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SET	A
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**INDIAN SCHOOL MUSCAT
HALF YEARLY EXAMINATION 2022
PHYSICS (042)**



CLASS: XII
DATE: 18-09-2022

TIME ALLOTTED: 3 HRS.
MAXIMUM MARKS: 70

GENERAL INSTRUCTIONS:

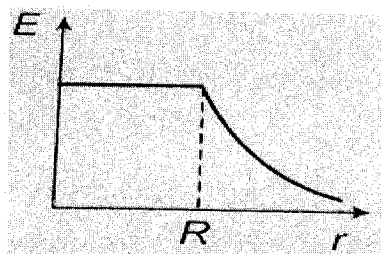
1. All questions are compulsory. There are 37 questions in all.
2. This question paper has five sections: Section A, Section B, Section C, Section D and Section E.
3. Section A contains twenty-two questions of one mark each, Section B contains two case study questions of four marks each, Section C contains five questions of two marks each, Section D contains five questions of three marks and Section E contains three questions of five marks each.
4. There is no overall choice. However, an internal choice has been provided in two questions of two marks, two questions of three marks and all the three questions of five marks weightage. You have to attempt only one of the choices in such questions.
5. You may use the following values of physical constants wherever necessary.

$$\epsilon_0 = 8.85 \times 10^{-12} \text{C}^2 \text{N}^{-1} \text{m}^{-2}, \quad \mu_0 = 4\pi \times 10^{-7} \text{Tm/A}, \quad \frac{1}{4\pi\epsilon_0} = 9 \times 10^9 \text{Nm}^2 \text{C}^{-2},$$

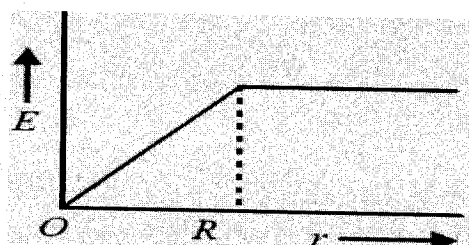
SECTION A

1. The electric field due to a uniformly charged hollow sphere of radius R as a function of the distance from its centre is represented graphically by

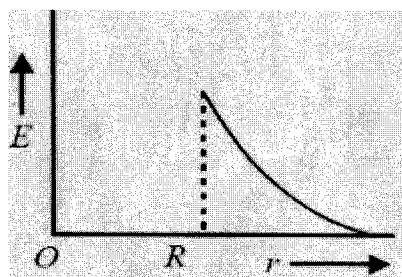
A.



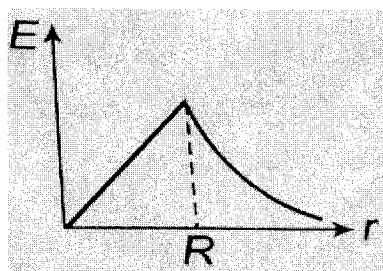
B.



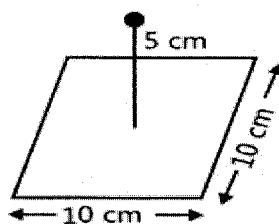
C.



D.

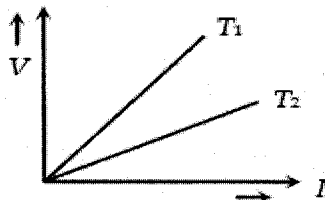


2. A point charge $+10 \mu\text{C}$ is at a distance 5 cm directly above the centre of a square of side 10 cm, as shown in figure. What is the magnitude of the electric flux through the square? 1



- A. Zero B. $8 \times 10^2 \text{ Nm}^2 \text{ C}^{-1}$ C. $1.8 \times 10^4 \text{ Nm}^2 \text{ C}^{-1}$ D. $1.8 \times 10^5 \text{ Nm}^2 \text{ C}^{-1}$
3. Electric field intensity between two equally and oppositely charged plates of surface charge densities $+\sigma$ and $-\sigma$ is 1
- A. $\epsilon_0 \sigma$ B. $\sigma/2 \epsilon_0$ C. σ/ϵ_0 D. $2\sigma/\epsilon_0$
4. Potential energy of an electric dipole held at an angle Θ in a uniform electric field is zero when Θ is equal to 1
- A. 0° B. 90° C. 180° D. 360°
5. A hollow metal sphere of radius 5 cm is charged so that the potential on its surface is 10V. The potential at the centre of the sphere is 1
- A. 0V B. 10V
- C. Same as at point 5cm away from the surface
- D. Same as at point 25cm away from the surface
6. On moving a charge of 20 coulombs by 2 cm, 2 J of work is done, then the potential difference between the points is 1
- A. 0.1 V B. 8V C. 2V D. 0.5V
7. Kirchhoff's first and second laws for electrical circuits are consequences of 1
- A. conservation of electric charge and energy respectively
- B. conservation of electric charge
- C. conservation of energy and electric charge respectively
- D. conservation of energy

8. For a cell, the terminal potential difference is 3.6 V, when the circuit is open. If the potential difference reduces to 3 V, when cell is connected to a resistance of $5\ \Omega$, the internal resistance of cell is 1
- A. $1\ \Omega$ B. $2\ \Omega$ C. $4\ \Omega$ D. $8\ \Omega$
9. The voltage V and current I graph for a conductor at two different temperatures T_1 and T_2 are shown in the figure. The relation between T_1 and T_2 is 1



- A. $T_1 > T_2$ B. $T_1 < T_2$ C. $T_1 = T_2$ D. $T_1 = 2 T_2$
10. A student measures the terminal potential difference (V) of a cell (of emf ϵ and internal resistance r) as a function of current (I) flowing through it. The slope and the intercept, of the graph between V and I, then respectively, equal 1
- A. $-r, \epsilon$ B. $-\epsilon, r$ C. $\epsilon, -r$ D. $r, -\epsilon$
11. A positive charge is moving towards an observer. The direction of magnetic field lines is 1
- A. Clockwise B. Anticlockwise C. Upwards D. Downwards
12. An electric current pass through a long straight copper wire. At a distance 5 cm from the straight wire, the magnetic field is B. The magnetic field at 20 cm from the straight wire would be 1
- A. $B/6$ B. $B/4$ C. $B/2$ D. $4B$
13. A current carrying conductor placed in a magnetic field experiences maximum force when angle between current and magnetic field is 1
- A. $3\pi/4$ B. $\pi/2$ C. $\pi/4$ D. zero

In question numbers **14 to 18**, two statements are given- one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the options (i), (ii), (iii) and (iv) as given below. 1

- (i) Both Assertion(A)and Reason(R) are true and Reason(R) is the correct explanation of A.
 (ii) Both Assertion(A)and Reason(R) are true but Reason(R) is not the correct explanation of A.
 (iii) Assertion(A) is true but Reason(R) is false.
 (iv) Assertion(A) is false and Reason(R) is also false.

14. Assertion: When we produce charge q_1 on a body by rubbing against another body which gets a charge q_2 in the process, then $q_1 + q_2 = 0$

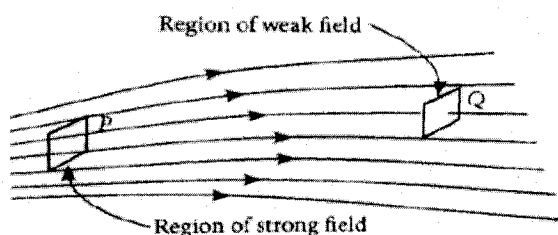
Reason: Charge on an isolated system remains constant.

15. Assertion: Electrons move away from a region of lower potential to a region of higher potential. 1
Reason: Electron is negatively charged.
16. Assertion: Work done in moving a charge between any two points in an electric field is 1
independent of the path followed by the charge, between these points.
Reason: Electrostatic forces are non-conservative.
17. Assertion: The drift velocity of electrons in a metallic conductor decreases with rise of 1
temperature of conductor.
Reason: On increasing the temperature, the collision of electrons with lattice ions increases, this
hinders the drift of electrons.
18. Assertion: Magnetic field lines always form closed loops. 1
Reason: Moving charges or currents produce a magnetic field.
19. Current sensitivity of a galvanometer can be increased by decreasing _____. 1
20. Two long parallel conductors carrying currents in the opposite direction _____ each 1
other.
21. Direction of electric field intensity due to an electric dipole on equatorial point is 1
_____ to the direction of dipole moment.
22. An electric dipole is placed inside uniform electric field. Net _____ on it is always 1
zero.

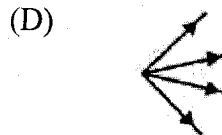
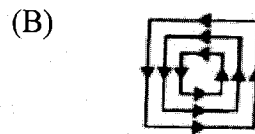
SECTION B

(Answer any four questions out of five questions for each case study question)

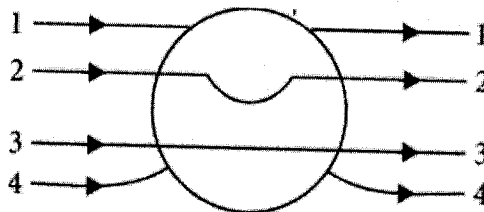
23. If one wishes to estimate the density of field lines, one has to consider the number of lines per unit 4
cross-sectional area, perpendicular to the lines. Since the electric field decreases as the square of
the distance from a point charge and the area enclosing the charge increases as the square of the
distance, the number of field lines crossing the enclosing area remains constant,
whatever may be the distance of the area from the charge. Having drawn a certain set of field
lines, the relative density (i.e., closeness) of the field lines at different points indicates the relative
strength of electric field at those points. The field lines crowd where the field is strong and are
spaced apart where it is weak.



- (i) Which of the following is false for electric field lines?
- (A) They always start from positive charge and terminate on negative charges.
 (B) They are always perpendicular to the surface of a charged conductor.
 (C) They always form closed loops.
 (D) They are parallel and equally spaced in a region of uniform electric field.
- (ii) Electric field lines about a positive point charge are always
- (A) radially outwards (B) circular clockwise
 (C) radially inwards (D) parallel straight lines
- (iii) Which one of the following patterns of electric field line is not possible in field due to stationary charges?

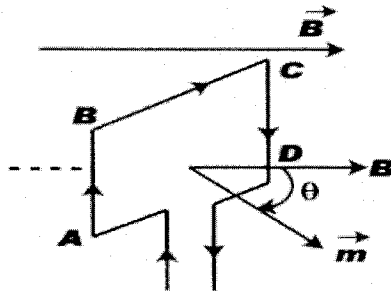


- (iv) A metallic solid sphere is placed in a uniform electric field. Which of the lines 1, 2, 3 and 4 shows the correct path of electric field lines?



- (A) 1 (B) 2 (C) 3 (D) 4
- (v) SI unit of electric field intensity is
- (A) C/N (B) C/m² (C) N/m (D) V/m

24. Consider a rectangular loop ABCD. Let the dimensions of the loop be l and b . There is a steady current in the loop. This loop is placed in the uniform magnetic field. Fleming's left-hand rule is a convention used to find the direction of the force acting on a wire from the direction of the magnetic field the wire is in and the direction of current through the wire. Torque is the measure of the force that causes an object to rotate around an axis. 4



- (i) A rectangular coil carrying current is placed in a non- uniform magnetic field. It experiences
- (A) a force of repulsion. (B) a force of attraction.
(C) a torque but not force. (D) a force and a torque
- (ii) A circular loop of area 1 cm^2 , carrying a current of 10 A is placed in a magnetic field of 0.1 T perpendicular to the plane of the loop. The torque on the loop due to the magnetic field is
- (A) 1 Nm (B) Zero (C) 10^{-2} Nm (D) 10^{-4} Nm
- (iii) A current carrying loop is free to rotate in a uniform magnetic field. The loop will then come into equilibrium when its plane is inclined at
- (A) Zero degree to the direction of the field (B) 45° to the direction of the field
(C) 90° to the direction of the field (D) 135° to the direction of the field
- (iv) The torque on a current carrying rectangular loop is τ when it is placed in a uniform magnetic field at an angle Θ . If the length and breadth of the loop is doubled then the torque on the loop at an angle Θ will be
- (A) τ (B) 2τ (C) $1/\tau$ (D) 4τ
- (v) The deflection in carrying loop in the magnetic field is
- (A) directly proportional to the area of coil
(B) inversely proportional to the area of coil
(C) inversely proportional to the current in coil
(D) inversely proportional to the magnetic field

SECTION C

25. Represent the orientation of the dipole in (a) stable, (b) unstable equilibrium in a uniform electric field with the help of diagram. 2

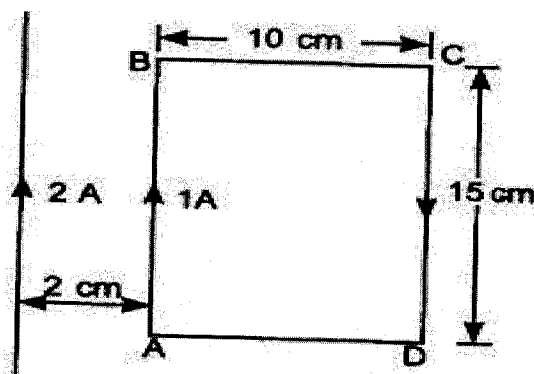
OR

Define electric dipole moment. Is it a scalar or a vector quantity? Write its SI unit.

26. Draw 3 equipotential surfaces corresponding to a field that uniformly increases in magnitude but remains constant along Z- direction. How are these surfaces different from that of a constant electric field along Z- direction? 2
27. A parallel plate capacitor is charged by a battery, which is then disconnected. A dielectric slab of dielectric constant 'K' is then inserted in the space between the plates. Explain what changes will occur in the values of (a) capacitance and (b) potential difference between the plates 2
28. A potential difference V is applied across the ends of copper wire of length 'l' and diameter D. What is the effect on drift velocity of electrons if (a) V is halved (b) D is halved? 2
29. A wire AB is carrying a steady current 12 A and is lying on the table. Another wire CD carrying 5 A is held directly above AB at a height of 1 mm. Find the mass per unit length of the wire CD so that it remains suspended at its position when left free. Give the directions of the current flowing in CD with respect to that in AB [Take the value of $g=10\text{ms}^{-2}$] 2

OR

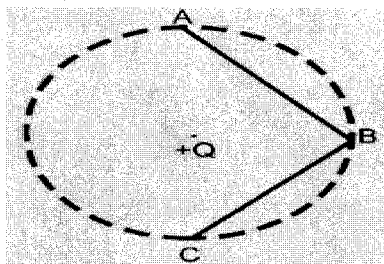
A rectangular loop of wire of size $15\text{cm} \times 10\text{cm}$ carries a steady current of 1A. A straight wire carrying 2A current is kept near the loop as shown. If the loop and the wire are coplanar, find the magnitude and direction of the net force on the loop due to the current carrying wire.



SECTION D

30. State Gauss's law in electrostatics. Using Gauss's law, derive an expression for the electric field intensity due to an infinitely long, straight wire of linear charge density λ C/m. 3
31. What is a capacitor? Derive an expression for the capacitance of a parallel plate capacitor with air as the medium between the plates. 3

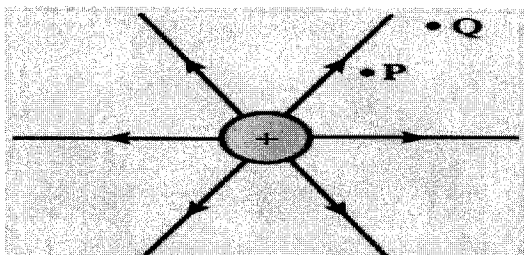
32. (i) In the given figure, charge $+Q$ is placed at the centre of a dotted circle. Work done in taking another charge $+q$ from A to B is W_1 and from B to C is W_2 . Which one of the following is correct: $W_1 > W_2$, $W_1 = W_2$ and $W_1 < W_2$? 3



- (i) Why is the potential inside a hollow spherical charged conductor constant and has the same value as on its surface?
- (ii) Define dielectric constant of a medium in terms of capacitance.

OR

- (i) Figure shows the field lines on a positive charge. Is the work done by the field in moving a small positive charge from Q to P positive or negative? Give reason.



- (ii) "For any charge configuration, equipotential surface through a point is normal to the electric field." Justify.
- (iii) Define dielectric strength of a dielectric.

33. Using the concept of free electrons in a conductor, derive the expression for the conductivity of a wire in terms of number density and relaxation time. Hence obtain the relation between current density and the applied electric field E . 3

OR

Two cells of emfs E_1 and E_2 and internal resistances r_1 and r_2 are connected in parallel. Derive the expression for the (i) emf and (ii) internal resistance of a single equivalent cell which can replace this combination.

34. Deduce an expression for the frequency of revolution of a charged particle in a perpendicular magnetic field and show that it is independent of velocity of charged particle. 3

SECTION E

35. (a) Using Gauss law, derive an expression for the electric field intensity at any point outside a uniformly charged thin spherical shell of radius R and charge density σ C/m². 5
(b) Two-point charges of $+5 \times 10^{-19}$ C and $+20 \times 10^{-19}$ C are separated by a distance of 2 m. Find the point on the line joining them at which electric field intensity is zero.

OR

- (a) An electric dipole is held in a uniform electric field. (i) Using suitable diagram show that it does not undergo any translatory motion, and (ii) derive an expression for torque acting on it and specify its direction.
(b) The sum of two-point charges is 7 μ C. They repel each other with a force of 1 N when kept 30cm apart in free space. Calculate the value of each charge.
36. (a) Define relaxation time of free electrons drifting in a conductor. Derive an expression for drift velocity of free electrons in a conductor in terms of relaxation time. 5
(b) On what factors does resistivity of a conductor depend?
(c) Why alloys like constantan and manganin are used for making standard resistors?

OR

- (a) State Kirchhoff's rules.
(b) Draw a circuit diagram showing balancing of Wheatstone bridge.
(c) Use Kirchhoff's rules to obtain the balance condition in terms of the resistances of four arms of Wheatstone Bridge.
37. (a) State Biot-Savart Law. 5
(b) Using Biot-Savart's law, derive an expression for the magnetic field at the centre of a circular coil of radius R , number of turns N , carrying current I .
(c) Sketch the magnetic field for a circular current loop, clearly indicating the direction of the field and direction of current.

OR

- (a) Draw a labelled diagram of a moving coil galvanometer. Describe briefly its principle and working.
(b) Answer the following:
(i) Why is it necessary to introduce a cylindrical soft iron core inside the coil of a galvanometer?
(ii) Increasing the current sensitivity of a galvanometer may not necessarily increase its voltage sensitivity. Explain, giving reason.

ROLL NUMBER				
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SET	B
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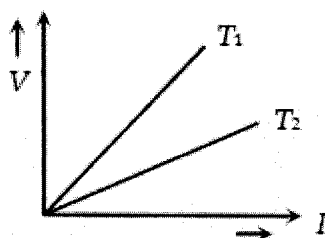
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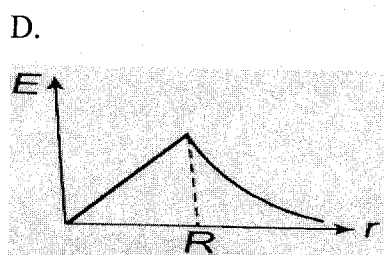
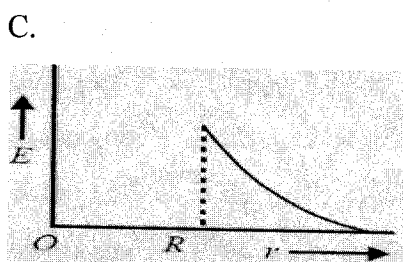
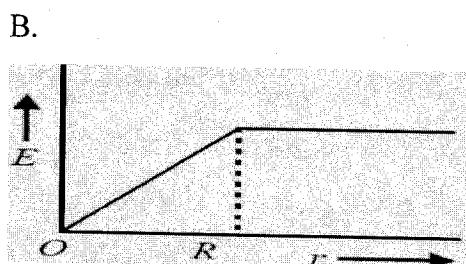
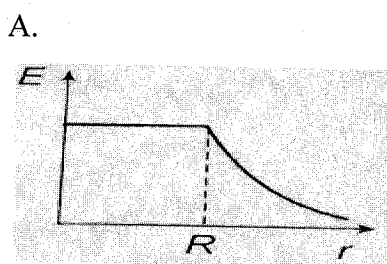
SECTION A

1. The voltage V and current I graph for a conductor at two different temperatures T_1 and T_2 are shown in the figure. The relation between T_1 and T_2 is 1

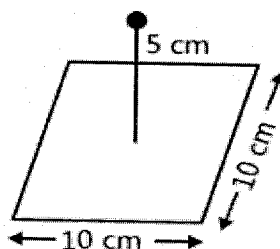


- A. $T_1 > T_2$ B. $T_1 < T_2$ C. $T_1 = T_2$ D. $T_1 = 2 T_2$

2. A student measures the terminal potential difference (V) of a cell (of emf ϵ and internal resistance r) as a function of current (I) flowing through it. The slope and the intercept, of the graph between V and I , then respectively, equal
- A. $-r, \epsilon$ B. $-\epsilon, r$ C. $\epsilon, -r$ D. $r, -\epsilon$
3. A positive charge is moving towards an observer. The direction of magnetic field lines is
- A. Clockwise B. Anticlockwise C. Upwards D. Downwards
4. An electric current pass through a long straight copper wire. At a distance 5 cm from the straight wire, the magnetic field is B . The magnetic field at 20 cm from the straight wire would be
- A. $B/6$ B. $B/4$ C. $B/2$ D. $4B$
5. A current carrying conductor placed in a magnetic field experiences maximum force when angle between current and magnetic field is
- A. $3\pi/4$ B. $\pi/2$ C. $\pi/4$ D. zero
6. The electric field due to a uniformly charged sphere of radius R as a function of the distance from its centre is represented graphically by



7. A point charge $+10 \mu\text{C}$ is at a distance 5 cm directly above the centre of a square of side 10 cm, as shown in figure. What is the magnitude of the electric flux through the square?



- A. Zero B. $8 \times 10^2 \text{ Nm}^2 \text{ C}^{-1}$ C. $1.8 \times 10^4 \text{ Nm}^2 \text{ C}^{-1}$ D. $1.8 \times 10^5 \text{ Nm}^2 \text{ C}^{-1}$

8. Electric field intensity between two equally and oppositely charged plates of surface charge densities $+\sigma$ and $-\sigma$ is 1
- A. $\epsilon_0 \sigma$ B. $\sigma/2 \epsilon_0$ C. σ/ϵ_0 D. $2\sigma/\epsilon_0$
9. Potential energy of an electric dipole held at an angle Θ in a uniform electric field is zero when Θ is equal to 1
- A. 0° B. 90° C. 180° D. 360°
10. A hollow metal sphere of radius 5 cm is charged so that the potential on its surface is 10V. The potential at the centre of the sphere is 1
- A. 0V B. 10V
- B. Same as at point 5cm away from the surface
- D. Same as at point 25cm away from the surface
11. On moving a charge of 20 coulombs by 2 cm, 2 J of work is done, then the potential difference between the points is 1
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12. Kirchhoff's first and second laws for electrical circuits are consequences of 1
- A. conservation of electric charge and energy respectively
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- D. conservation of energy
13. For a cell, the terminal potential difference is 3.6 V, when the circuit is open. If the potential difference reduces to 3 V, when cell is connected to a resistance of 5Ω , the internal resistance of cell is 1
- A. 1Ω B. 2Ω C. 4Ω D. 8Ω

In question numbers **14 to 18**, two statements are given- one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the options (i), (ii), (iii) and (iv) as given below.

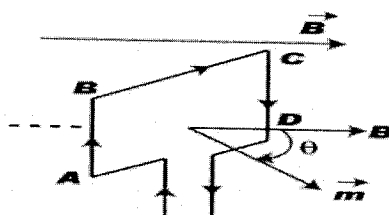
- (i) Both Assertion(A)and Reason(R) are true and Reason(R) is the correct explanation of A. 1
- (ii) Both Assertion(A)and Reason(R) are true but Reason(R) is not the correct explanation of A.
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14. Assertion: The drift velocity of electrons in a metallic conductor decreases with rise of temperature of conductor. 1
Reason: On increasing the temperature, the collision of electrons with lattice ions increases, this hinders the drift of electrons.
15. Assertion: Magnetic field lines always form closed loops. 1
Reason: Moving charges or currents produce a magnetic field.
16. Assertion: When we produce charge q_1 on a body by rubbing against another body which gets a charge q_2 in the process, then $q_1 + q_2 = 0$ 1
Reason: Charge on an isolated system remains constant.
17. Assertion: Electrons move away from a region of lower potential to a region of higher potential. 1
Reason: Electron is negatively charged.
18. Assertion: Work done in moving a charge between any two points in an electric field is independent of the path followed by the charge, between these points. 1
Reason: Electrostatic forces are non-conservative.
19. To convert galvanometer into a voltmeter of given range, a suitable high resistance should be connected in _____ with the galvanometer. 1
20. Torque on a current carrying rectangular coil inside a galvanometer is maximum and constant, irrespective of its orientation, as it is suspended inside _____ magnetic field. 1
21. Direction of electric field intensity due to a dipole on axial point is _____ the direction of dipole moment. 1
22. Net electric flux from a closed surface does not depends upon distribution of _____ inside the surface 1

SECTION B

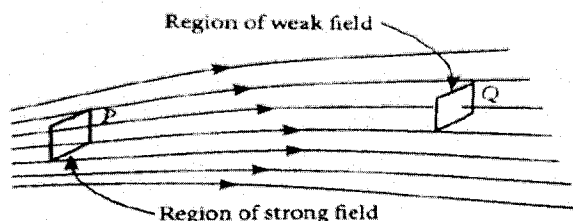
(Answer any four questions out of five questions for each case study question)

23. Consider a rectangular loop ABCD. Let the dimensions of the loop be l and b . There is a steady current in the loop. This loop is placed in the uniform magnetic field Fleming's left-hand rule is a convention used to find the direction of the force acting on a wire from the direction of the magnetic field the wire is in and the direction of current through the wire. Torque is the measure of the force that causes an object to rotate around an axis: 4

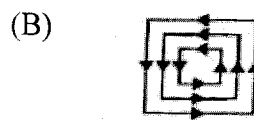
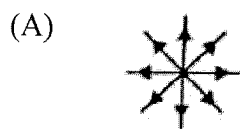


- (i) A circular loop of area 1 cm^2 , carrying a current of 10 A is placed in a magnetic field of 0.1 T perpendicular to the plane of the loop. The torque on the loop due to the magnetic field is
 (A) 1 Nm (B) Zero (C) 10^{-2} Nm (D) 10^{-4} Nm
- (ii) A current carrying loop is free to turn in a uniform magnetic field. The loop will then come into equilibrium when its plane is inclined at
 (A) Zero degree to the direction of the field (B) 45° to the direction of the field
 (C) 90° to the direction of the field (D) 135° to the direction of the field
- (iii) A rectangular coil carrying current is placed in a non-uniform magnetic field. It experiences
 (A) a force of repulsion. (B) a force of attraction.
 (C) a torque but not force. (D) a force and a torque
- (iv) The deflection in carrying loop in the magnetic field is
 (A) directly proportional to the area of coil
 (B) inversely proportional to the area of coil
 (C) inversely proportional to the current in coil
 (D) inversely proportional to the magnetic field
- (v) The torque on a current carrying rectangular loop is τ when it is placed in a uniform magnetic field at an angle θ . If the length and breadth of the loop is doubled then the torque on the loop at an angle θ will be:
 (A) τ (B) 2τ (C) $1/\tau$ (D) 4

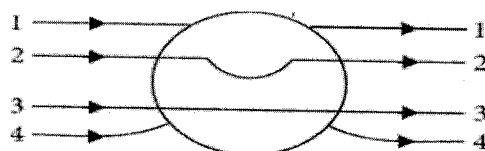
24. If one wishes to estimate the density of field lines, one has to consider the number of lines per unit cross-sectional area, perpendicular to the lines. Since the electric field decreases as the square of the distance from a point charge and the area enclosing the charge increases as the square of the distance, the number of field lines crossing the enclosing area remains constant, whatever may be the distance of the area from the charge. Having drawn a certain set of field lines, the relative density (i.e., closeness) of the field lines at different points indicates the relative strength of electric field at those points. The field lines crowd where the field is strong and are spaced apart where it is weak.



- (i) SI unit of electric field intensity is
 (A) C/N (B) C/m^2 (C) N/m (D) V/m
- (ii) Which one of the following patterns of electric field line is not possible in field due to stationary charges?



- (iii) A metallic solid sphere is placed in a uniform electric field. Which of the lines 1, 2, 3 and 4 shows the correct path of electric field lines?



- (A) 4 (B) 3 (C) 2 (D) 1

- (iv) Which of the following is false for electric field lines?
- (A) They always start from positive charge and terminate on negative charges.
 (B) They are always perpendicular to the surface of a charged conductor.
 (C) They always form closed loops.
 (D) They are parallel and equally spaced in a region of uniform electric field.

- (v) Electric field lines about a positive point charge are
 (A) radially (B) circular clockwise
 (C) radially inwards (D) parallel straight lines

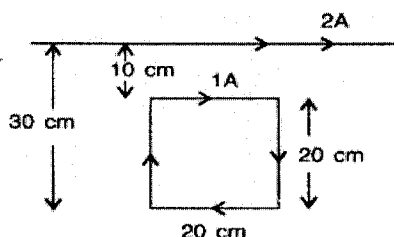
SECTION C

25. (a) Represent graphically the variation of electric field with distance, due to an infinitely long straight uniformly charged wire. 2
 (b) Explain why two electric field lines never cross each other at any point.

OR

- (a) Two insulated charged copper spheres A and B of identical size have charges q_A and $-3q_A$ respectively. When they are brought in contact with each other and then separated, what are the new charges on them?
 (b) Is electric potential a scalar or a vector quantity? Write its S.I. unit.

26. Draw 3 equipotential surfaces corresponding to a field that uniformly increases in magnitude but remains constant along Z- direction. How are these surfaces different from that of a constant electric field along Z- direction? 2
27. A parallel plate capacitor is charged by a battery. When the battery remains connected, a dielectric slab of dielectric constant 'K' is inserted in the space between the plates. Explain what changes will occur in the values of (a) capacitance and (b) charge on the plates. 2
28. Define the term 'mobility' of charge carriers in a conductor. How does the mobility of electrons in a conductor change, if the potential difference applied across the conductor is doubled, keeping the length and temperature of the conductor constant? 2
29. A square loop of side 20 cm carrying current of 1 A is kept near an infinite long straight wire carrying a current of 2 A in the same plane as shown in the figure. 2



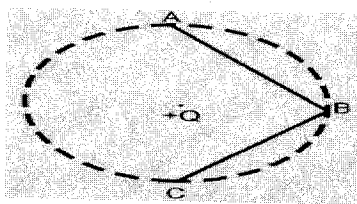
Calculate the magnitude and direction of the net force exerted on the loop due to the current carrying wire.

OR

A wire AB is carrying a steady current 10 A and is lying on the table. Another wire CD carrying 6 A is held directly above AB at a height of 2 mm. Find the mass per unit length of the wire CD so that it remains suspended at its position when left free. Give the directions of the current flowing in CD with respect to that in AB [Take the value of $g=10\text{ms}^{-2}$]

SECTION D

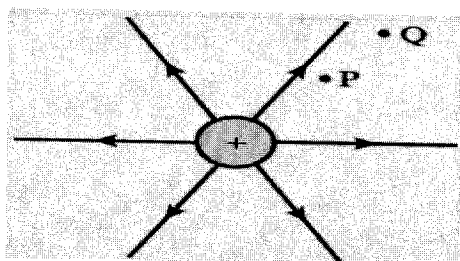
30. State Gauss's law in electrostatics. Using Gauss's law, obtain the expression for electric field intensity at a point due to an infinitely large, plane sheet of charge of charge density $\sigma \text{ C/m}^2$. 3
31. What is a capacitor? Derive an expression for the capacitance of a parallel plate capacitor with air as the medium between the plates. 3
32. (i) In the given figure, charge +Q is placed at the centre of a dotted circle. Work done in taking another charge +q from A to B is W_1 and from B to C is W_2 . Which one of the following is correct: $W_1 > W_2$, $W_1 = W_2$ and $W_1 < W_2$? 3



- (ii) Why is the potential inside a hollow spherical charged conductor constant and has the same value as on its surface?
- (iii) Can electric potential at a point be zero, while the electric field is not zero? Illustrate with an example.

OR

- (i) Figure shows the field lines on a positive charge. Is the work done by the field in moving a small positive charge from Q to P positive or negative? Give reason.



- (ii) "For any charge configuration, equipotential surface through a point is normal to the electric field." Justify.
- (iii) An uncharged insulated conductor A is brought near a charged insulated conductor B. What happens to the charge and potential of B?

33. Using the concept of free electrons in a conductor, derive the expression for the conductivity of a wire in terms of number density and relaxation time. Hence obtain the relation between current density and the applied electric field E .

3

OR

Two cells of emfs E_1 and E_2 and internal resistances r_1 and r_2 are connected in parallel. Derive the expression for the (i) emf and (ii) internal resistance of a single equivalent cell which can replace this combination.

34. Deduce an expression for the frequency of revolution of a charged particle in a perpendicular magnetic field and show that it is independent of velocity of charged particle.

3

SECTION E

35. (a) State Biot-Savart Law.

5

- (b) Using Biot-Savart's law, derive an expression for the magnetic field at the centre of a circular coil of radius R , number of turns N , carrying current I .
- (c) Sketch the magnetic field for a circular current loop, clearly indicating the direction of the field and direction of current.

OR

(a) Draw a labelled diagram of a moving coil galvanometer. Describe briefly its principle and working.

(b) Answer the following:

- (i) Why is it necessary to introduce a cylindrical soft iron core inside the coil of a galvanometer?
- (ii) Increasing the current sensitivity of a galvanometer may not necessarily increase its voltage sensitivity. Explain, giving reason.

36. (a) Using Gauss law, derive an expression for the electric field intensity at any point outside a uniformly charged thin spherical shell of radius R and charge density σ C/m². 5
- (b) Two-point charges of $+5 \times 10^{-19}$ C and $+20 \times 10^{-19}$ C are separated by a distance of 2 m. Find the point on the line joining them at which electric field intensity is zero.

OR

- (a) An electric dipole is held in a uniform electric field. (i) Using suitable diagram show that it does not undergo any translatory motion, and (ii) derive an expression for torque acting on it and specify its direction.
- (b) The sum of two-point charges is 7 μ C. They repel each other with a force of 1 N when kept 30cm apart in free space. Calculate the value of each charge

37. (a) Define relaxation time of free electrons drifting in a conductor. Derive an expression for drift velocity of free electrons in a conductor in terms of relaxation time. 5
- (b) On what factors does resistivity of a conductor depend?
- (c) Why alloys like constantan and manganin are used for making standard resistors?

OR

- (a) State Kirchhoff's rules.
- (b) Draw a circuit diagram showing balancing of Wheatstone bridge.
- (c) Use Kirchhoff's rules to obtain the balance condition in terms of the resistances of four arms of Wheatstone Bridge.

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**INDIAN SCHOOL MUSCAT
HALF YEARLY EXAMINATION 2022
PHYSICS (042)**



CLASS: XII
DATE: 18-09-2022

TIME ALLOTTED: 3 HRS.
MAXIMUM MARKS: 70

GENERAL INSTRUCTIONS:

1. All questions are compulsory. There are 37 questions in all.
2. This question paper has five sections: Section A, Section B, Section C, Section D and Section E.
3. Section A contains twenty-two questions of one mark each, Section B contains two case study questions of four marks each, Section C contains five questions of two marks each, Section D contains five questions of three marks and Section E contains three questions of five marks each.
4. There is no overall choice. However, an internal choice has been provided in two questions of two marks, two questions of three marks and all the three questions of five marks weightage. You have to attempt only one of the choices in such questions.
5. You may use the following values of physical constants wherever necessary.

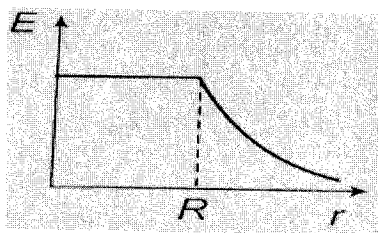
$$\epsilon_0 = 8.85 \times 10^{-12} \text{C}^2 \text{N}^{-1} \text{m}^{-2}, \quad \mu_0 = 4\pi \times 10^{-7} \text{Tm/A}, \quad \frac{1}{4\pi\epsilon_0} = 9 \times 10^9 \text{Nm}^2 \text{C}^{-2} \text{ Type equation here.}$$

SECTION A

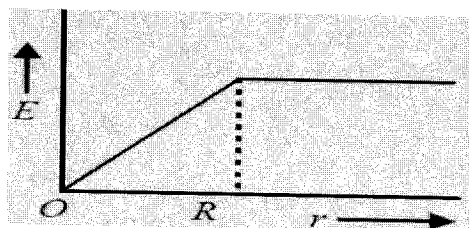
1. An electric current pass through a long straight copper wire. At a distance 5 cm from the straight wire, the magnetic field is B. The magnetic field at 20 cm from the straight wire would be 1
A. B/6 B. B/4 C. B/2 D. 4B
2. A current carrying conductor placed in a magnetic field experiences maximum force when angle between current and magnetic field is 1
A. $3\pi/4$ B. $\pi/2$ C. $\pi/4$ D. zero

3. The electric field due to a uniformly charged sphere of radius R as a function of the distance from its centre is represented graphically by 1

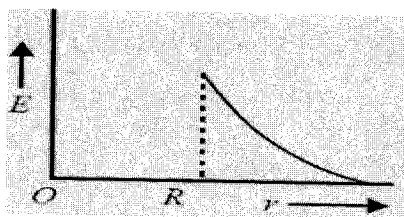
A.



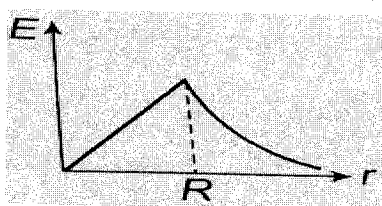
B.



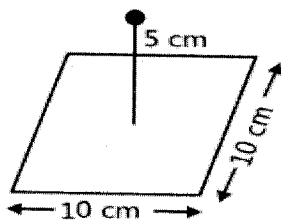
C.



D.



4. A point charge $+10 \mu\text{C}$ is at a distance 5 cm directly above the centre of a square of side 10 cm, as shown in figure. What is the magnitude of the electric flux through the square? 1



- A. Zero B. $8 \times 10^2 \text{ Nm}^2 \text{ C}^{-1}$ C. $1.8 \times 10^4 \text{ Nm}^2 \text{ C}^{-1}$ D. $1.8 \times 10^5 \text{ Nm}^2 \text{ C}^{-1}$

5. Electric field intensity between two equally and oppositely charged plates of surface charge densities $+\sigma$ and $-\sigma$ is 1

- A. $\epsilon_0 \sigma$ B. $\sigma/2 \epsilon_0$ C. σ/ϵ_0 D. $2\sigma/\epsilon_0$

6. Potential energy of an electric dipole held at an angle Θ in a uniform electric field is zero when Θ is equal to 1

- A. 0° B. 90° C. 180° D. 360°

7. A hollow metal sphere of radius 5 cm is charged so that the potential on its surface is 10V. The potential at the centre of the sphere is 1

- A. 0V B. 10V C. Same as at point 5cm away from the surface
D. Same as at point 25cm away from the surface

8. On moving a charge of 20 coulombs by 2 cm, 2 J of work is done, then the potential difference between the points is 1

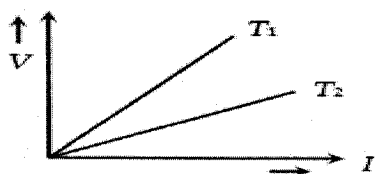
- A. 0.1 V B. 8V C. 2V D. 0.5V

9. Kirchhoff's first and second laws for electrical circuits are consequences of 1
- conservation of electric charge and energy respectively
 - conservation of electric charge
 - conservation of energy and electric charge respectively
 - conservation of energy

10. For a cell, the terminal potential difference is 3.6 V, when the circuit is open. If the potential difference reduces to 3 V, when cell is connected to a resistance of $5\ \Omega$, the internal resistance of cell is 1

A. $1\ \Omega$ B. $2\ \Omega$ C. $4\ \Omega$ D. $8\ \Omega$

11. The voltage V and current I graph for a conductor at two different temperatures T_1 and T_2 are shown in the figure. The relation between T_1 and T_2 is 1



A. $T_1 > T_2$ B. $T_1 < T_2$ C. $T_1 = T_2$ D. $T_1 = 2 T_2$

12. A student measures the terminal potential difference (V) of a cell (of emf ϵ and internal resistance r) as a function of current (I) flowing through it. The slope and the intercept, of the graph between V and I , then respectively, equal 1

A. $-r, \epsilon$ B. $-\epsilon, r$ C. $\epsilon, -r$ D. $r, -\epsilon$

13. A positive charge is moving towards an observer. The direction of magnetic field lines is 1
- Clockwise
 - Anticlockwise
 - Upwards
 - Downwards

In question numbers 14 to 18, two statements are given- one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the options (i), (ii), (iii) and (iv) as given below.

- Both Assertion(A) and Reason(R) are true and Reason(R) is the correct explanation of A. 1
- Both Assertion(A) and Reason(R) are true but Reason(R) is not the correct explanation of A.
- Assertion(A) is true but Reason(R) is false.
- Assertion(A) is false and Reason(R) is also false.

14. Assertion: Electrons move away from a region of lower potential to a region of higher potential. 1

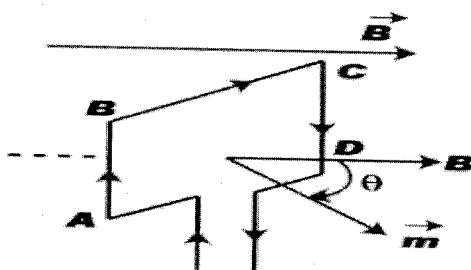
Reason: Electron is negatively charged.

15. Assertion: Work done in moving a charge between any two points in an electric field is independent of the path followed by the charge, between these points.
Reason: Electrostatic forces are non-conservative. 1
16. Assertion: The drift velocity of electrons in a metallic conductor decreases with rise of temperature of conductor.
Reason: On increasing the temperature, the collision of electrons with lattice ions increases, this hinders the drift of electrons. 1
17. Assertion: Magnetic field lines always form closed loops.
Reason: Moving charges or currents produce a magnetic field. 1
18. Assertion: When we produce charge q_1 on a body by rubbing against another body which gets a charge q_2 in the process, then $q_1 + q_2 = 0$
Reason: Charge on an isolated system remains constant. 1
19. Direction of electric field intensity due to an electric dipole on equatorial point is _____ to the direction of dipole moment. 1
20. An electric dipole is placed inside uniform electric field. Net _____ on it is always zero. 1
21. To convert galvanometer into a voltmeter of given range, a suitable high resistance should be connected in _____ with the galvanometer. 1
22. Torque on a current carrying rectangular coil inside a galvanometer is maximum and constant, irrespective of its orientation, as it is suspended inside _____ magnetic field. 1

SECTION B

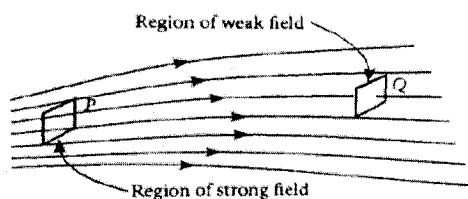
(Answer any four questions out of five questions for each case study question)

23. Consider a rectangular loop ABCD. Let the dimensions of the loop be l and b . There is a steady current in the loop. This loop is placed in the uniform magnetic field Fleming's left-hand rule is a convention used to find the direction of the force acting on a wire from the direction of the magnetic field the wire is in and the direction of current through the wire. Torque is the measure of the force that causes an object to rotate around an axis 4

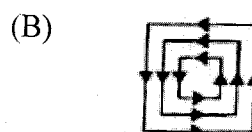
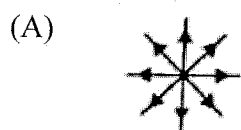


- (i) The deflection in carrying loop in the magnetic field is
 (A) directly proportional to the area of coil
 (B) inversely proportional to the area of coil
 (C) inversely proportional to the current in coil
 (D) inversely proportional to the magnetic field
- (ii) The torque on a current carrying rectangular loop is τ when it is placed in a uniform magnetic field at an angle Θ . If the length and breadth of the loop is doubled then the torque on the loop at an angle Θ will be
 (A) τ (B) 2τ (C) $1/\tau$ (D) 4τ
- (iii) A circular loop of area 1cm^2 , carrying a current of 10A is placed in a magnetic field of 0.1T perpendicular to the plane of the loop. The torque on the loop due to the magnetic field is
 (A) 1Nm (B) Zero (C) 10^{-2}Nm (D) 10^{-4}Nm
- (iv) A current carrying loop is free to rotate in a uniform magnetic field. The loop will then come into equilibrium when its plane is inclined at
 (A) Zero degree to the direction of the field (B) 45° to the direction of the field
 (C) 90° to the direction of the field (D) 135° to the direction of the field
- (v) A rectangular coil carrying current is placed in a non-uniform magnetic field. It experiences
 (A) a force of repulsion. (B) a force of attraction.
 (C) a torque but not force. (D) a force and a torque

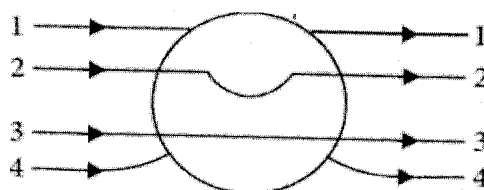
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- (i) Electric field lines about a positive point charge are
 (A) radially outwards (B) circular clockwise
 (C) radially inwards (D) parallel straight lines
- (ii) SI unit of electric field intensity is
 (A) C/N (B) C/m² (C) N/m (D) V/m
- (iii) Which one of the following patterns of electric field line is not possible in field due to stationary charges?



- (iv) A metallic solid sphere is placed in a uniform electric field. Which of the lines 1, 2, 3 and 4 shows the correct path of electric field lines?



- (A) 4 (B) 3 (C) 2 (D) 1
- (v) Which of the following is false for electric field lines?
 (A) They always start from positive charge and terminate on negative charges.
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SECTION C

25. A parallel plate capacitor is charged by a battery. When the battery remains connected, a dielectric slab of dielectric constant 'K' is inserted in the space between the plates. Explain what changes will occur in the values of (a) capacitance and (b) charge on the plates. 2
26. Define the term 'mobility' of charge carriers in a conductor. How does the mobility of electrons in a conductor change, if the potential difference applied across the conductor is doubled, keeping the length and temperature of the conductor constant? 2

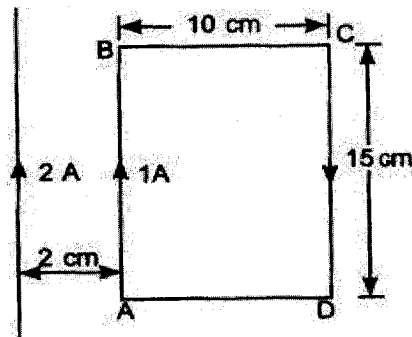
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28. Draw 3 equipotential surfaces corresponding to a field that uniformly increases in magnitude but remains constant along Z- direction. How are these surfaces different from that of a constant electric field along Z- direction? 2
29. A wire AB is carrying a steady current 12 A and is lying on the table. Another wire CD carrying 5 A is held directly above AB at a height of 1 mm. Find the mass per unit length of the wire CD so that it remains suspended at its position when left free. Give the directions of the current flowing in CD with respect to that in AB [Take the value of $g=10\text{ms}^{-2}$] 2

OR

A rectangular loop of wire of size $15\text{cm} \times 10\text{cm}$ carries a steady current of 1A. A straight wire carrying 2A current is kept near the loop as shown. If the loop and the wire are coplanar, find the magnitude and direction of the net force on the loop due to the current carrying wire.



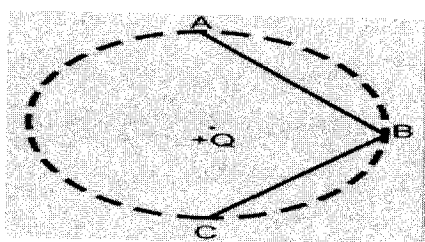
SECTION D

30. Using the concept of free electrons in a conductor, derive the expression for the conductivity of a wire in terms of number density and relaxation time. Hence obtain the relation between current density and the applied electric field E . 3

OR

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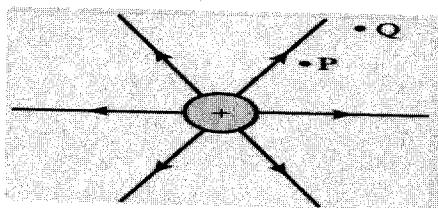
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32. State Gauss's law in electrostatics. Using Gauss's law, obtain the expression for electric field intensity at a point due to an infinitely large, plane sheet of charge of charge density σ C/m². 3
33. What is a capacitor? Derive an expression for the capacitance of a parallel plate capacitor with air as the medium between the plates. 3
34. (i) In the given figure, charge $+Q$ is placed at the centre of a dotted circle. Work done in taking another charge $+q$ from A to B is W_1 and from B to C is W_2 . Which one of the following is correct: $W_1 > W_2$, $W_1 = W_2$ and $W_1 < W_2$? 3



- (ii) Why is the potential inside a hollow spherical charged conductor constant and has the same value as on its surface?
- (iii) Define dielectric constant of a medium in terms of capacitance.

OR

- (i) Figure shows the field lines on a positive charge. Is the work done by the field in moving a small positive charge from Q to P positive or negative? Give reason.



- (ii) "For any charge configuration, equipotential surface through a point is normal to the electric field." Justify.
- (iii) Define dielectric strength of a dielectric.

SECTION E

35. (a) Define relaxation time of free electrons drifting in a conductor. Derive an expression for drift velocity of free electrons in a conductor in terms of relaxation time. 5
- (b) On what factors does resistivity of a conductor depend?
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- (a) State Kirchhoff's rules.
- (b) Draw a circuit diagram showing balancing of Wheatstone bridge.
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- (b) Using Biot-Savart's law, derive an expression for the magnetic field at the centre of a circular coil of radius R , number of turns N , carrying current I .
- (c) Sketch the magnetic field for a circular current loop, clearly indicating the direction of the field and direction of current.

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- (a) Draw a labelled diagram of a moving coil galvanometer. Describe briefly its principle and working.
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37.

- (a) Using Gauss law, derive an expression for the electric field intensity at any point outside a uniformly charged thin spherical shell of radius R and charge density σ C/m².
- (b) Draw the field lines when the charge density of the sphere is (i) positive, (ii) negative.
- (c) Two-point charges of $+5 \times 10^{-19}$ C and $+20 \times 10^{-19}$ C are separated by a distance of 2 m. Find the point on the line joining them at which electric field intensity is zero.

OR

- (a) An electric dipole is held in a uniform electric field. (i) Using suitable diagram show that it does not undergo any translatory motion, and (ii) derive an expression for torque acting on it and specify its direction.
- (b) The sum of two-point charges is $7 \mu\text{C}$. They repel each other with a force of 1 N when kept 30cm apart in free space. Calculate the value of each charge.

******END OF THE QUESTION PAPER******

