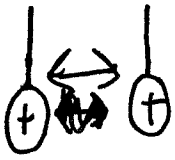
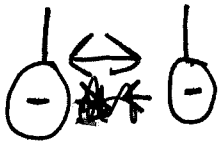
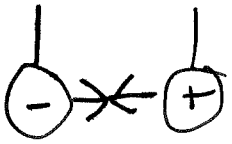
Recall that electrons have a negative charge. If there are more electrons than protons in a substance it has a negative charge. If there are more protons than electrons in a substance it has a positive charge.

When an acetate ruler is rubbed on paper towel electrons move from the acetate strip to the paper towel, this give the ruler a positive charge and the paper towel a negative charge.

When vinyl is rubbed on fur, electrons move from the fur to the vinyl, this gives the vinyl a negative charge and the fur a positive charge.

Two Positive Charges	Two Negative Charges	A Positive and a Negative
		

Law of Charges:

- Like repels like
- Opposites attract
- Charged attracts Uncharged

Protons have a positive charge and electrons have a negative charge. Importantly the magnitude of these charges is identical. If a substance has 10 electrons and 5 protons it would have a charge of −5 charges.

Since working with electrons and protons is very difficult we use a different unit for charge, the coulomb,

1 coulomb = 6,241,509,629,152,650,000 elementary charges.

What is the force generated by electric charges?

$F_E = \frac{k q_1 q_2}{r^2}$ where k is Coulomb's constant: $8.988 \times 10^9 \frac{N \cdot m^2}{C^2}$

q_1, q_2 are the charges

r is the distance between charges

Notice the similarity between this and Gravity

However, gravity always attracts but electric force can repel or attract.

Example: Two objects are 4.0 metres apart, one has a charge of +2.0 C, while the other has a charge of -5.0 C. Will the two objects attract or repel each other and what is the electrostatic force between them?

Attract

$$F_E = \frac{\left(8.988 \times 10^9 \frac{N \cdot m^2}{C^2}\right)(2.0C)(5.0C)}{(4.0m)^2}$$

$$= 5.6 \times 10^9 N$$

Generally static charges we will experience are considerably less than a coulomb, typically the unit we will use will be the micro-coulomb (μC), this is a millionth of a coulomb.

$1\mu C = 10^{-6} C$ or $1 C = 10^{6} \mu C$

Example: Two objects 0.50 metres apart each have a charge of 2.0 μC. Will the objects attract each other or repel each other? What is the electrostatic force between them?

Repel

$$F_E = \frac{8.988\times10^{9} \times 2.0\times10^{-6} \times 2.0\times10^{-6}}{(0.50)^2}$$

$$= 0.14\ N$$

Example: A 55.6 μC object is near a -74.3 μC object. Each object feels an attraction of 7.40 N towards each other. How far apart are they?

$$F_E = \frac{Kq_1q_2}{r^2}$$

$$r^2 F_E = Kq_1q_2$$

$$r^2 = \frac{Kq_1q_2}{F_E}$$

$$r = \sqrt{\frac{Kq_1q_2}{F_E}}$$

$$r = \sqrt{\frac{8.988\times10^{9} \times 55.6\times10^{-6} \times 74.3\times10^{-6}}{7.40\ N}}$$

$$= 2.24\ m$$

$K = 8.988\times10^{-3}\ \frac{N\cdot m^2}{\mu C^2}$

↑ can be used for measurements in μC