LAKSHYA (JEE)

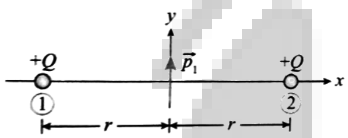
Electric Charges and Field

DPP-11

1. An electric dipole is formed by + 4 μC and –4 μC charges at 5 mm distance. Calculate the dipole moment and give its direction.

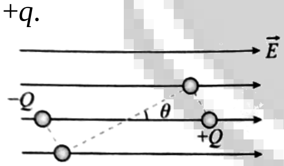
2. An electric dipole of dipole moment 4×10^{-5} C m is placed in a uniform electric field of 10^{-3} N C^{-1} making an angle of 30° with the direction of the field. Determine the torque exerted by the electric field on the dipole.

3. For the electrostatic charge system as shown in the figure.



Find the force acting on dipole.

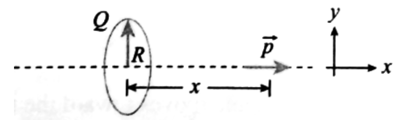
4. An electric dipole formed by two particles fixed at the end of a light rod of length l. The mass of each particle is m and the charges are $-q$ and $+q$.



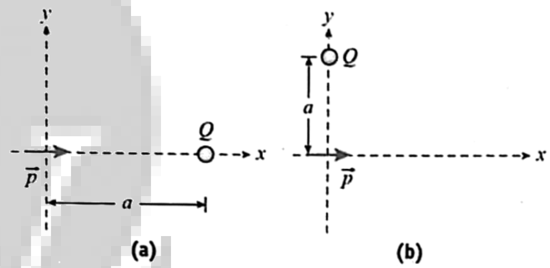
The system is placed in such a way that the dipole axis is parallel to a uniform electric field E that exists in the region. The dipole is slightly rotated about its center and released. Show that for small angular displacement, the motion is angular SHM and evaluate its time period.

5. Two-point charges of + 0.2 μ μC and – 0.2 μ μC are separated by 10^{-8} m. Determine the electric field at an axial point at a distance of 0.1 m from their midpoint. Use the standard value of ϵ_0.

6. A dipole having dipole moment 'p' is place at the axis of a charged ring having charge Q and radius R, at a distance x from the center as shown in figure. Find the force experienced by the dipole of dipole moment $\vec{p} = p\hat{i}$ placed along the axes of the uniformly charged ring.



7. A positive point charge Q and a dipole of dipole moment p are arranged as shown in the given Figs. (a) and (b). Find the force acting on the dipole in each case.



8. Calculate the field due to an electric dipole of length 10 cm and consisting of charges of ± 100 μC at a point 20 cm from each charge.

9. An electric dipole has a fixed dipole moment $\vec{P}$, which makes angle θ with respect to X-axis. When subjected to an electric field $\vec{E}_1 = E\hat{i}$, it experiences a torque $\vec{T}_1 = \tau\hat{k}$. When = subjected to another electric field $\vec{E}_2 = \sqrt{3}E_1\,\hat{j}$ it experiences a torque $T_2 = -T_1$. The angle θ is

(a) 45° (b) 60°

(c) 90° (d) 30°

ANSWERS

1. 2×10^{-8} C m, from –ve to +ve charge

2. 2×10^{-8} Nm

3. $\dfrac{1}{2\pi\epsilon_0}\dfrac{pQ}{r^3}(\hat{j})$

4. $T = 2\pi\sqrt{\dfrac{ml}{2qE}}$

5. 3.6×10^{-9} NC^{-1}

6. $\dfrac{Qp}{4\pi\epsilon_0}\dfrac{R^2 - 2x^2}{(R^2 + x^2)^{5/2}}$

7. $\vec{F}_{2,\ \text{dipole}} = \dfrac{1}{4\pi\epsilon_0}\dfrac{pQ}{a^3}(i)$

8. 1125×10^{7} NC^{-7}

9. (b)