Summary of chapter 21

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1.

- There are two types of electric charges in nature;
  Positive charge (proton) and negative charge (electron).
- An object is positively charged if it has lost electrons.
- An object is negatively charged if it has gained electrons.

2. **Conductors** are materials in which electric charge (electrons) can move quite freely. Metals such as copper and aluminum are conductors.
   Insulators are materials in which electric charge (electrons) are ***not*** free to move. Materials such as glass, rubber, and plastic are insulators.
   Semi-conductors have electrical properties between metals and insulators.

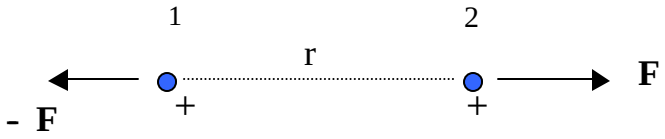
3. Coulomb's Law state that the **electrostatic force** between two charged particles separated by a distance r is given by:

$$F = \frac{1}{4\pi\varepsilon_o}\frac{|q_1||q_2|}{r^2}$$

$$\frac{1}{4\pi\varepsilon_o} = k = 9\times10^{-9} \ \text{N m}^2/\text{C}^2$$

ε_o is the permitivity of free space and k is the electrostatic constant, q_1 and q_2 are the charges of the two particles and r is the distance between the two charges.

- If the two charges have same signs, there is **repulsion** between them.



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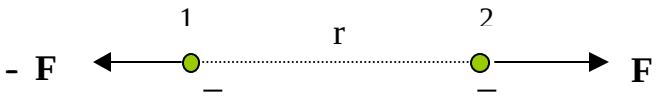
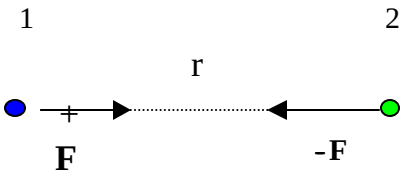
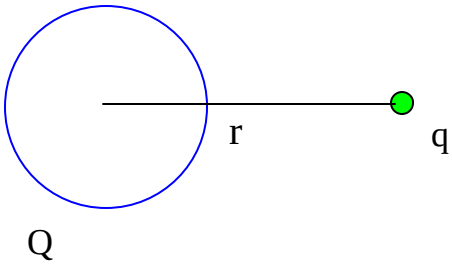


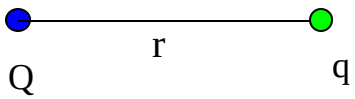
- If the two charges have opposite signs, there is **attraction** between them.



4. The shell theorem

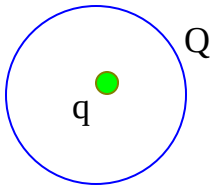
(i) A charge q is outside a uniformly charged shell carrying a charge Q.





The force on the charge q in both cases is

$$F = \frac{1}{4\pi\varepsilon_o}\frac{|Q||q|}{r^2}$$



If the charge q in inside the uniformly charged shell then the force on the charge q is **ZERO**.

- The elementary charge is that of the electron $|e| = 1.6 \times 10^{-19}$ C.
  Any charge on a body is an integer multiple of the electron charge,i.e.,
  $Q = n\,e,\ n = \pm 1, \pm 2, \ldots$

- Electric charge is always conserved. It can be transferred from one body to another but cannot be lost.