SET-1

No. of printed pages: 3

INDIAN SCHOOL SOHAR
UNIT TEST I (2023-24)
PHYSICS

CLASS: XII **MAX. MARKS: 20**
DATE: 23/05/2023 **TIME: 40 MINUTES**

General Instructions:

(1) There are 10 questions in all. All questions are compulsory.
(2) This question paper has five sections: Section A, Section B, Section C, Section D and Section E.
(3) Section A contains six questions, four MCQ and two Assertion Reasoning based on one mark each, Section B contains one question of two marks, Section C contains one question of three marks, Section D contains one case study based question of four marks and Section E contains one long answer question of five marks.

Section A

1. According to Coulomb's law, which is the correct relation for the following figure?

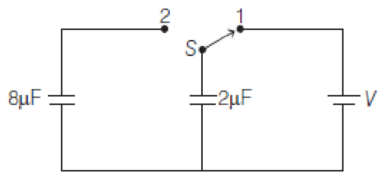
(a) $q_1 q_2 > 0$ (c) $q_1 q_2 \geq 0$
(b) $q_1 q_2 < 0$ (d) $0 < q_1 q_2 < 1$ [1]

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

(a) 2V (c) V/2
(b) -V (d) Zero

[1]

3. In the given figure, a 2μF capacitor is charged. When switch S is turned to position 2, the percentage of stored energy loss is



(a) 0% (c) 75%
(b) 20% (d) 80%

[1]

4. Which physical quantity has the unit Farad/metre?

(a) Electric Field (c) Electric dipole moment.
(b) Capacitance (d) permittivity.

[1]

For questions 5 to 6, 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 the 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.

5. **Assertion:** A parallel plate capacitor is connected across the battery through a key. A dielectric slab of dielectric constant K is introduced between the plates. The energy which is stored becomes K times.
Reason: The surface density of charge on the plate remains constant or unchanged. [1]

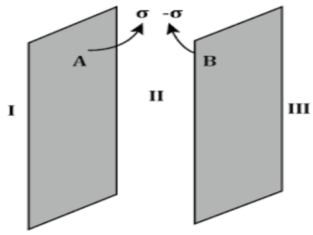
6. **Assertion**: The net force on a dipole in a uniform electric field is zero.
Reason: Electric dipole moment is a vector directed from –q to +q. [1]

Section B

7. Two large, thin metal plates are parallel and close to each other. On their inner faces, the plates have surface charge densities of opposite signs and of magnitude $17.7 \times 10^{-22}\ C/m^2$. What is electric field intensity **E**:

    (a) in the outer region of the first plate, and

    (b) between the plates? [2]



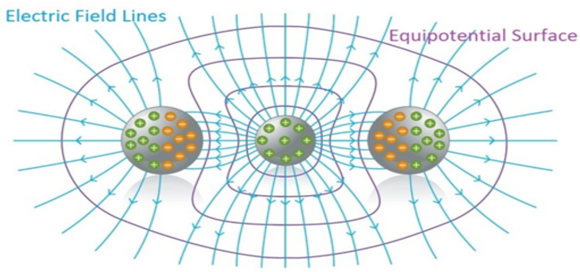
Section C

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

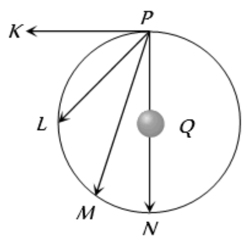
Section D

9. **Case Study:**
Read the following paragraph and answer the questions. Equipotential surface is defined as a region in space in which every specified point has the same potential. If these points are connected by a line or curve, it is known as an equipotential line. When such points lie on a surface,then it is called an equipotential surface and when they lie in space or a volume, then it is called an equipotential volume.

    1. What work must be done to move a test charge from one point on an equipotential surface to another point on the same equipotential surface?
        (a) Positive
        (b) Negative
        (c) Infinite
        (d) Zero [1]



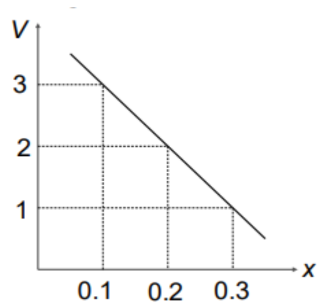
    2. The equipotential surface will be spherical for a
    (a) dipole (b) quadrupole (c) dielectric molecule (d) point charge [1]
    3. A charge Q is located at the centre of a circle. Work done will be maximum, when another charge is taken from point P to
    (a) K (b) L (c) M (d) N [1]



4. The variation of potential V with distance x from a fixed point charge is as shown in figure. The electric field strength between x = 0.1 m and 0.3 m is

(a) $0.4\ \mathrm{Vm^{-1}}$ (b) $-0.4\ \mathrm{Vm^{-1}}$

(c) $10\ \mathrm{Vm^{-1}}$ (d) $-10\ \mathrm{Vm^{-1}}$



[1]

OR

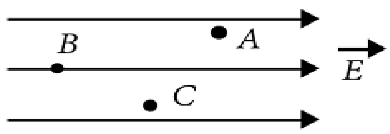
5. A, B and C are three points in a uniform electric field. The electric potential is

(a) maximum at C

(b) same at all the three points A, B and C

(c) maximum at A.

(d) maximum at B



[1]

Section E

10. (a) Use Gauss's law to show that a uniformly charged spherical shell of radius R, the electric field at any point situated outside the shell at a distance r from its centre is equal to the electric field at the same point, when the entire charges on the shell were concentrated at its centre. Also plot the graph showing the variation of electric field with r, for $r \leq R\ and\ r \geq R.$

(b) Two point charges of + 1 μC and +4 μC are kept 30 cm apart. How far from the + 1 μC charge on the line joining the two charges, will the net electric field be zero ?

OR

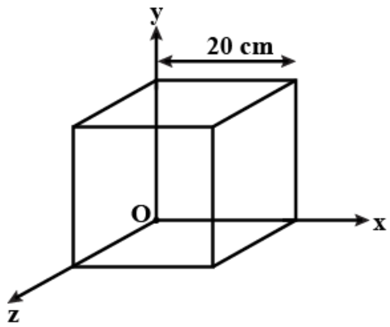
a. Two point charges q_1 and q_2 are kept r distance apart in a uniform external electric field $\overline{E}$ Find the amount of work done in assembling this system of charges.

b. A cube of 20 cm is kept in a region as shown in the figure. An electric field E exists in the region such that the potential at a point is given by $V = 10x + 5$, where V is in volt and x is in m.

Find the

(i) electric field, and

(ii) electric flux through cube



[5]

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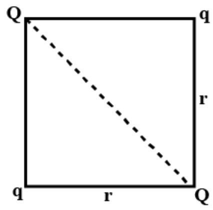
1. In the figure, if net force on Q is zero then the magnitude of $\frac{Q}{q}$ is:



   (a) $2\sqrt{2}$ (c) $\frac{1}{2\sqrt{2}}$
   (b) $\sqrt{2}$ (d) $\frac{1}{\sqrt{2}}$ [1]

2. Four charges + 8Q, - 3Q, +5Q and -10 Q are kept inside a closed surface. What will be the outgoing flux through the surface?
   (a) 26 V-m (b) 0 V-m (c) 10 V-m (d) 8 V-m [1]

3. Two plates of a parallel plate capacitor are 1 cm apart and the potential difference between them is 10 V. The electric field between the plates is
   (a) 10 N/C (b) 250 N/C (c) 500 N/C (d) 1000 N/C [1]

4. Two conducting spheres A and B of radii a & b respectively are at the same potential. The ratio of surface charge densities of A and B is
   (a) $\frac{b}{a}$ (b) $\frac{a}{b}$ (c) $\frac{a^2}{b^2}$ (d) $\frac{b^2}{a^2}$ [1]

For questions 5 to 6, two statements are given –one labelled Assertion and other labelled Reason. Select the correct answer to these questions from the options as given below.
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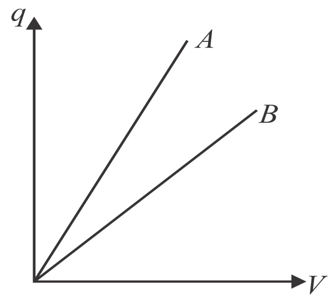
(d) If both Assertion and Reason are false.

5. **Assertion** : Capacity of a conductor is independent of the amount of charge on it.
   Reason: Capacitance depends on the dielectric constant of the surrounding medium, shape and size of the conductor. [1]

6. **Assertion**: In a nonuniform electric field, a dipole will have translatory as well as rotatory motion.
   Reason: the torque experienced by a dipole is given by $\tau = pEsin\theta$. [1]

Section B

7. The given graph shows variation of charge *q* versus potential difference *V* for two capacitors C1 and C2. Both the capacitors have the same plate separation but the plate area of C2 is greater than that of C1. Which line (A or B) corresponds to C1 and why ?



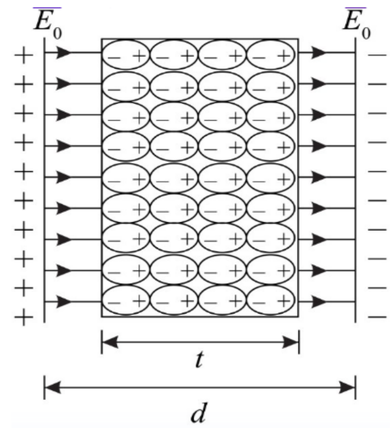
[2]

Section C

8. (a) Derive an expression for the electric field E due to a dipole of length '2a' at a point distant r from the centre of the dipole on the axial line.
(b) Draw a graph of E versus r for r >> a. [3]

Section D

9. Case study: Electric Polarisation.
When a substance is kept in an electric field. The positive and negative elements of the substance experience some force and due to which they develop a dipole or electric displacement. This reduces the value of the net electric field in the medium. This phenomenon of electric displacement is known as electric polarisation. The extent of electric polarisation is directly proportional to the permittivity of the material or the value of the dielectric constant of the material. For the conductors, the value of the permittivity is infinite. Therefore the magnitude of the electric field in the conductor is zero in electrostatics.



1. The best definition of polarisation is
   (a) Orientation of dipoles in random direction
   (b) Electric dipole moment per unit volume
   (c) Orientation of dipole moments
   (d) Change in polarity of every dipole [1]

2. Calculate the polarisation vector of the material which has 100 dipoles per unit volume in a volume of 2 units.

   (a) 200 (c) 0.02
   (b) 50 (d) 100 [1]

3. The total polarisation of a material is the
   (a) Product of all types of polarisation
   (b) Sum of all types of polarisation
   (c) Orientation directions of the dipoles
   (d) Total dipole moments in the material [1]
4. Dipoles are created when dielectric is placed in __________

   a. magnetic Field
   b. electric field
   c. vacuum
   d. inert environment.

[1]

OR

4. Identify which type of polarisation depends on temperature.

   a. Electronic
   b. Ionic
   c. Orientational
   d. Interfacial

Section E

10. (i) Define the capacitance of a capacitor. Obtain the expression for the capacitance of a parallel plate capacitor in vacuum in terms of plate area A and separation d between the plates.
(ii) A slab of material of dielectric constant K has the same area as the plates of a parallel plate capacitor but has a thickness $\frac{3d}{4}$. Find the ratio of the capacitance with dielectric inside it to its capacitance without the dielectric.

OR

(a) State Gauss's law and use it to derive the expression for the electric field **E** due to a straight uniformly charged infinite line of charge of density λ C/m.
(b) Draw a graph to show the variation of **E** with perpendicular distance **r** from line of charge. [5]