Electrostatics

1. Three identical charges each +q are placed at the corners of an equilateral triangle of side d cm. Calculate the force on a +ve charge +2q at the centroid of the triangle.

2. Force acting on a charged particle kept between the pair of plates, having equal and opposite charge, is F. If one of the plates is removed, find the force acting on the same particle.

3. The plates of a parallel plate system are charged upto 100V. A 4mm thickness dielectric slab is inserted between the plates. Then to maintain the same potential difference, the distance between the systems plates is increased by 2mm. find the dielectric constant.

4. A point charge placed at any point on the axis of an electric dipole at some large distance experiences a force F. Find the force acting on the point charge when its distance from the dipole is quadrupled.

5. In the electric field of a point charge ‘q’, the four points A,B,C and D are equidistant from q, however AB>AC>AD. Calculate the work done in taking a unit charge along AB, AC and AD.

6. N identical spherical drops charged to the same potential ‘V’ is combined to form a big drop. Find the potential of the new big drop formed.

7. An electron is projected with an initial speed of 25×10^5 m/s directly towards a proton which is at rest. Initially the electron is supposed to be at a fairly large distance from the proton. Find the distance of the electron from the proton when its instantaneous speed becomes twice the initial speed.

8. Two conducting spheres one of radius 6cm and the other of radius 12cm each carrying 3×10^-8C are placed very far apart. If these spheres are connected by a conducting wire, find the direction of motion and the magnitude of charge transferred.

9. A solid metal disc of radius ‘R’ rotates with constant angular velocity about its axis. Calculate the electric field ‘E’ at a distance ‘x’ from the axis and the potential difference ‘V’ between the centre and the edge of the disc.

10. Three charges of +0.1C each is placed at the corners of an equilateral triangle, 1m side. If energy is supplied at the rate of 1kW, how many days would be required to move one of the charges to the mid point of the line joining the other two?
HOTS (solved) Questions

Electrostatics

Q1 The bob of a simple pendulum is a small metal ball of mass ‘m’. When it oscillates between the two uncharged plates of a parallel plate capacitor, its time period is \( T \) what would be the effect on the time period if the metal ball is given a +ve charge and the capacitor is charged as shown in figure:

\[
\begin{array}{cccc}
+ & + & + & + \\
\hline
\circ & +q \\
\hline
- & - & - & - \\
\end{array}
\]

Ans : \( mg^1 = mg + qE \)

\[
g^1 = g + q \frac{E}{m}
\]

\[
T^1 = 2\pi \sqrt{\frac{l}{g^1}}
\]

\[
T^1 = 2\pi \sqrt{\frac{l}{q + \frac{qE}{m}}}
\]

\[
T = 2\pi \sqrt{\frac{l}{g}}
\]

\( T^1 < T \) Time period decreases

Q2. A comb run through one’s hair attract small bits of paper why? What happens if the hairs are wet.

Ans : The comb gets charged by friction if the hairs are wet Friction between the hair and the comb reduces.

Q3. Plot a graph showing the variation of Coulomb Force (F) versus \( \frac{1}{r^2} \), where \( r \) is the distance between two charges of each pair of charge \( (1\mu C, 2\mu C) \) and \( (2\mu C, 3\mu C) \)

Ans :
Charges (1μc, 2μc)

\[ F \propto 2 \ (\text{+ve, Repulsive}) \]

\[ F \propto \frac{1}{r^2} \]

By OA

Charges (2μc, -3μc)

\[ F \propto -6 \ (-\text{ve, attractive}) \]

\[ F \propto \frac{1}{r^2} \]

By OB

Q.4. Two small balls having equal positive charge ‘q’ coulomb are suspended by two insulating strings of equal length ‘l’ metre from a hook fixed to stand the whole setup is taken in a satellite into space where there is no gravity what is the angle between the strings and the tension in each string.

Ans : mg = 0

On account of electrostatic force of repulsion between the balls the string become horizontal

\[ \therefore \ \text{angle between the strings} = 180^0 \]

Tension in each string \( T = \frac{1}{4\pi\varepsilon_0} \frac{q^2}{(2l)^2} N \)

Q.5. Two points charges of +2μc and +6μc repel each other with a force of 12 N. If each is given an additional charge of -4μc. What will be the new force.

\( q_1 = +2\mu c, \ q_2 = +6\mu c \)

\( q'_1 = -2\mu c, \ q'_2 = +2\mu c \)

\[ \frac{F'}{F} = \frac{q'_1 q'_2}{q_1 q_2} = \frac{(-2)(2)}{(2)(6)} = -4 \text{N (attractive)} \]

6. Keeping the voltage of the the charging source constant, what would be the percentage change in the energy stored in a parallel plate capacitor if the separation between its plates were to be decreased by 10%?

\[ E = \frac{1}{2} CV^2 = \frac{1}{2} \frac{\varepsilon_0 A}{d} V^2 \]
Q 7 Point charge Q is placed at point O as shown in figure.

Is the potential difference \((V_A-V_B)\) Positive, negative or zero?

If Q is positive

\[
\text{Ans } = (V_A-V_B)
\]

\[
= \frac{K\Psi}{OA} - \frac{K\Psi}{OB}
\]

\(OA < OB\)

When \(\Psi\) is positive. Then \(V_A-V_B\) is positive.

Q 8 Body A repels another body B, A attracts body C, C repels body D. It is given that body D is positively charged. What is the charge on body B?

Ans: B is negatively charged.

Q 9 Ordinary rubber is an insulator but the special rubber tyres of aircraft are made slightly conducting. Why is this necessary?

Ans: On account of friction between the tyre and the runway, electricity is produced therefore frictional electricity is conducted to the earth.

Q 10 Electric charge is distributed uniformly on the surface of a spherical rubber balloon. Show how the value of electric intensity and potential vary.
i) On the surface.

ii) Inside and

iii) Outside

Ans  i) $E = \text{constant, } V = \text{constant}$

ii) $E = 0, \; V = \text{constant same as on the surface.}$

iii) $E \propto \frac{1}{r^2}, \; V \propto \frac{1}{r}$