Pratap Public School, Karnal

Mid-Term Examination (2023)

Class - XII

Subject - Physics

Time : 3 Hours **M.M : 70**

Name ..... Roll No. ..... Section .....

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 two question in Section B, two 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.

SECTION-A

1. The electric potential on the axis of an electric dipole at a distance r from its centre is 2V. Then the potential at a point at the same distance on its equatorial line will be: (1)

   (a) 2V (b) -V

   (c) V/2 (d) Zero

2. Large-scale transmission of electrical energy over long distances is done with 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

3. An electron with angular momentum L moving around the nucleus has a magnetic moment given by: (1)

   (a) e L/ 2m (b) e L/3m

   (c) e L /4m (d) e L / m

4. An ammeter of resistance 0.81 ohm reads up to 1 A. The value of the required shunt to increase the range to 10 A is: (1)

   (a) 0.9 ohm (b) 0.09 ohm

   (c) 0.03 ohm (d) 0.3 ohm

5. The relative magnetic permeability of a substance X is slightly less than unity and that of substance Y is slightly more than unity, then: (1)

   (a) X is paramagnetic and Y is ferromagnetic (b) X is diamagnetic and Y is ferromagnetic

   (c) X and Y both are paramagnetic (d) X is diamagnetic and Y is paramagnetic

6. An electron is moving along positive x-axis in a magnetic field parallel to the positive y-axis. In what direction will the magnetic force be acting on the electron? (1)

(a) Along -x axis (b) Along -z axis

(c) Along +z axis (d) Along -y axis

7. An electric dipole placed in an electric field of intensity 2×10^5 N/C at an angle of 30° experiences a torque equal to 4 Nm. The charge on the dipole of dipole length 2 cm is: (1)

(a) 7 μC (b) 8 mC

(c) 2 mC (d) 5 Mc

8. Which of the following is not the property of an equipotential surface? (1)

(a) They do not cross each other.

(b) The work done in carrying a charge from one point to another on an equipotential surface is zero.

(c) For a uniform electric field, they are concentric spheres.

(d) They can be imaginary spheres.

9. If the magnetizing field on a ferromagnetic material is increased, its permeability: (1)

(a) decreases (b) increases

(c) remains unchanged (d) first decreases and then increases

10. A rectangular, a square, a circular and an elliptical loop, all in the (x-y) plane, are moving out of a uniform magnetic field with a constant velocity $\vec{v} = v\hat{i}$ .The magnetic field is directed along the negative z-axis direction. The induced emf, during the passage of these loops, out of the field region, will not remain constant for: (1)

(a) any of the four loops (b) the circular and elliptical loops

(c) rectangular, circular and elliptical loops (d) only the elliptical loops

11. Current density is a _____. (1)

(a) scalar quantity (b) vector quantity

(c) dimensionless quantity (d) none of these options

12. The magnetic moment of a current I carrying a circular coil of radius r and number of turns N varies as: (1)

(a) r^4 (b) r^2

(c) $1/r^2$ (d) r

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:** Electric lines of force never cross each other.
Reason: Electric field at a point superimpose to give one resultant electric field. (1)

14. **Assertion:** In a cavity within a conductor, the electric field is zero.
Reason: Charges in a conductor reside only at its surface.

15. **Assertion:** Diamagnetic materials can exhibit magnetism. (1)
Reason: Diamagnetic materials have permanent magnetic dipole moment. (1)

Reason: Domains are destroyed at high temperature. (1)

SECTION-B

17. A metallic rod of length L is rotated with angular frequency ω with one end 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. Deduce the expression for the emf between the centre and the metallic ring. (2)

18. A heating element using nichrome connected to a 230 V supply draws an initial current of 3.2 A which settles after a few seconds to a steady value of 2.8 A. What is the steady temperature of the heating element if the room temperature is 27.0 °C and the temperature coefficient of resistance of nichrome is 1.70×10^{-4} °C^{-1}? (2)

OR

Estimate the average drift speed of conduction electrons in a copper wire of cross-sectional area 25×10^{-7}m^2 carrying a current of 1.8 A. Assume the density of conduction electrons to be 9×10^{28} m^{-3}. (3)

19. Calculate the quality factor of a series LCR circuit with L= 2.0 H, C= 2 μ F and R= 10Ω . Mention the significance of quality factor in LCR circuit. (2)

OR

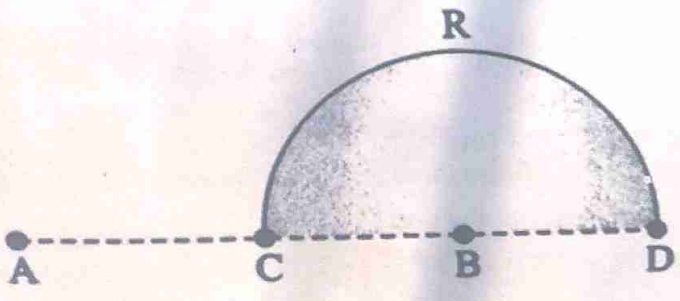
An alternating voltage given by v =70 sin 100πt is connected across a pure resistor of 25 Ω. Find the frequency of the source & rms current through the resistor. (2)

20. A cell of emfE and internal resistance r is connected across a variable load resistor R. Draw the plot of the terminal voltage Vversus (i) resistance R and (ii) currentI. It is found that when R=4 Ω, the current is 1A and when R is increased to 9Ω the current reduce to 0.5A.Find the values of the emf E and internal resistance r. (2)

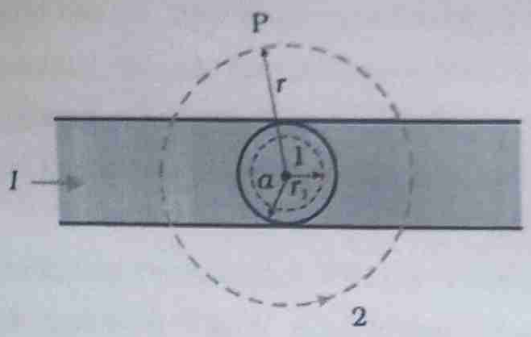
21. Derive an expression for the electric potential at any point along the axial line of an electric dipole. (2)

SECTION-C

22. Charges (+2q) and (–2q) are placed at the points A and B respectively which are a distance 2L apart. C is the midpoint between A and B. What is the work done in moving a charge +Q along the semicircle CRD. (3)



23. The given figure shows a long straight wire of a circular cross-section (radius a) carrying steady current I. The current I is uniformly distributed across this cross-section. Calculate the magnetic field in the region r < a and r > a. (3)



24. a. Define mutual inductance and write its SI unit.

b. Two circular loops, one of small radius r and other of larger radius R, such that R >> r, are placed coaxially with centres coinciding. Obtain the mutual inductance of the arrangement. (3)

OR

Two long straight parallel current carrying conductors are kept 'd' distant apart in air. The direction of current in both the conductors is same. Find the magnitude of force per unit length and direction of the force between them. Hence define one ampere. (3)

25. Two cells of emfs ε1 and ε2 and internal resistances r_1 and r_2 respectively are connected in parallel. Deduce the expression for the

(i) equivalent emf of the combination

(ii) equivalent internal resistance of the combination. (3)

26. What do you understand by sharpness of resonance in a series LCR circuit? Derive an expression for Q-factor of the circuit. (3)

OR

A small town with a demand of 800 kW of electric power at 220 V is situated 15 km away from an electric plant generating power at 440 V. The resistance of the two wire line carrying power is 0.5 Ω per km. The town gets power from the line through a 4000-220 V step-down transformer at a sub-station in the town. (a) Estimate the line power loss in the form of heat. (b) How much power must the plant supply, assuming there is negligible power loss due to leakage? (c) Characterise the step up transformer at the plant. (3)

27. Two-point charges + q and -2q are placed at the vertices B and C of an equilateral triangle ABC of side a. Obtain the expression for (i) the magnitude and (ii) the direction of the resultant electric field at the vertex A due to these two charges. (3)

28. Find the expression for magnetic dipole moment of a revolving electron. What is Bohr magneton? (3)

SECTION-D

29. Self-Induction. When a current I flows through a coil, flux linked with it is $\phi = LI$, where L is a constant known as self-inductance of the coil. (4)

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) 0.5Wb (b)12.5Wb

(c) zero (d) 2 Wb

(iii) The inductance L of a solenoid depends upon its radius R as

(a) $L \alpha R$ (b) $L \alpha 1/R$

(c) $L \alpha R^2$ (d) $L \alpha R^3$

(iv) The unit of self-inductance is

(a) Weber ampere (b) $Weber^{-1}$ ampere

(c) Ohm second (d) Farad

OR

The induced emf in a coil of 10 henry inductance in which current varies from 9 A to 4 A in 0.2second is

(a) 200 V (b) 250 V

(c) 300 V (d) 350 V

30. Smallest charge that can exist in nature is the charge of an electron. During friction it is only the transfer of electron which makes the body charged. Hence net charge on anybody is an integral multiple of charge of an electron (1.6×10^{-19} C) i.e., $q = \pm ne$ where $n = 1, 2, 3, 4 \ldots$.
Hence nobody can have a charge represented as 1.8e, 2.7e, 2e/5, etc.
Recently, it has been discovered that elementary particles such as protons or neutrons are elemental units called quarks.

(i) Which of the following properties is not satisfied by an electric charge?

(a) Total charge conservation. (b) Quantization of charge.

(c) Two types of charge. (d) Circular line of force.

(ii) Which one of the following charges is possible?

(a) 5.8×10^{-18} C (b) 3.2×10^{-18} C

(c) 4.5×10^{-19} C (d) 8.6×10^{-19} C

(iii) If a charge on a body is 1 nC, then how many electrons are present on the body?

(a) 6.25×10^{27} (b) 1.6×10^{19}

(c) 6.25×10^{28} (d) 6.25×10^{9}

(iv) If a body gives out 10^9 electrons every second, how much time is required to get a total charge of 1 from it?

(a) 190.19 years (b) 150.12 years

(c) 198.19 years (d) 188.21 years

OR

A polythene piece rubbed with wool is found to have a negative charge 3.2×10^{-7} C. Calculate the number of electrons transferred.

SECTION-E

31. (a) Draw equipotential surfaces for (i) an electric dipole and (ii) two identical positive charges placed near each other.

(b) In a parallel plate capacitor with air between the plates, each plate has an area of 6×10^{-3} m^2 and the separation between the plates is 3 mm. (i) Calculate the capacitance of the capacitor. (ii) If the capacitor is connected to 100V supply, what would be the charge on each plate? (iii) How would charge on the plate be affected if a 3 mm thick mica sheet of k=6 is inserted between the plates while the voltage supply remains connected? (5)

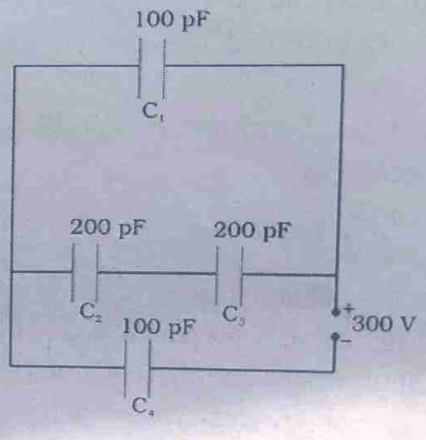
OR

(a) Three charges –q, Q and –q are placed at equal distances on a straight line. If the potential energy of the system of these charges is zero, then what is the ratio Q:q?

(b) Obtain the expression for the electric field intensity due to a uniformly charged spherical shell of radius R at a point distant r from the centre of the shell outside it. Draw a graph showing the variation of electric field intensity E with r, for r > R and r < R. (5)

32. (a) Derive an expression for the capacitance of a parallel plate capacitor with air present between the two plates.

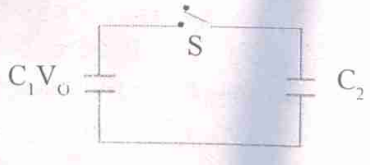
(b) Obtain the equivalent capacitance of the network shown in figure. For a 300 V supply, determine the charge on each capacitor. (5)



OR

(a) A dielectric slab of thickness 't' is kept between the plates of a parallel plate capacitor with plate separation 'd' (t < d). Derive the expression for the capacitance of the capacitor.

(b) A capacitor of capacity C_1 is charged to the potential of V_0. On disconnecting with the battery, it is connected with an uncharged capacitor of capacity C_2 as shown in the adjoining figure. Find the ratio of energies before and after the connection of switch S. (5)



33. Explain, using a labelled diagram, the principle and working of a moving coil galvanometer. What is the function of (i) uniform radial magnetic field (ii) soft iron core?
Define the terms (i) current sensitivity and (ii) voltage sensitivity of a galvanometer. Why does increasing the current sensitivity not necessary increase voltage sensitivity? (5)

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. (5)

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