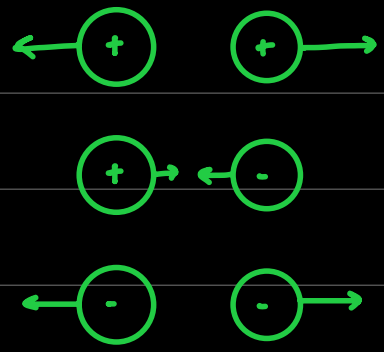
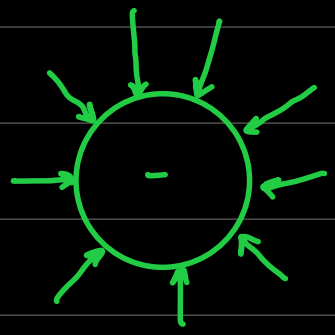
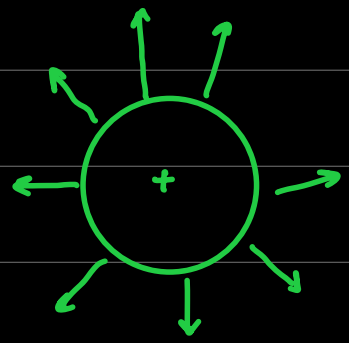
Electric Field ch #22

- Opposite charges attract
- Like charges repel



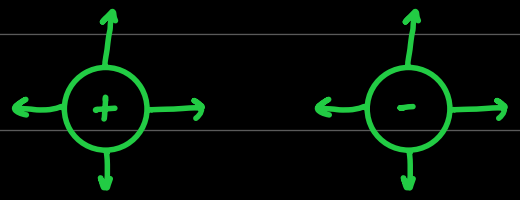




- $\vec{E} = \frac{\vec{F}}{q_o}$

F= Force E= Electric Field

q= charge



Note: Direction of electric field is the direction of force. 'E' is also tangent to electric field lines.

Coulomb's Law

· Take care of length & direction of arrows

· $F = \frac{kQ_1Q_2}{r^2}$

r = distance b/w point charges
Q_1 = test charge
Q_2 = source charge

$F = \frac{1}{4\pi\varepsilon_0} \cdot \frac{Q_1Q_2}{r^2}$; $k = \frac{1}{4\pi\varepsilon_0}$

Electric Field Derivation

· $F = \frac{1}{4\pi\varepsilon_0} \cdot \frac{Q_1Q_2}{r^2}$

$E = \frac{F}{Q_1} \rightarrow F = EQ_1$ -①

· $E = \frac{kQ}{r^2}$

$EQ_1 = \frac{1}{4\pi\varepsilon_0} \times \frac{Q_1Q_2}{r^2}$

$$\boxed{E = \frac{1}{4\pi\varepsilon_0} \times \frac{Q_2}{r^2}}$$

Q_2 = source charge

- Net electric Field: $E_{net} = E_1 + E_2 + E_3 \cdots$
- Net electric Force: $F_{net} = F_1 + F_2 + F_3 \cdots$

Electric Dipole

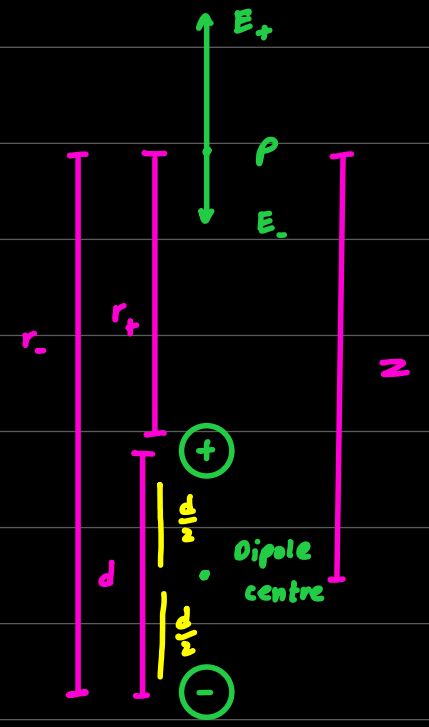
$$E_{net} = E_+ - E_-$$

$$= \frac{kq}{r_+^2} - \frac{kq}{r_-^2}$$

$$= \frac{kq}{\left(z-\frac{d}{2}\right)^2} - \frac{kq}{\left(z+\frac{d}{2}\right)^2} \qquad r_+ = z - \frac{d}{2}, \quad r_- = z + \frac{d}{2}$$

$$= \frac{q}{4\pi\varepsilon_0}\left(\frac{1}{\left(z-\frac{d}{2}\right)^2} - \frac{1}{\left(z+\frac{d}{2}\right)^2}\right)$$

$$= \frac{q}{4\pi\varepsilon_0 z^2}\left(\frac{1}{\left(1-\frac{d}{2z}\right)^2} - \frac{1}{\left(1+\frac{d}{2z}\right)^2}\right)$$



$$= \frac{q}{4\pi\varepsilon_0 z^2}\left(\frac{1+\frac{d}{2z}+\frac{d^2}{4z^2}-1+\frac{d}{2z}-\frac{d^2}{4z}}{\left(1-\frac{d}{2z}\right)^2\left(1+\frac{d}{2z}\right)^2}\right)$$

Dipole: Arrangement of two unlike charges

$$= \frac{q}{2\pi\varepsilon_0 z^2}\left(\frac{\frac{d}{z}}{\left(1-\left(\frac{d}{2z}\right)^2\right)^2}\right)$$

$$= \frac{q}{2\pi\varepsilon_0 z^3}\left(\frac{d}{\left(1-\left(\frac{d}{2z}\right)^2\right)^2}\right) \quad : \text{for values of } z \geq d,\ \frac{d}{2z} \leq 1$$

$$= \frac{q}{2\pi\varepsilon_0 z^3} \times d$$

$$E = \frac{qd}{2\pi\varepsilon_0 z^3}$$

$$\rightarrow \quad E = \frac{p}{2\pi\varepsilon_0 z^3}$$

Electric dipole momment = qd

Sample: 1,2

Exercise: 3,5,7,11,14,20,22,42,44,47