	INDIAN SCHOOL AL WADI AL KABIR

UNIT TEST (2023 - 24)

Class: XII Sub: PHYSICS (042) Max Marks: 30

Date:21.05.2023 Set - 2 Time : 1 hour

General Instructions

- There are 15 questions in all. All questions are compulsory.
- This question paper has five sections: Section A, B, C, D & E. **Section A** contains eight questions, six MCQ's and two Assertion Reasoning based of 1 mark each. **Section B** contains two questions of two marks each, **Section C** contains three questions of three marks each, **Section D** contains one case study-based question of 4 marks and **Section E** contains one long answer question of five marks.
- There is no overall choice. However, an internal choice has been provided in one question of two marks, one question of three marks, one question for case study and for long answer question. You have to attempt only one of the choices in such questions.
- You may use log tables if necessary but use of calculator is not allowed.
- You may use the following values of physical constants wherever necessary:

  $c = 3 \times 10^{8}\ ms^{-1}$

  $h = 6.626 \times 10^{-34} Js$

  $e = 1.602 \times 10^{-19}\ C$

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

  $k = 9 \times 10^{9}\ C^{-2}Nm^2$

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

  $m_n = 1.675 \times 10^{-27} kg$

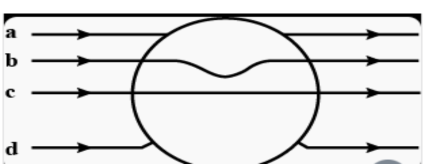
  $m_p = 1.673 \times 10^{-27}\ kg$

  Avogadro's number $N_A = 6.023 \times 10^{23}\ /mol^{-1}$

  Boltzmann Constant $= 1.38 \times 10^{-23}\ J/K$

SECTION A [1 MARK]

[1] A metallic sphere is placed in a uniform electric field as shown in the figure. Which path is followed by electric field lines?



(a) a (b) b (c) c (d) d

[2] The electric flux through a closed Gaussian surface depends upon

(a) Net charge enclosed and permittivity of the medium.

(b) Net charge enclosed, the size of the Gaussian surface and permittivity of the medium.

(c) Net charge enclosed only.

(d) Permittivity of the medium only.

[3] Electric field at a point varies as r^0 for

(a) An electric dipole

(b) A point charge

(c) A plane infinite sheet of charge

(d) A line charge of infinite length

[4] Which of the following is not the property of an equipotential surface?

(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 uniform electric field, they are concentric circles.

(d) They can be imaginary spheres.

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

(a) 0 V

(b) 10 V

(c) Same at a point 5cm away from the surface.

(d) Same at a point 25cm away from the surface.

[6] A capacitor is charged by a battery. The battery is removed and another identical uncharged capacitor is connected in parallel. The total electrostatic energy of the resulting system is

(a) Increases by a factor of 4

(b) Decreases by a factor of 2

(c) Remains the same

(d) Increases by a factor of 2

For Questions 7 & 8, 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.

[7] **Assertion :** A metallic shield in form of a hollow shell may be built to block an electric field.
Reason : In a hollow spherical shield, the electric field inside it is zero at every point.

[8] **Assertion :** The total charge stored in a capacitor is zero.
Reason : The field just outside the capacitor is $\sigma/\varepsilon 0$. (σ is the charge density).

<u>SECTION-B [2 marks]</u>

[9] Define relative permittivity. Obtain an expression for relative permittivity in terms of force exerted between two charges in air and in medium.

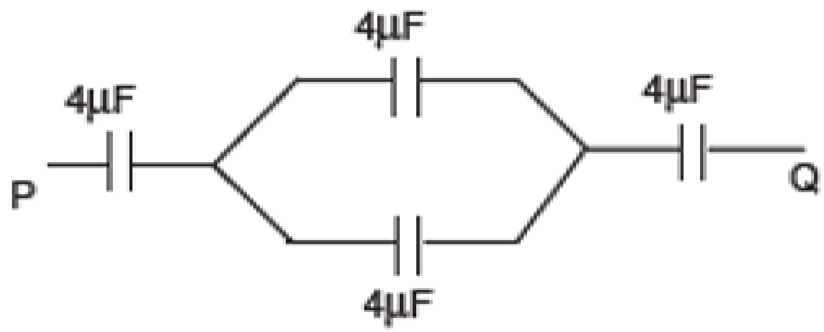
OR

Derive an expression for the torque experienced by an electric dipole in a uniform electric field.

[10] The electric field intensity at a point due to a point charge is 20 N/C and the electric potential is 10 J/C. Find the magnitude of the charge and distance of the point from charge.

<u>SECTION C [3 marks]</u>

[11] Four capacitors each of capacitance 4μF are connected as shown in the figure. The voltage across P and Q is 15volts.Calculate the energy stored in the system.



OR

A parallel plate capacitor filled with mica having $\varepsilon r = 5$ is connected to a 10 V battery. The area of the parallel plate is 6 m^2 and separation distance is 6 mm. Find the capacitance, stored charge and the stored energy.

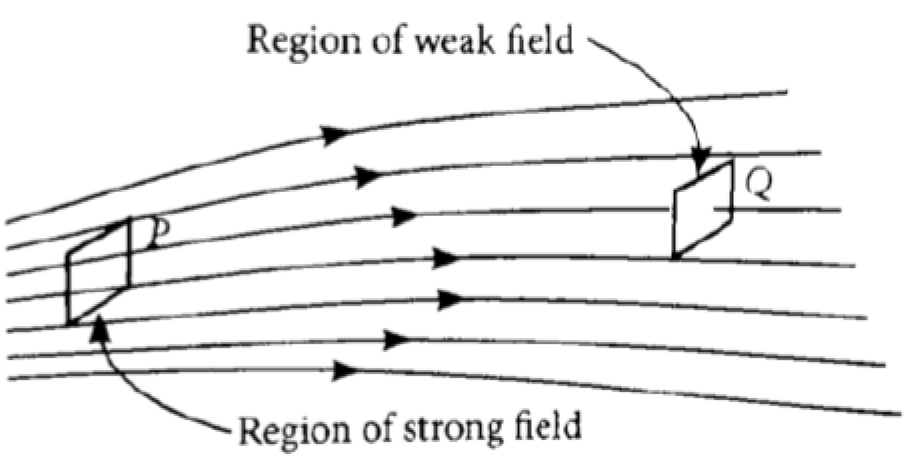
[12] State Gauss's law. Using Gauss's law obtain an expression for the electric field due to an infinitely long straight uniformly charged wire.

[13] What are equipotential surfaces? Draw the equipotential surfaces
a) for a single positive charge b) for a uniform electric field (c) for a dipole.

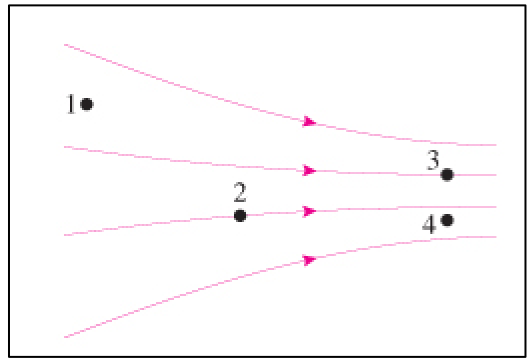
SECTION D [4 marks]

[14] Read the passage given below and answer the questions

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) Where is the electric field strength minimum?



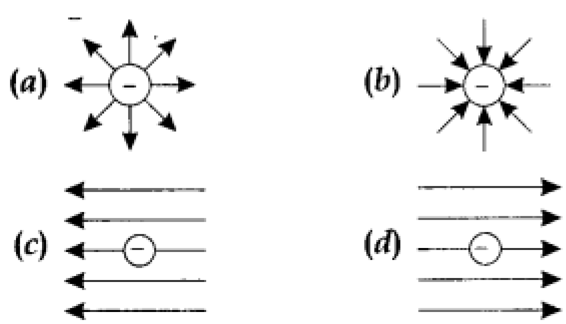
(a) At point 1
(b) At point 2
(c) At point 3
(d) At point 4

(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?

OR

(iii) Which of the following figures represent the electric field lines due to a single negative charge?



(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)

SECTION E [5 marks]

[15] (a)Derive an expression for the capacitance of a parallel plate capacitor with a dielectric slab partially filling the space.

(b) A parallel plate capacitor is connected with the terminals of a battery. The distance between the plates is 6mm. What will be the capacitance if a glass plate (dielectric constant K =9) of 4.5mm is introduced between the plates?

OR

A parallel plate is charged by a battery. When the battery remains connected, a dielectric slab is inserted in the space between the plates. Explain with reason what changes if any, occur in the values of

(i) Potential difference between the plates

(ii) Electric field strength between the plates.

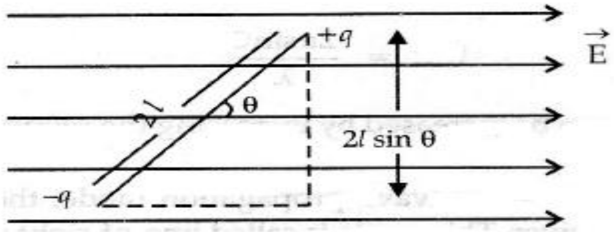
(iii) Capacitance

(iv) Charge on the plates

(v) Energy stored in the capacitance

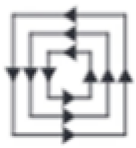
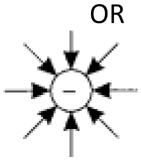
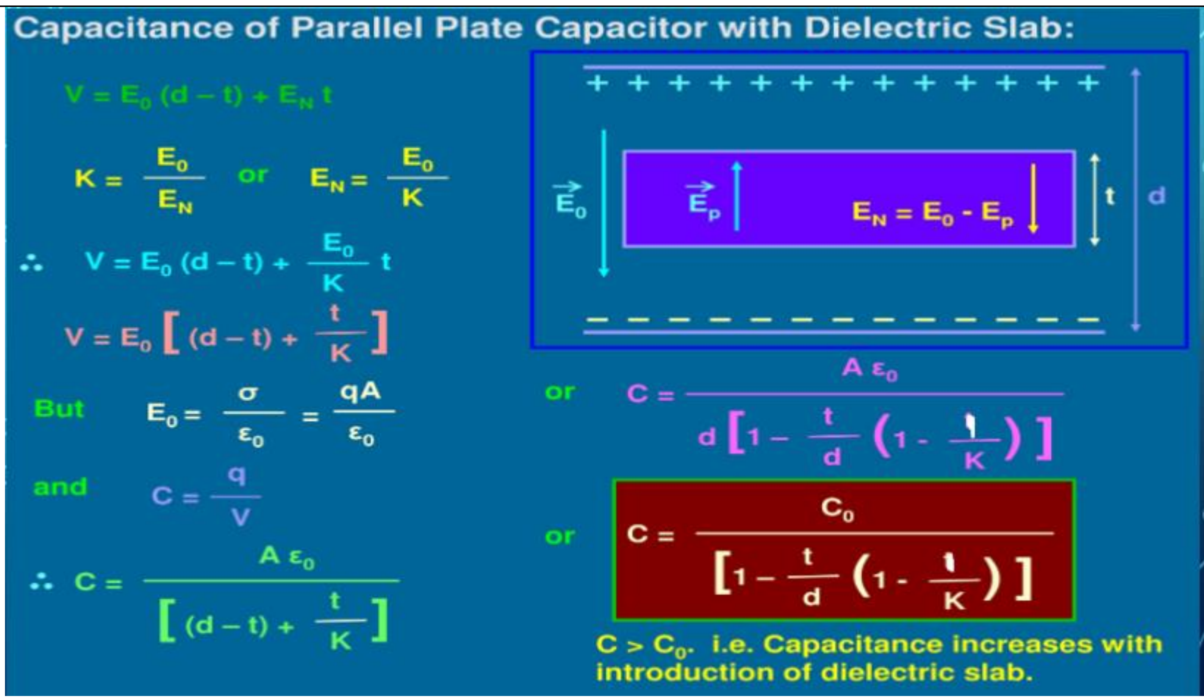
MARKING SCHEME

SL.NO	ANSWER KEY-SECTION A	
1.	d.	1
2.	(e) Net charge enclosed and permittivity of the medium.	1
3.	C. A plane infinite sheet of charge	
4.	c.For uniform electric field, they are concentric circles.	
5.	b. 10 V	
6.	b.Decreases by a factor of 2	
7.	a) If both Assertion and Reason are true and Reason is correct explanation of Assertion.	

8.	c) If Assertion is true but Reason is false.	
	SECTION B	
9.	The dielectric constant of a medium is the ratio of force between two charges placed some distance apart in vacuum to the force between same two charges placed same distance apart in the given medium. Derivation of F0/Fm =εr OR Let an electric dipole be placed in uniform electric field vector E  Force on each charge $= q\vec{E}$ Perpendicular distance between two forces $= 2\vec{l}\sin\theta$ $\therefore$ Torque $= q\vec{E}\times 2\vec{l}\sin\theta$ $= \left(q\times 2\vec{l}\right)\vec{E}\sin\theta$ $=$ pE sin θ $= \vec{P}\times\vec{E}$	1 1 1/2 1/2 1/2 1/2
10.	Here, $E = \frac{Q}{4\pi \in_0 r^2} = 20NC^{-1}$ and $V = \frac{Q}{4\pi \in_0 r} = 10JC^{-1}$ $\therefore \frac{V}{E} = r = \frac{10}{20} = 0.5m$ From $Q = 4\pi \in_0 r \times V$ $= \frac{1}{9\times 10^9} \times 0.5 \times 10 = 0.55 \times 10^{-9}C$	1/2 1/2 1/2 1/2

	SECTION C	
11.	**Sol.** Total capacitance of given system] $1/C_R = 5/8 \Rightarrow C_R = 8/5\ \mu F$ Energy stored $= 1/2\ C_R V^2$ $= 1/2 \times 8/5 \times 10^{-6} \times 225$ $= 180 \times 10^{-6}$ joule OR The capacitance of the capacitor in the presence of dielectric is $C = \frac{\varepsilon_r \varepsilon_0 A}{d} = \frac{5 \times 8.85 \times 10^{-12} \times 6}{6 \times 10^{-3}}$ $= 44.25 \times 10^{-9} F = 44.25 nF$ The stored charge is $Q = CV = 44.25 \times 10^{-9} \times 10$ $= 442.5 \times 10^{-9} C = 442.5 nC$	1 ½ ½ 1 ½ + ½ +1/2 ½ 1
12.	Statement of Gauss's law Derivation	1 ½ - DIAGRAM

	The surface area of the curved part is given as: $S = 2\pi rl$ The total charge enclosed by the Gaussian surface is given as: $q = \lambda l$ The electric flux through the end surfaces of the cylindrical Gaussian surface is given as: $\Phi_1 = 0$ The electric flux through the curved surface of the cylindrical Gaussian surface is given as: $\Phi_2 = E \cos\theta . s$ $\Phi_2 = E \times 1 \times 2\pi rl$ The total electric flux is given as: $\Phi = \Phi_1 + \Phi_2$ $\Phi = 0 + E \cos\theta . s$ $\Phi_2 = 2\pi rlE$ (eq. 1) From Gauss law, we know that $\varphi = \frac{q}{\epsilon_o} = \frac{\lambda l}{\epsilon_o}(eq.2)$ From eq 1. And eq 2 $2\pi rlE = \frac{\lambda l}{\epsilon_o}$ $E = \frac{1}{2\pi\epsilon_o}\frac{\lambda}{r}$	½ ½ ½
13.	• Definition of equipotential surface-Any surface over which the potential is constant is called an equipotential surface. In other words, the potential difference between any two points on an equipotential surface is zero. Diagram of equipotential surfaces a) for a single positive charge b) for a uniform electric field c) for a dipole.	1 1/2 1/2 1

<table>
<tr><td></td><td>SECTION D</td><td></td></tr>
<tr><td>14.</td><td>(I) (a) At point 1
(II) (c) They always form closed loops.
(III)
(c) 
OR
(b) 
(IV) (d) both (b) and (c)</td><td></td></tr>
<tr><td></td><td>SECTION E</td><td></td></tr>
<tr><td>15.</td><td>

(e)
$$C \propto \frac{1}{d} \Rightarrow \frac{C_{medium}}{C_{air}} = \frac{d}{d - t + \frac{t}{K}}$$
$$= \frac{6}{6 - 4.5 + \frac{4.5}{9}} = \frac{6}{2} = 3$$</td><td>½ - diagram

1

1

½

1

1/2 + 1/2</td></tr>
<tr><td></td><td>OR
. (i) Potential difference remains the same as battery remains connected.</td><td>1

1</td></tr>
</table>

	(ii) As electric field $E = V/d$, $V=$ constant and $d =$ constant, there fore electric field strength remains the same.	1
	(iii) The capacitance of the capacitor increases as $C = K\ C0$.	1
	(iv)The charge $Q= CV$, $V=$ constant, C increases, therefore charge increases.	1
	(v) Energy stored in the capacitance $U = 1/2\ CV^2$, also increases	