# I TERM EXAMINATION : 2021–22

CLASS : XII (CBSE) E/M

Time : 3 hrs. **PHYSICS (THEORY)** M.M.: 70

**General Instructions :**

Read the following instructions carefully and strictly follow them:

i) All questions are compulsory. There are 33 questions in all.

ii) This question paper has five sections : Section A, Section B, Section C, Section D and Section E.

iii) Section 'A' contain **ten** very short answer type questions and four assertion reasoning MCQs of 1 marks each.

iv) Section 'B' has **two** case based questions of 4 marks each.

v) Section 'C' contain **nine** short answer questions of 2 marks each.

vi) Section 'D' contains **five** short answer questions of 3 marks each.

vii) Section 'E' contains three long answer questions of 5 marks each.

viii) There is no overall choice. However, an internal choice is provided. You have to attempt only one of the choices in such questions.

ix) In addition to this, appropriate instructions have been given with each section and question.

x) Use of calculators and log tables is not allowed.

xi) You can use the following values of physical constants whenever necessary.

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

$h = 6.63 \times 10^{-34}$ Js

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

$\mu_0 = 4\pi \times 10^{-7}\ \mathrm{TmA^{-1}}$

$\varepsilon_0 = 8.854 \times 10^{-12}\ \mathrm{C^{-2}N^{-1}m^{-2}}$

$\frac{1}{4\pi \in_0} = 9 \times 10^9\ \mathrm{Nm^2/C^{-2}}$

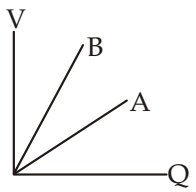
$m_e = 9.1 \times 10^{-31}$ kg

## SECTION -A

**All questions are compulsory. In case of internal choices, attempt any one of them.**

1. For which orientation a dipole placed in a uniform electric field is in a) Stable, b) Unstable Equilibrium? [1]

2. The graph shows the variation of voltage V across the plates of two capacitors. A and B versus increase of charge Q stored on them. Which of the capacitors has higher capacitance? Give reason for your answer. [1]




3. Why must the electrostatic potential inside a hollow charged conductor be the same at every point? [1]

4. An electron does not suffer any deflection while passing through a region of uniform magnetic field. What is the direction of the magnetic field? [1]

5. A resistance R is connected across a cell of emf $\varepsilon$ and internal resistance r. A potentiometer now measures the potential difference between the terminals of the cell as V. write the expression for 'r' in terms of $\varepsilon$, V and R. [1]

**OR**

What is the work done in moving a test charge q through a distance of 1 cm along the equatorial axis of an electric dipole?

6. What is the direction of the electric field at the surface of a charged conductor having charge density $\sigma < 0$? [1]
7. What is the geometrical shape of equipotential surfaces due to a single isolated charge? [1]
8. Define Potential Gradient. [1]

**OR**

Write any two uses of capacitors.

9. "For any charge configuration, equipotential surface through a point is normal to the electric field." Justify. [1]

**OR**

What is the electrostatic potential due to an electric dipole at an equatorial point?

10. Magnetic field lines can be entirely confined within the core of a toroid, but not within a straight solenoid. Why? [1]

**For question numbers 11, 12, 13 and 14, two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.** [4]

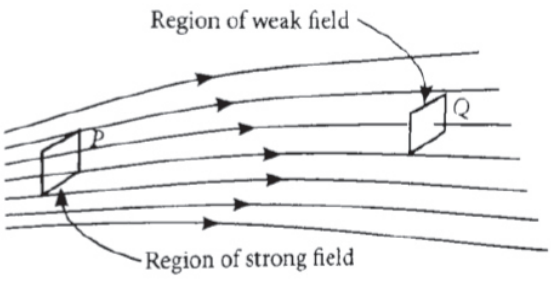
a) Both A and R are true and R is the correct explanation of A
b) Both A and R are true but R is NOT the correct explanation of A
c) A is true but R is false
d) A is false and R is also false

11. **Assertion :** Electric lines of force never cross each other.
**Reason :** Electric fields at a point superimpose to give one resultant electric field.
12. **Assertion :** If there is coulombian force of attraction between two spheres then both the spheres may not have charge.
**Reason :** In coulombian attraction bodies are oppositely charged.
13. **Assertion :** Electron move away from a region of lower potential to a region of higher potential.
**Reason :** Reason: An electron has a negative charge.
14. **Assertion :** In a simple battery circuit, the point of the lowest potential is positive terminal of the battery.
**Reason :** The current flows towards the point of the higher potential, as it does in such a circuit from the negative to the positive terminal.

## SECTION – B

**Questions 15 and 16 are Case Study based questions and are compulsory. Attempt any 4 subparts from each question. Each question carries 1 mark.**

15. Electric field strength is proportional to the density of lines of force i.e., electric field strength at a point is proportional to the number of lines of force cutting a unit area element placed normal to the field at that point. As illustrated in given figure, the electric field at P is stronger than at Q.



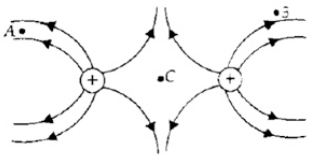
(i) Electric lines of force about a positive point charge are
(a) radially outwards (b) circular clockwise
(c) radially inwards (d) parallel straight lines

(ii) Which of the following is false for electric lines of force?
(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.

(iii) Which one of the following patterns of electric line of force is not possible in field due to stationary charges?


(iv) Electric field lines are curved
(a) in the field of a single positive or negative charge
(b) in the field of two equal and opposite charges.
(c) in the field of two like charges.
(d) both (b) and (c)

(v) The figure below shows the electric field lines due to two positive charges. The magnitudes $E_A$, $E_B$ and $E_C$ of the electric fields at point A, B and C respectively are related as
(a) $E_A > E_B > E_C$
(b) $E_B > E_A > E_C$
(c) $E_A = E_B > E_C$
(d) $E_A > E_B = E_C$




16. Ohm's law is obeyed by many substances, but one can't say that it is a fundamental law of nature. It's a basic law regarding flow of the current which defines resistance as constant of proportionality. The dependence of R was also discussed by Ohm's law. The potential applied across a conductor and current through it was also one of the important points discussed in this law. [4]

(i) What will be resistance across a slab if area is doubled?
(a) Resistance will be doubled. (b) Resistance will be halved.
(c) No change. (d) Resistance will be zero.

**(ii)** On what factor does the resistance depends on?
(a) Material only. (b) Dimension of conductor only.
(c) Material and dimension both. (d) None of these.

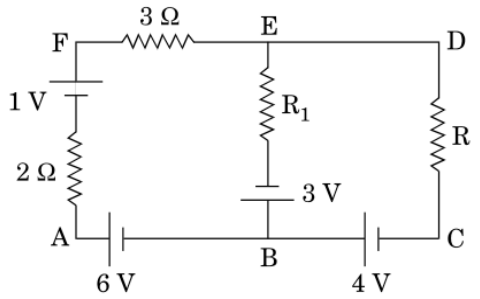
**(iii)** How does the Resistivity vary if area is doubled?
(a) Resistivity becomes half.
(b) Resistivity becomes doubled.
(c) Resistivity does not vary.
(d) Resistivity is only dependent on current.

(iv) How does the resistivity change with temperature?
(a) Increases linearly
(b) Decreases linearly
(c) First increases and then decreases
(d) None of the above

(v) What can you say about the relation between V and I from Ohm's law?
(a) V depend on I linearly (b) V depend on I non – linearly
(c) V does not depend on I (d) Can't say.

## Section – C

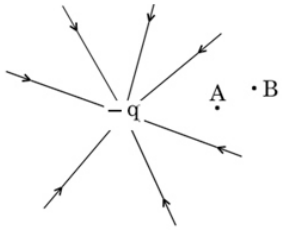
17. Use Kirchhoff's rules to determine the potential difference between the points A and D when no current flows in the arm BE of the electric network shown in the figure. [2]




18. Distinguish between emf and terminal voltage of a cell. [2]

**OR**

The field lines of a negative point charge are as shown in the figure. Does the kinetic energy of a small negative charge increase or decrease in going from B to A?




19. Write the expression for the work done on an electric dipole of dipole moment p in turning it from its position of most stable equilibrium to a position of most unstable equilibrium in a uniform electric field E. [2]
20. Why is a potentiometer preferred over a voltmeter for determining the emf of a cell? [2]
21. Write the expression in vector form, for the magnetic force F acting on a charged particle moving with velocity V in the presence of a magnetic field B. [2]
22. Define the charge mobility of a conductor. Write its SI unit. [2]

OR

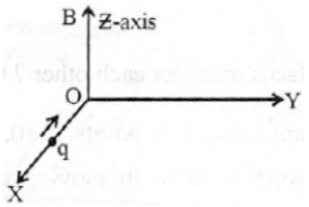
What is the effect of temperature on relaxation time? Explain.

23. In an ammeter (consisting of a galvanometer and a shunt). 0.5% of the main current passes through the galvanometer. Resistance of the galvanometer coil is G. Calculate the resistance of the shunt in terms of galvanometer resistance G. [2]
24. Two point charges, $q_1 = 10 \times 10^{-5}$ C, 2 = $-2 \times 10^{-8}$ C are separated by a distance of 60 cm in air. Find at what distance from the 1st charge, $q_1$ would the electric potential be zero. [2]

OR

Draw a plot showing variation of electric potential with distance from the centre of a solid conducting sphere of radius R, having a charge of +Q on its surface. [2]

Q.25. A charge 'q' moving along the x-axis with a velocity $\vec{V}$ is subjected to a uniform magnetic field B acting along the z-axis as it crosses the origin.



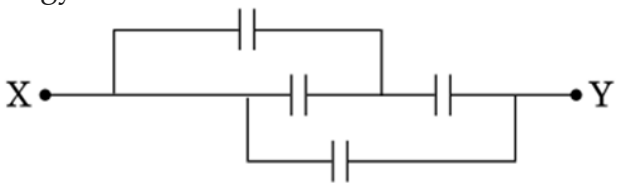

(i) Trace its trajectory.

(ii) Does the charge gain kinetic energy as it enters the magnetic field ? Justify your answer.

## SECTION -D

All questions are compulsory. In case of internal choice, attempt any one.

Q.26. Find the equivalent capacitanace of the network shown in the figure, when each capacitor is of 1 μF. When the ends X any Y are connected to a 6 V battery, find out (i) the charge and (ii) the energy stored in the network. [3]




Q.27. (a) State the working principle of a potentiometer with help of a circuit diagram.

(b) How are the following affected in the potentiometer circuit when

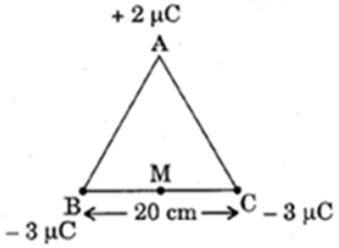
(i) the internal resistance of the driver cell increases and

(ii) the series resistor connected to the driver cell is reduced ?Justify your answer. [3]

**OR**

Using Ampere's circuital law, obtain an expression for the magnetic field along the axis of a current carrying solenoid of length $\ell$ and having N number of turns.

Q.28. Three point charges of -2μC. -3μC and -3 μC are kept at the vertices A, B and C respectively of an equilateral triangle of side 20 cm as shown in the figure. What should be the sign and magnitude of the charge to be placed at the mid point M of side BC so that the charge at A remain in equilibrium .




Q.29. Two metallic wires of same material have the same length but cross sectional area in the ratio 3:2. They are connected (i) in series and (ii) in parallel. Compare the drift velocities of electrons in the two wires in both cases. [3]

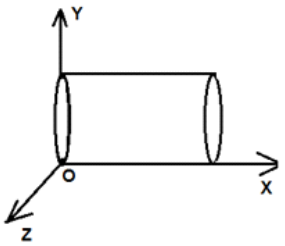
**OR**

Write an expression for the torque experienced by an electric dipole kept in a uniform electric field in vector form. Show using a diagram when it will be maximum and when it will be minimum. [3]

Q.30. A hollow cylindrical box of length 1m and area of cross-section 25 $cm^2$ is placed in a three dimensional coordinate system as shown in the figure. The electric field in the region is given by $\vec{E} = 2\hat{i} + 3\hat{j} + 6\hat{k}$ where $\vec{E}$ is in $NC^{-1}$ and x is in metre. Find:

(i) Net flux through the cylinder.

(ii) Charge enclosed by the cylinder. [3]




## SECTION – E

All questions are compulsory. In case of internal choices, attempt any one.

Q.31. (a) Using Gauss's law, prove that the electric field at a point due to a uniformly charged infinite plane sheet is independent of the distance from it.

(b) How is the field directed if
(i) The sheet is positively charged,
(ii) Negatively charged? [5]

**OR**

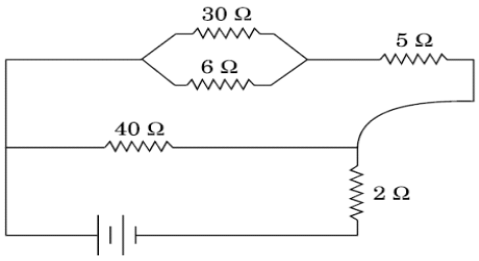
Derive an expression for the force per unit length between two long straight parallel current carrying conductors. Hence define SI unit of current (ampere) on the basis of this expression.

Q.32. State Biot-Sarvart law. Giving the mathematical expression for it.
Use this law to drive the expression for the magnetic field due to a circular coil carry current at a point along its axis.
How does a circular loop carrying current behave as a magnet ?

**OR**

(a) Define the term 'drift velocity' of a charge carriers in a conductor. Obtin the expression for the current density in terms of relaxation time.

(b) A battery is connected to the electric network as shown . If the power consumed in the 2Ω resistor is 200 W. determine the power dissipated in the 5Ω resistor. [5]




Q.33. (a) Derive the expression for the energy stored in a parallel plate capacitor. Hence obtain the expression for the energy density of the electric field.

(b) A fully charged parallel plate capacitor is connected across an uncharged identical capacitor. Show that the energy stored in the combination is less than that stored initially in the single capacitor. [5]

**OR**

Two identical coils, each of radius 'R' and number of turns 'N' are lying in perpendicular planes such that their centres coincide. Find the magnitude and direction of the resultant magnetic field at the centre of the coils, if they are carrying currents I and 2I respectively.

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