17

N.K.BAGRODIA PUBLIC SCHOOL, SEC-4, DWARKA

CLASS: XII **MID TERM EXAMINATION** **SESSION: 2025-26**

TIME: 3HRS **SUB: PHYSICS** **MAX. MARKS: 70**

General Instructions:

1. There are **33 questions** in all. All Questions are compulsory.
2. This question paper has five sections, Section A,B,C,D and E
3. All the sections are compulsory
4. Section A contains 16 questions 12 MCQ and 4 Assertion Reasoning based of 1 mark each, Section B contains 5 Questions of 2 marks each, Section C contains 7 Questions of 3 marks each, Section D contains 2 case study based Question of 4 marks and Section E contains 3 long answer Questions of 5 marks .
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 of CBQ and in 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. A semicircular rod of radius r is charged uniformly with a total charge Q coulomb. Find electric field intensity at the center of curvature, 1

   a) $\frac{1}{4\pi\varepsilon_0}\frac{3Q}{\pi r^2}$ b) $\frac{1}{4\pi\varepsilon_0}\frac{Q}{\pi r^2}$ c) $\frac{1}{\pi\varepsilon_0}\frac{Q}{\pi r^2}$ d) $\frac{1}{4\pi\varepsilon_0}\frac{2Q}{\pi r^2}$

2. Equipotential at a great distance from a collection of charges whose sum is not zero are approximately 1

   a) sphere b) planes c) paraboloids d) ellipsoids

3. Which one of the following instrument has least resistance? 1

   a) Ammeter of range 0-1 amp b) Voltmeter of range 0-1V
   c) Ammeter of range 0-10 amp d) Voltmeter of range 0-10V

4. Four charges equal to –Q are placed at four corners of a square and charge q at its centre. If the system is in equilibrium , the value of q is 1

   a) $-Q(1+2\sqrt{2})/4$ b) $Q(1+2\sqrt{2})/4$
   c) $-Q(1+2\sqrt{2})/2$ d) $Q(1+2\sqrt{2})/2$

5. If the rms current in a 50Hz AC circuit is 5A, the value of the current 1/300 seconds after its value become zero is 1

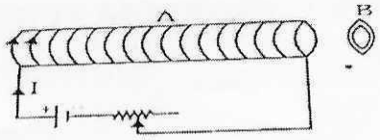
   a) $5\sqrt{2}$ b) $5\sqrt{3/2}$ c) $5/6$ d) $5/\sqrt{2}$

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) a^4c b) $\frac{1}{3}a^3c$ c) $\frac{1}{3}a^4c$ d) 0

7. An aluminium ring B faces an electromagnet A. The current I through A can be altered. Then which of the following statement is correct 1

a) If I decrease A will repel B
b) Whether I increase or decreases, B will not experience any force
c) If I increase, A will attract B
d) If I increase A will repel B



8. The relative magnetic permeability of a substance X is slightly more than unity and that of substance Y is slightly less than unity, then 1
a) X is paramagnetic and Y is ferromagnetic
b) X is diamagnetic and Y is Paramagnetic
c) X and Y both are paramagnetic
d) Y is diamagnetic and X is paramagnetic

9. Five equal resistors when connected in series dissipates 5watt power. If they are connected in parallel, the power dissipated will be 1
a) 100W b) 125W c) 50W d) 25W

10. A series LCR-circuit driven by 300 V at a frequency of 50 Hz contains a resistance R= 3k Ω, inductor of inductive reactance $250\pi\ \Omega$ and an unknown capacitor. The value of capacitance to maximize the average power should be(take $\pi^2 = 10$) 1
a) 25μ F b) 4 μ F c) 40 μ F d) 400 μ F

11. A test charge of 1.6×10^{-19} C is moving with a velocity $\vec{v} = (4\hat{\imath} + 3\hat{k})ms^{-1}$ in a magnetic field $\vec{B} = (3\hat{k} + 4\hat{\imath})$T. The force on this test charge is: 1
a) $24\hat{\jmath}$N b) $-24\hat{\imath}$N c) $24\hat{k}$N d) zero

12. $m^2 V^{-1} s^{-1}$ is the SI unit of which of the following? 1
a) Drift velocity b) Mobility
c) Resistivity d) Potential gradient

For question numbers 13, 14, 15 and 16, two statements are given-one labeled Assertion (A) and the other labeled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.

a) Both A and R are true and R is the correct explanation of A
b) Both A and R are true but R is NOT the correct explanation of A
c) A is true but R is false
d) A is false and R is also false

13. **Assertion (A):** Total current entering a circuit is equal to leaving it by Kirchhoff's law. 1
Reason(R): It is based on conservation of energy.

14 **Assertion (A):** Electric potential energy is negative 1
Reason (R): Work is done in the direction of the electric field.

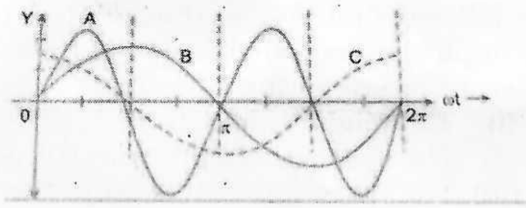
15. **Assertion (A):** The internal resistance of a cell is constant. 1
Reason(R): Ionic concentration of the electrolyte remains same during use of a cell.

16. **Assertion (A):** Inductance coils are made of copper. 1
Reason (R): Induced current is more in the wire having less resistance.

Section B

17. A rectangular wire loop of sides 8cm and 2cm with a small cut is moving out of a region of uniform magnetic field of magnitude 0.3T directed normal to the loop. What is the emf developed across the cut if the velocity of the loop is $1 cms^{-1}$ in a direction normal to the (i) longer side (ii) shorter side of the loop? For how long does the induced voltage last in each case? 2

18. A device X is connected to an ac source V=Vo Sin wt. The variation of voltage, current and power in one cycle is shown in the given graph: 2
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?



19 i) Write the relation between mobility and drift velocity in a current carrying conductor. 2
ii) A conductor of uniform cross-sectional area is connected across a dc source of variable voltage. Draw a graph showing variation of drift velocity (Vd) of electrons as a function of current density (j) in it.

20. Show that the time period (T) of oscillations of a freely suspended magnetic dipole of magnetic moment M in a uniform magnetic field B is given by $T=2\pi\sqrt{(I/MB)}$, where I is moment of inertia of the dipole. 2

OR

A straight wire of length 4 m carrying a current of 0.5 A can be turned into either a square or a circular loop of 2 turns, before placing it in a magnetic field of intensity 0.1 T. Which loop do you think will require less counter torque in order to hold it in a position such that the axis of the loop is perpendicular to magnetic field. Justify your answer

21. A variable resistor R is connected across a cell of emf E and internal resistance r. 2
(i) Plot the graph showing variation of potential drop across R as function of R
(ii) At what value of R current in circuit will be maximum?

Section C

22. i) Two isolated metallic solid sphere of radii R and 2R are charged such that both have same charge density σ_1. The sphere are then connected by a thin conducting wire. If the new charge density of bigger sphere is σ_2. Find the ratio of σ_1/σ_2. 3
ii) A 600 pF capacitor is charged by a 200 V supply. Then it is disconnected from the supply and connected to another uncharged 600 pF capacitor. How much electrostatic energy is lost in this process?

23. (i) Derive the expression for mutual inductance of two coaxial concentric circular coils of radius r_1 and r_2 where $r_1 > r_2$. 3

(ii) A rectangular loop and a circular loop are moving out of a uniform magnetic field region to a field free region with a constant velocity. In which loop do you except the induced emf to be constant during the passage out of field region, give reason in support of your answer.

24. A short bar magnet of magnetic moment m = 0.32 JT^{-1} is placed in a uniform magnetic field of 0.15 T. If the bar is free to rotate in the plane of the field. 3

(i) which orientation would correspond to its (a) stable, and (b) unstable equilibrium?

(ii) What is the potential energy of the magnet in each case?

25. The following table gives the length of the three copper wires, their diameters, and the applied potential difference across their ends. Arrange the wires in increasing order according to the following:

(i) The magnitude of the electric field within them, 3

(ii) The drift speed of the electrons through them,

(iii) The current density within them

Wire no.	Length	Diameter	Potential difference
1	L	3d	V
2	2L	D	V
3	3L	2d	2V

26. In a plane electromagnetic wave, the electric field oscillates sinusoidally at a frequency of 2.0 X 10^{10} Hz and amplitude 48Vm^{-1}. (Taking c= 3 x 10^8m/s) 3

(i) What is the wavelength of the wave?

(ii) What is the amplitude of the oscillating magnetic field?

(iii) Show that the average energy density of the electric field E equals the average energy density of the magnetic field B.

27. A heating element connected across a battery of 100 V having an internal resistance of 1 Ω draws an initial current of 10 A at room temperature 20.0 °C which settles after a few seconds to a steady value. Temperature coefficient of resistance averaged over the temperature range involved is 3.70 × 10^{-4} °C^{-1}. 3

(i) What is the power consumed by battery itself after the steady temperature of 320.0 °C is attained?

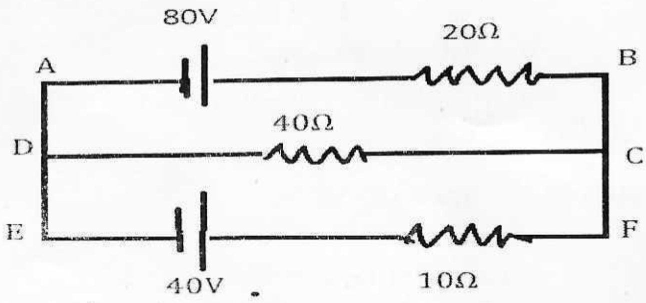
(ii) Plot a graph showing the variation of resistance of a conducting wire as a function of its radius, keeping the length of the wire and its temperature as constant.

OR

Using Kirchhoff's law

(i) calculate the current through the 40Ω and 20Ω resistors in the following circuit.

(ii) potential difference between points A and B.



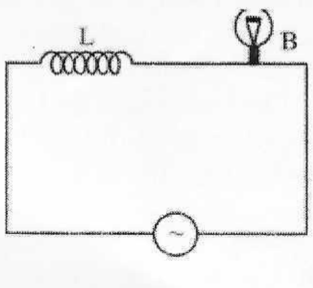
28. (i) Why it is necessary to use cylindrical soft iron core in galvanometer. 3
(ii) Can a galvanometer as such be used to measure current? Explain
(iii) How the voltage sensitivity will vary, if the current sensitivity of galvanometer increased by 20 %, and its resistance also increases by 25 %,

Section D

29. **Case Study Based Question** 4

In a series LCR circuit, all three components are connected in a single loop, so the same current flows through each. An open coil inductor L of inductive reactance X_L is connected in series with a bulb B and an a.c. source. An interesting characteristic of a series LCR-circuit is the phenomenon of resonance The sharpness of resonance is an important matter in radio reception of transmitting stations. If it is not sharp, other transmitting stations may produce a current I of the same value as the station required. Then interference will occur. If resistance R in the series LCR-circuit is small, then the resonance is sharp.

(i) When an iron rod is inserted into the interior of the inductor, the brightness of bulb



a. increases　　b. decreases
c. remains same　　d. first increases then decreases

(ii). A capacitor of capacitive reactance $X_C = X_L$ is connected in series in the above circuit, then phase difference between current and voltage in circuit will be
a. 90^0　　b. zero　　c. 180^0　　d. 45^0

(iii) In series LCR circuit the capacitance changed from C to C/4. For The resonant frequency to remain unchanged, the inductance should be changed from L to NL, where N is
a. ½　　b. 2　　c. 4　　d. ¼

(iv). Metal detector is based on

a. self-induction
b. mutual induction
c. electrical resonance
d. power transmission

OR

If wattless current flows in the ac circuit, then the circuit is

a. purely resistive
b. purely inductive
c. LCR series
d. RC series circuit only

30 Consider a system of two point charges +4μC and -4μC and , placed 20 cm apart in a vacuum. The charges are fixed at points A and B respectively along the x-axis, with A at x= -10cm and B at x =+10 cm The electric field and equipotential surfaces generated by these charges are symmetric about the midpoint between the two charges. Equipotential surfaces are surfaces on which the potential at every point is the same. Near the charges, these surfaces are nearly spherical, and at greater distances, the surfaces become elongated along the axis connecting the charges. At the midpoint between the charges, the potential is zero. However, the electric field at this point is not zero, as the electric fields due to the individual charges add up in magnitude but point in opposite directions. 4

(i) Select the correct statements from the following

1. Inside a charged or neutral conductor, electrostatic field is zero
2. The electrostatic field at the surface of the conductor must be tangential to the surface at any point
3. There is no net charge at any point inside the conductor

a) 1 and 2
b) 1 and 3
c) 2 and 3
d) 1, 2, and 3

(ii) Which of the following statements about equipotential surfaces is correct?

a) Equipotential surfaces are always parallel to the electric field lines.
b) Equipotential surfaces are perpendicular to electric field lines.
c) The work done by the electric field in moving a test charge between two points on the same equipotential surface is not zero.
d) Equipotential surfaces do not exist near charges.

(iii) If the test charge is moved from a point on an equipotential surface at 10 cm from the origin to another point at 15 cm from the origin, what is the work done by the electric field?

a) Positive
b) Negative
c) Zero
d) Depends on the charge type

iv) When a soap bubble is given an electric charge

a) It contracts
b) It expands
c) Its size remains the same
d)It expands or contracts depending upon whether the charge is positive or negative

OR

Two copper spheres of the same radius, one solid and the other hollow, are charged to the same potential. Which will have more charge?

a) Solid sphere
b) Hollow sphere
c) Both will have an equal charge
d) None of these

Section E

31. (i) Using Gauss law drive the expression for electric field due to charged conducting sphere of radius 'R' on a point with a position vector r with respect to the center of the sphere when r > R and r < R. 5

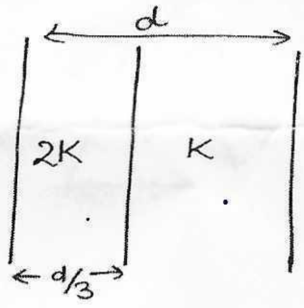
(ii) Plot the graph showing the variation of electric field with the distance in the above case.

(iii) The electric field in a region is given by $\vec{E} = 40\, x\hat{\imath}$ N/C. Find the amount of work done in taking a unit positive charge from a point (0,3m) to the point (5m,0).

OR

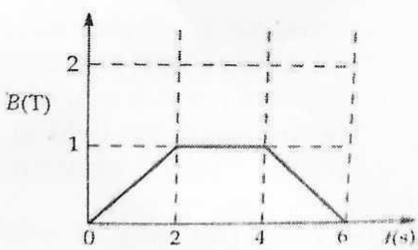
(i) A dielectric slab of dielectric constant K and of thickness b is introduced between plates of parallel plate capacitor separated by a distance d (b<d). Derive the expression for capacitance of capacitor,

(ii) Two slabs of dielectric constants 2K and K fill the space between the plates of a parallel plate capacitor of plate area 'A' and plate separation 'd' as shown in figure. Find equivalent capacitance of the system.



Also plot the variation of potential difference between plates and distance d as measured from given figure.

32. (i) The magnetic field through a circular loop of wire 10 cm in radius and 8 Ω resistance, changes with time as shown in figure. The magnetic field is perpendicular to the plane of loop. Calculate the induced current in the loop and plot it as a function of time. 5



(ii) A circular coil of radius 8.0 cm and 20 turns is rotated about its vertical diameter with an angular speed of 50 rad s^{-1} in a uniform horizontal magnetic field of magnitude 3.0×10^{-2} T. Obtain the maximum and average emf induced in the coil. If the coil forms a closed loop of resistance 10 Ω, calculate I_{max}.

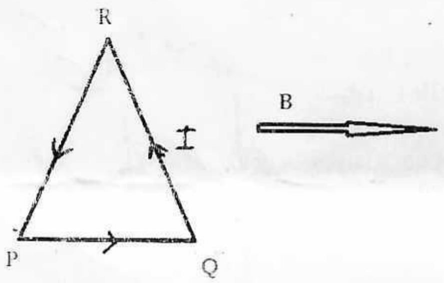
OR

(i) A series LR circuit connected with an ac source E= (25 sin 1000t) V has power factor $1/\sqrt{2}$. Calculate the new power factor of the circuit if the source of emf is changed to E= (20 sin 2000t) V.

(ii) 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. If the town gets power from the line through 40,000-220 V step down transformer, how much power loss could be saved?

33 (i) A charge particle of mass m charge Q moving at uniform velocity V enters a uniform magnetic field B acting normal to the plane of the paper. Deduce expression for radius of circular paths, the kinetic energy of the charge particle and the work done by the magnetic force on the charge particle.

(ii) An equilateral triangular loop PQR with side equal to L is carrying current I. If a uniform magnetic field B exists parallel to PQ, then find the force acting on the wires separately.



OR

(i) A straight thick long wire of uniform circular cross-section of radius 'a' is carrying a steady current I. The current is uniformly distributed across the cross-section. Use Ampere's circuital law to obtain a relation showing the variation of the magnetic field (B_r) inside and outside the wire with distance r ($r \leq a$) and ($r > a$) of the field point from the centre of cross-section. What is the magnetic field at the surface of this wire? Plot a graph showing the nature of this variation.

(ii) Calculate the ratio of magnetic field at a point a/2 above the surface of the wire to that at a point a/2 below its surface. What is the maximum value of the field of this wire?

---------------------X---------------------