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Electric dipole, electric field due to a dipole

CLASS-XII

SUBJECT : PHYSICS
CHAPTER NUMBER: 01
CHAPTER NAME : ELECTRIC CHARGES AND FIELDS

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LEARNING OUTCOME

- **Students will be able to know and explore translational & rotational motion for a dipole in a Uniform electric field**
- **Students will be able to: understand the expression of torque produced by electric dipole placed in uniform and non-uniform field.**
- **Students will be able to know about the maximum and minimum torque produced by dipole placed in the electric field.**
- **Students can able to strengthen problem-solving skill and quantitative reasoning.**
- **Students will be excited and feel interested to learn about how and why behind the current topic of discussion**

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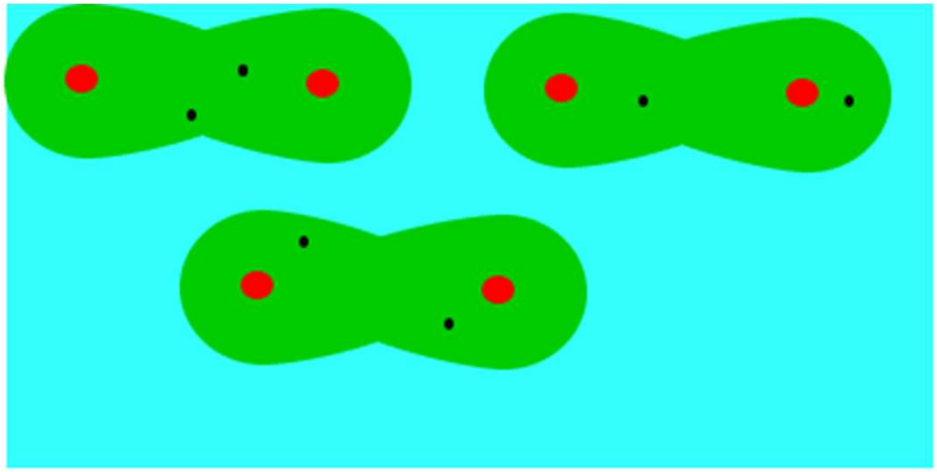
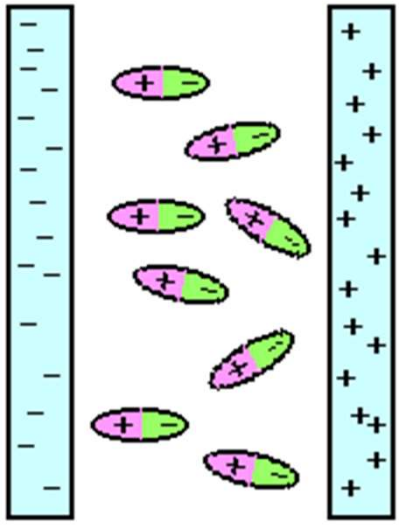
REVIEW

- Define electric dipole moment?
- What is the direction of the dipole moment?
- What is a point dipole or short dipole?
- What is the angle between dipole moment and electric field for a point on the equatorial line of the dipole?
- What is the ratio of the magnitude of an electric field at an axial point and equatorial point of a dipole?
- How will you separate Polar and non-polar molecules based on dipole moment?

INTRODUCTION





- What are polar and non polar molecules?
- What is polarity?
- What is the role of polar and non-polar molecules in electrostatics?

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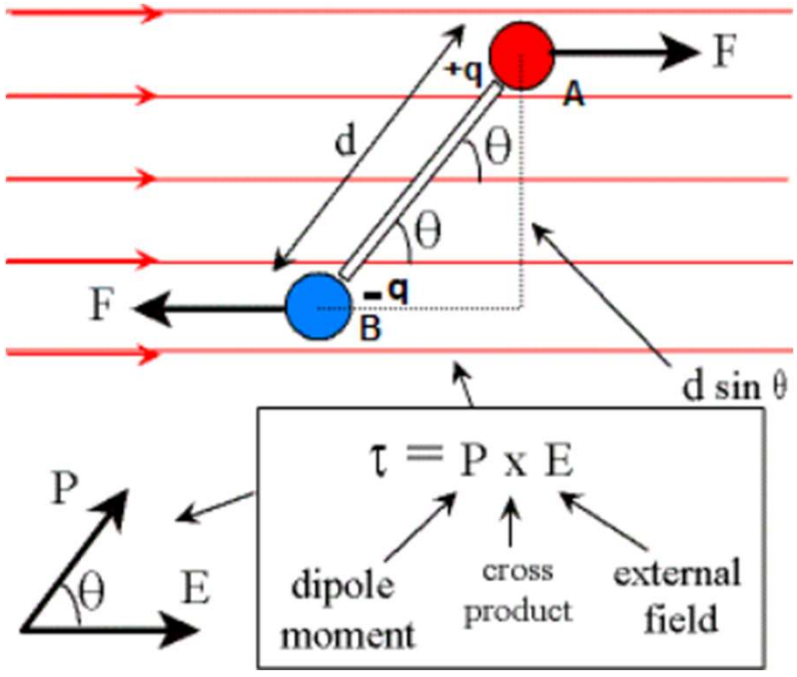
Dipole in a uniform external field

$$\tau = pE \sin\theta$$

Hence net force on the dipole is zero but net torque is non-zero.



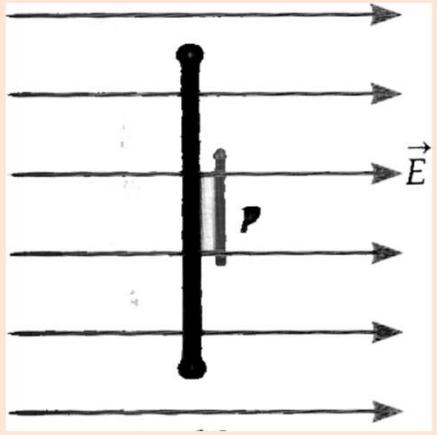
PERIODIC MOTION

Maximum Torque

When, $\theta = 90^o$

$\Rightarrow \quad sin\,\theta = 1 \quad and$

$\tau = PE$

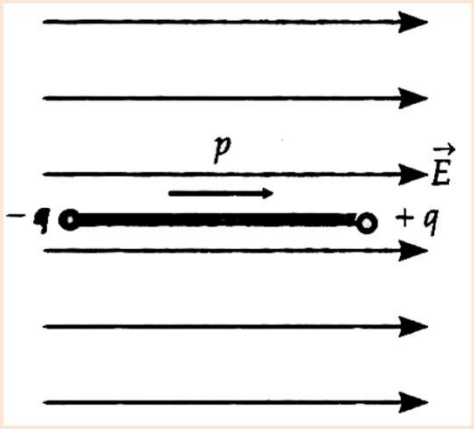


Minimum Torque

When $\theta = 0^o or 180^0$

$\Rightarrow sin\,\theta = 0 \qquad and$

$\tau = PE\,sin\,0 = 0$



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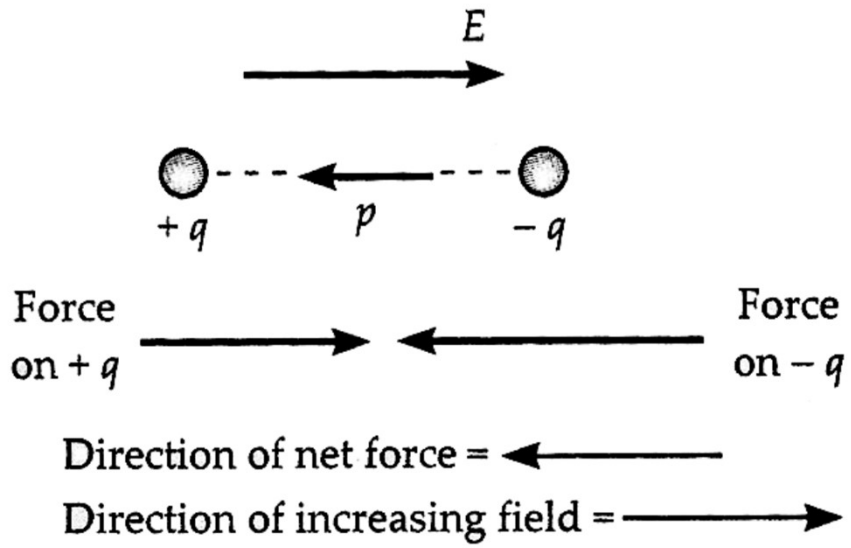
Dipole in a non-uniform electric field

Case – I, when the dipole is placed in a decreasing field. Hence the net force is along the opposite direction of the electric field.

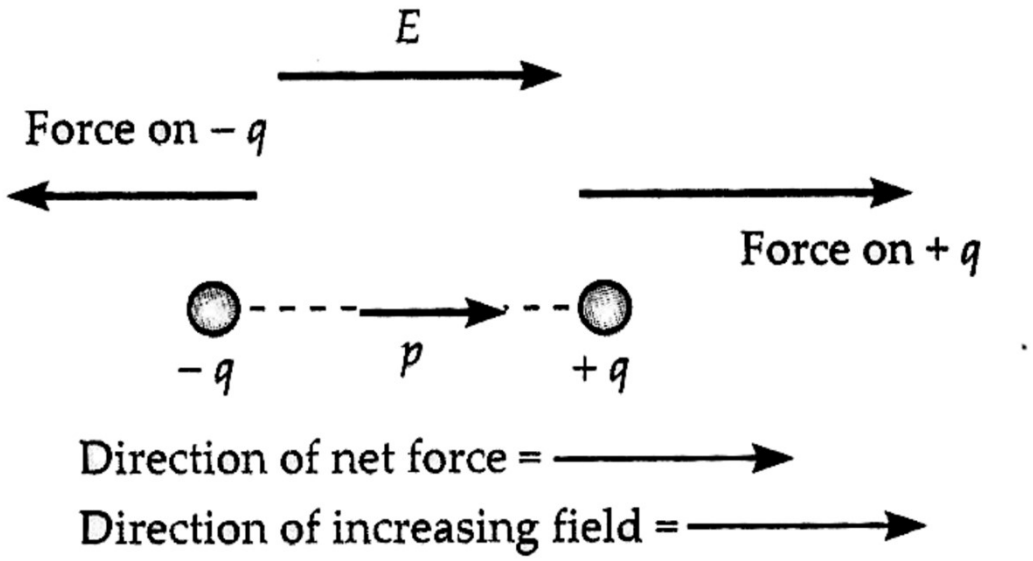
Here $\tau = 0$ But $F_{net} \neq 0$



Dipole in a non-uniform electric field

Case – II, when the dipole is placed in an increasing field. Hence the net force is along the direction of the electric field.

Here $\tau = 0$ But $F_{net} \neq 0$



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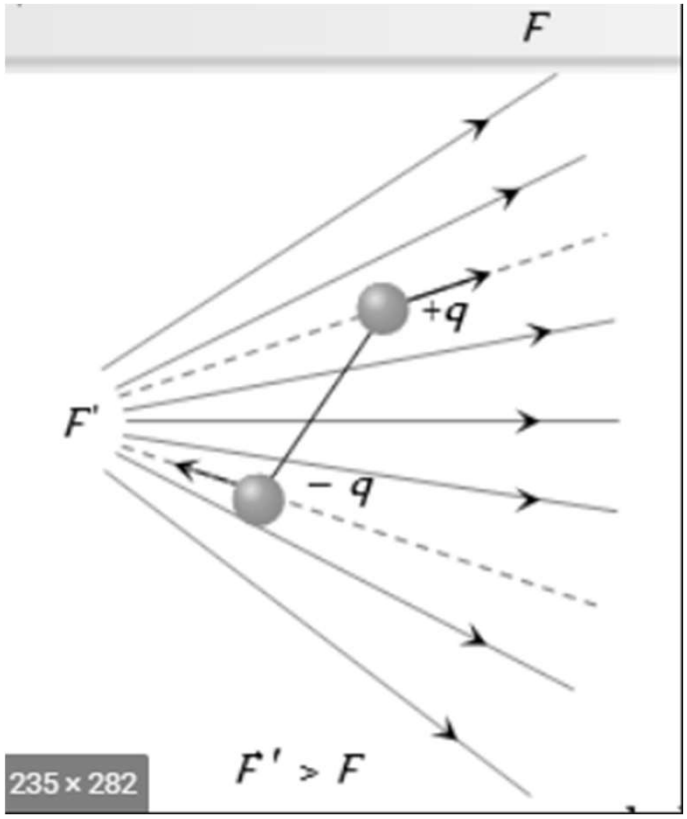
Dipole in a non-uniform electric field

Case – III, If the dipole is placed making a certain angle with the field it experience force as well as torque.



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POINTS TO REMEMBER

1. If the electric dipole is placed in a field of changing magnitude but the same direction along the dipole axis then force on the dipole is, $\vec{F} = p\frac{d\vec{E}}{dx}$

2. Except being parallel to the direction of the field, for any other configuration of the dipole, it experiences both force and torque.

HOME ASSIGNMENT

1. An electric dipole is placed at an angle of 600 with an electric field of 105 N/C. It experiences a torque on $8\sqrt{3}$Nm. Calculate the charge on dipole if the dipole length is 2 cm.

2. An electric dipole of dipole moment $\vec{p}$ is placed in a uniform electric field $\vec{E}$. Derive an expression for the torque experienced by the dipole. Show diagrammatically the orientation of the dipole in the field for which the torque is : (i) maximum value and (ii) zero.

3. Two small identical electrical dipoles AB and CD each of dipole moment is kept at an angle of 1200C. What is the resultant dipole moment of this combination? If this system is subjected to an electric field. directed along the direction, what will be the magnitude and direction of the torque acting on this?

THANKING YOU

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