) Ampere-(metre)$^{-2}$

4. An a.c. ammeter reads : 1

(a) Mean value of current (b) RMS value of current

(c) Instantaneous value of current (d) Peak value of current

5. The current in a coil of 16 mH increases uniformly from zero to 4A in 0.002 second. The emf induced in the coil will be : 1

(a) 32.0 V (b) 16.0 V

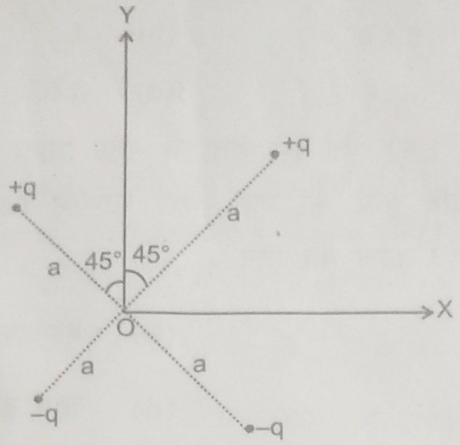
(c) 8.0 V (d) 4.0 V

6. A square sheet of side 'a' is lying parallel to XY plane at z = a. The electric field in the region is $\vec{E} = CZ^2\hat{k}$. The electric flux through the sheet is : 1

(a) zero (b) a^3c

(c) a^4c (d) $2a^4c$

7. Two identical dipoles are arranged in X-Y plane as shown in the figure. The net electric field at origin will be : 1



(a) $\frac{kq}{\sqrt{2}a^2}(-\hat{j})$ (b) $2\sqrt{2}\frac{kq}{a^2}(-\hat{j})$

(c) $2\sqrt{2}\frac{kq}{a^2}(\hat{j})$ (d) $\frac{kq}{\sqrt{2}a^2}(\hat{j})$

8. The electric potential at any point (x, y, z) is given by $V = 3x^3$ where x is in metres and V in volts. The electric field at point (1m, 0, 2 m) is : 1

(a) $9\sqrt{5}$ v/m along positive x-axis

(b) 9 v/m along positive x-axis

(c) $9\sqrt{5}$ v/m along negative x-axis

(d) 9 v/m along negative x-axis

9. Displacement current exists only when : 1

(a) Electric field is changing (b) Magnetic field is changing

(c) Electric field is constant (d) Magnetic field is constant

10. Which of the following electro-magnetic wave is used in speed guns : 1

(a) x-rays (b) uv-rays

(c) Microwaves (d) Gamma rays

11. A biconvex lens of focal length 10 cm and refractive index 1.47 is immersed in a liquid. It becomes invisible, the refractive index of liquid is : 1

(a) 1.33 (b) 1.57

(c) 1.47 (d) 1.62

12. The refractive index of a prism is 1.52. It is placed in air and angle of minimum deviation is found to be 'δm'. If air is replaced by a liquid of refractive index 1.2, the angle of minimum deviation will : 1

(a) remain same (b) increase

(c) become zero (d) decrease

For question number 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 code (a), (b), (c) and (d) as given below:

(a) Both Assertion (A) and Reason (R) are true and (R) is the correct explanation of Assertion (A).

(b) Both Assertion (A) and Reason (R) are true and (R) is the not correct explanation of Assertion (A).

(c) Assertion (A) is true and Reason (R) is false.

(d) Assertion (A) is false and Reason (R) is also false.

13. Assertion : A sphere and or cube, both enclose a charge q inside them. The electric flux is more associated with sphere than that of cube. 1

Reason : For a given volume, the surface area of sphere is more than that of the cube.

14. Assertion : For a capacitor to store a large amount of charge without leaking, its capacitance should be high. 1

Reason : A large potential difference implies a strong electric field which leads to reduction in insulating power of the intervening medium.

15. Assertion : Higher the range, lower is the resistance of an ammeter. 1

Reason : When a resistance is connected in series with galvanometer, its resistance is decreased.

16. Assertion : In an electromagnetic wave, electric field and magnetic field oscillate perpendicular to each other. 1

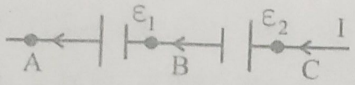
Reason : The phase difference between electric field and magnetic field, in an electromagnetic wave is always 90°.

SECTION-B

17. Lenz's law is a consequence of the law of conservation of energy. Explain. 2

18. A power transmission line feeds input power at 11,000 V to a step down transformer with its primary windings having 30,000 turns. Calculate the number of turns in the secondary to get the power output at 220V. 2

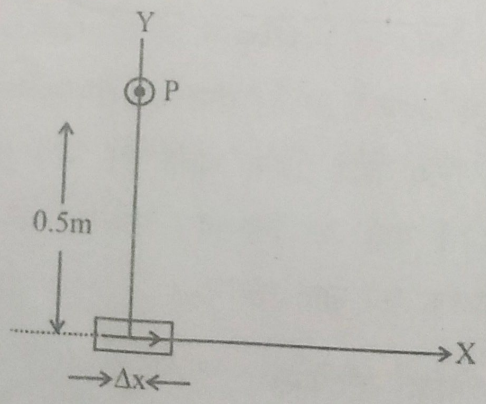
19. Two cells of emfs $\in_1$ and $\in_2$ and internal resistance r_1 and r_2 respectively are connected as shown in figure. Derive an expression for equivalent emf and equivalent internal resistance for the given combination, 2



20. A square coil of side 0.1 m consists of 20 turns and carries a current of 12A. The coil is suspended vertically and plane of coil makes an angle of 30° with the direction of a uniform magnetic field of magnitude 0.80T. Calculate the magnitude of torque experienced by the coil. 2

OR

An element $\Delta\vec{\ell} = \Delta x\,\hat{i}$ is placed at the origin and carries a large current I = 10A as shown in figure. Calculate direction and magnitude of magnetic field on Y-axis at a distance of 0.5m. ($\Delta x = 1$ cm)



21. Explain, why does a paramagnetic sample display greater magnetism (for same magnetizing field) when cooled whereas, a diamagnetic sample, in contrast is almost independent of temperature. 2

SECTION-C

22. An electric dipole of dipole moment $\vec{p}$ is placed in a uniform electric field $\vec{E}$. Write the expression for the torque $\vec{\tau}$ experienced by the dipole. Identify two pairs of vectors in this expression which are perpendicular to each other. Show diagrammatically the orientation of dipole in the electric field in :

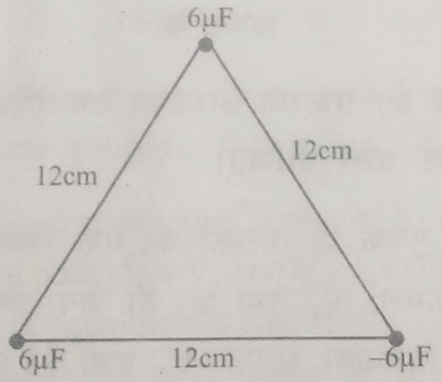
(i) Stable equilibrium

(ii) Unstable equilibrium

23. (a) Define temperature coefficient of resistivity of a material

(b) The resistance of a wire is 10Ω, at 27°c. Find its resistance at–73°c. The temperature coefficient of resistance of material of the wire is $1.70 \times 10^{-4}\ °c^{-1}$. 3

24. Calculate the work done to dissociate the system of three charges placed on the vertices of a triangle as shown in the figure : 3



25. A bar magnet of dipole moment M is placed in uniform magnetic field B, making an angle θ, and then released to oscillate. If this angle 'θ' is very small, show that the bar magnet will execute simple harmonic motion, and find time period of oscillation. I is the moment of inertia of bar magnet. 3

26. (a) Define mutual induction.

(b) Write any four factors affecting mutual inductance of a pair of two coils.

(c) Write SI unit of mutual inductance. 3

27. The magnetic field in a plane electromagnetic wave is given by : 3

$B_y = 2\times10^{-7}\sin(0.3\times10^3 x + 9\times10^{10} t)T$

(a) Calculate the wavelength and the frequency of the wave

(b) Write expression for the electric field.

(use $\pi = 3$) 3

28. An object is placed in front of a concave mirror of focal length 20 cm. There are two positions of the object for which the image formed is four times the size of the object.

(a) Draw the ray diagram for each case, and

(b) Find the distance between these two positions of the object. 3

OR

A screen is placed at a distance of 100 cm from an object. The image of the object is formed on the screen by a convex lens for two different locations of the lens separated by 20 cm. Calculate the focal length of the lens used. Draw ray diagram for any one location of the lens.

SECTION-D

Note: Question number 29 are case study based questions. Read the paragraph given below and answer the questions that follow :

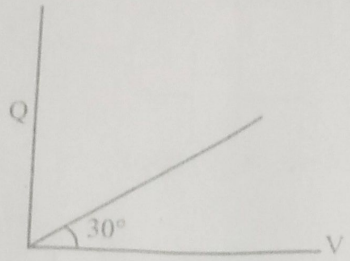
29. A capacitor is a system of two conductors separated by an insulator. The conductors have charges say Q_1 and Q_2, and potentials V_1 and V_2. Usually, in practice, the two conductors have charges Q and –Q with potential difference $V = V_1 - V_2$ between them. Q is called the charge of the capacitor-though the total charge of the capacitor is zero. A parallel plate capacitor consists of two large plane parallel conducting plates separated by small distance. We can combine several capacitors to obtain a system with some effective capacitance. 4

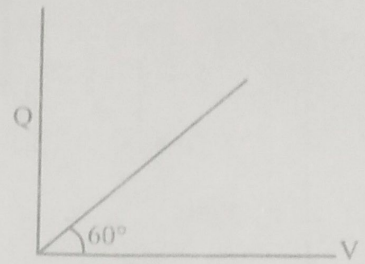
(i) n-identical capacitor of capacitance C_1 each are connected in series. The equivalent capacitance is C. Now n-identical capacitors of capacitance C_2 each are connected in parallel. The equivalent capacitance is C_0. If $C = C_0$, then ratio C_1/C_2 is given by:

(a) n^2 (b) $1/n^2$

(c) n (d) 1/n

(ii) Two graphs given below, are to show variation in Q-charge on capacitor and V-potential difference between the plates. In one case, the intervening medium is air and in second case, the intervening medium is some dielectric of dielectric constant K. The value of K is :





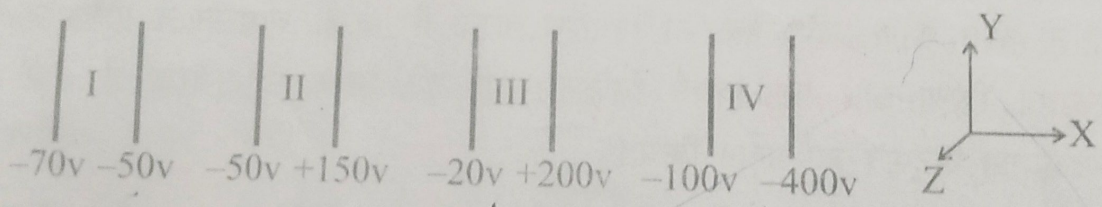
(a) $\sqrt{3}$

(b) 3

(c) 9

(d) $2\sqrt{3}$

(iii) The figure shows four pairs of parallel identical conducting plates, separated by the same distance 2.0 cm and arranged perpendicular to X-axis. The electric potential of each plate is mentioned. The electric field between the pair of plates is uniform and normal to the plates. For which pair of plates the electric field is along $\hat{i}$.



(a) I

(b) II

(c) III

(d) IV

(iv) In the above diagram, if E_1, E_2, E_3 and E_4 be the magnitude of electric field between the pairs of plates I, II, III and IV respectively, then :

(a) $E_1 > E_2 > E_3 > E_4$

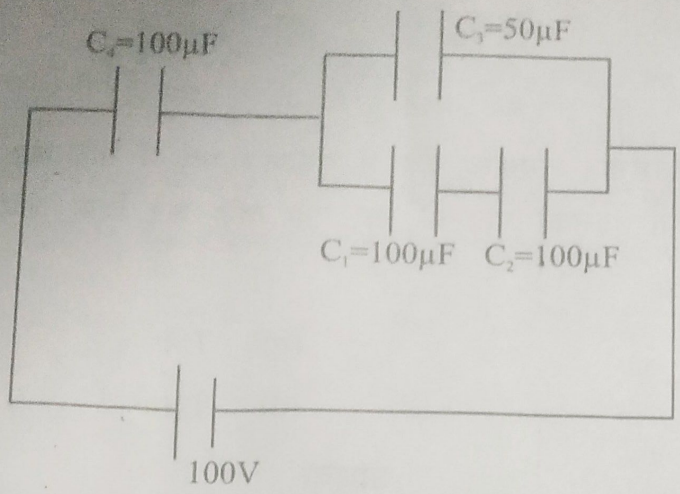
(b) $E_3 > E_4 > E_1 > E_2$

(c) $E_4 > E_3 > E_2 > E_1$

(d) $E_2 > E_3 > E_4 > E_1$

OR

In the given network, the charge on capacitor C_2 is :



(a) 2 mC (b) 2 μC

(c) 2.5 mC (d) 2.5 μC

30. A charge particle q when placed in an electric field $\vec{E}$, expression a force $\vec{F}_e$ which on 'q' and $\vec{E}$. When it move in a magnetic field $\vec{B}$ it experiences a magnetic force $\vec{F}_m$ which depends on q, $\bar{v}$ (velocity) and $\vec{B}$. The trajectory of a charge particle is influenced by both the fields. The angle between velocity of charge particle and the direction of field decide the trajectory of the charge-particle. J.J. Thomson studied the trajectory of electron in the region of combined fields (E and $\vec{B}$) to measure the charge to mass ratio of the electron. 4

(i) An electron moving with velocity $\bar{v} = v\hat{i}$ enters into a region where an electric field $\vec{E} = E\hat{j}$ and magnetic field $\vec{B} = B\hat{k}$ exist. The Lorentz force acting on the electron is given by :

(a) $\vec{F} = e(E + vB)\hat{j}$ (b) $\vec{F} = e(E + vB)\hat{i}$

(c) $\vec{F} = -e(E + vB)\hat{j}$ (d) $\vec{F} = e(-E + vB)\hat{j}$

(ii) In above question if the electron undeflected in the region of combined fields then :

(a) $v = \frac{E}{B}$ (b) $v = \frac{B}{E}$

(c) $v = EB$ (d) $v = \frac{E^2}{B^2}$

(iii) The path of a charge particle moving in a uniform magnetic field is a Helix. The angle between the magnetic field and its velocity is :

(a) 90° (b) 30°

(c) 0° (d) 180°

(iv) A proton is moving in a uniform magnetic field along a circular path. Its time period is T. If its speed is increased by four times, the new time period will be:

(a) 4T (b) T/4

(c) T (d) T/16

OR

Which of the following is correct statement?

(a) Magnetic force always increases the K.E. of a charge particle.

(b) Magnetic force always decreases the K.E. of a charge particle.

(c) Magnetic force never changes the K.E. of a charge particle.

(d) Magnetic force increase the K.E. of a positively charged particle and decreases the K.E. of a negatively charged particle.

SECTION-E

(a) Using drift velocity deduce Ohm's law.

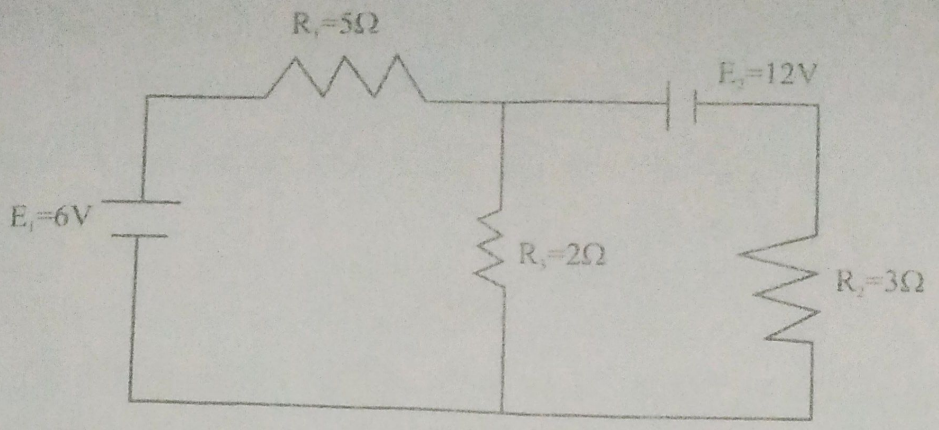
(b) Write Ohm's law in vector form.

(c) Two wires X and Y of same resistivity are connected in series. If the length of the two wires is same and the ratio of their resistances is 4:9, calculate the ratio of drift speeds of the electrons in the two wires. 5

OR

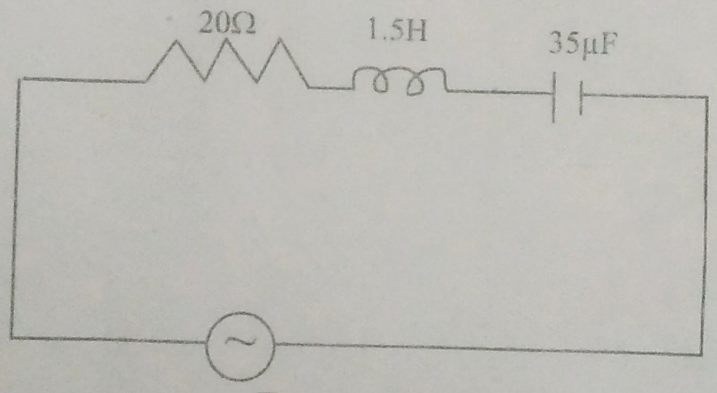
(a) State Kirchhoff's rules. Write their significance.

(b) Using Kirchhoff's rules, find current flowing in resistor R_3 of the given circuit.



32. (a) An a.c. source of voltage of $V = V_0 \sin wt$ is connected to a pure resistor. Derive an expression for the average power dissipated in the circuit over one cycle.

(b) In the given a.c. circuit, phase difference between current and voltage is 0°. Calculate the average power absorbed by circuit in one complete cycle. 5



$V = 200\sqrt{2} \sin (100t + \phi)$

OR

(a) What do you understand by Resonance in series LCR circuit? Obtain expression for resonating frequency in a series LCR circuit.

(b) A series LCR circuit is connected to an a.c. source (200V, 50Hz). The voltage across the resistor, capacitor and inductor are respectively 200V, 250V and 250V. If the value of resistance R is 40Ω, calculate the current in the circuit.

33. (a) State two conditions for total internal reflection (TIR).

(b) Define critical angle and obtain an expression for it in terms of refractive index.

(c) The critical angle of a pair of a medium and air is 30°. Calculate speed of light in the medium. 5

OR

(a) Draw a ray diagram of a reflecting type telescope. Mention two advantages of a reflecting type telescope over a refracting telescope.

(b) A small telescope has an objective lens of focal length 140 cm and an eye piece of focal length 5.0 cm. Calculate the magnifying power of telescope and separation between the objective lens and the eye-pieces when final image is formed at infinity.