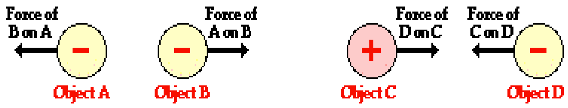
DAILY ANNOUNCEMENTS

PRACTICE	LABS	TESTS
	• Goldberg corrections • Aluminum Can Interactive • Electrostatic Foce Interactive	• Unit 14 Test Thursday (5/9/19)

Static Electricity

Learning Targets	14.1	I can describe, interpret, and solve problems involving electric charge.

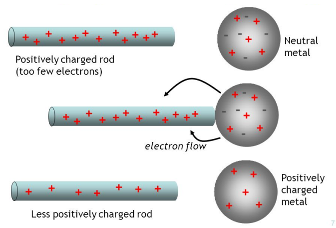


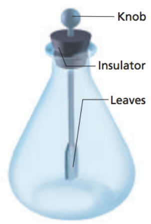
Charged Objects

Key Concepts
- There are two kinds of electric charge, positive and negative. Interactions of these charges explain the attraction and repulsion that you observed in the strips of tape.
- Electric charge is not created or destroyed; it is conserved. Charging is the separation, not creation, of electric charges.
- Objects can be charged by the transfer of electrons. An area with excess electrons has a net negative charge; an area with a deficit of electrons has a net positive charge.
- Charges added to one part of an insulator remain on that part. Insulators include glass, dry wood, plastics, and dry air.
- Charges added to a conductor quickly spread over the surface of the object. In general, examples of conductors include graphite, metals, and matter in the plasma state.
- Under certain conditions, charges can move through a substance that is ordinarily an insulator. Lightning moving through air is one example.

Forces on Charged Bodies

Charging a neutral body by touching it with a charged body is called **charging by conduction** .

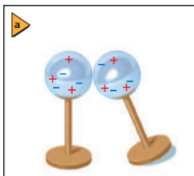




Electroscope

Forces on Charged Bodies

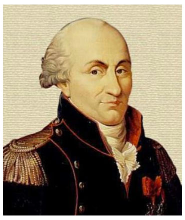
This process of charging an object without touching it is called **charging by induction** .

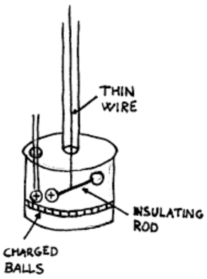
Forces on Charged Bodies

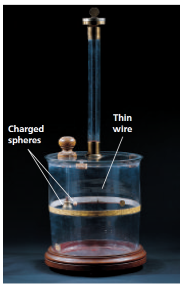
A single object can be charged by induction through **grounding** , which is the process of connecting a body to Earth to eliminate excess charge.

Coulomb's Law



CHARLES COULOMB (1785)





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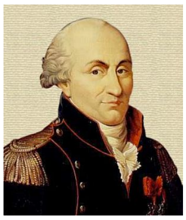
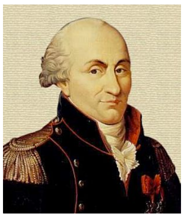


The unit of charge: the coulomb

The SI standard unit of charge is called the **coulomb** (C). q

Coulomb's Law



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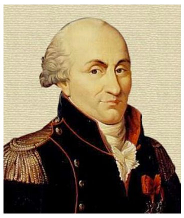
The SI standard unit of charge is called the **coulomb** (C).

- One coulomb is the charge of 6.24×10^{18} electrons or protons.
- A typical lightning bolt can carry 5 C to 25 C of charge.
- The magnitude of the charge of an electron is called the **elementary charge**.

Coulomb's Law



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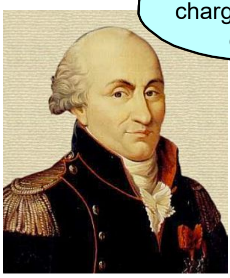
Electron charge magnitude, $e = 1.60 \times 10^{-19}$ C

Coulomb's Law

The force between charges depends on........



Coulomb's Law

Force depends on distance

Force depends on charge

Coulomb's Law

Force depends on distance

$$F \propto \frac{1}{r^2}$$

Force depends on charge

$$F \propto q_A q_B$$

Coulomb's Law

Coulomb's Law $|\vec{F}_E| = k\left|\frac{q_1 q_2}{r^2}\right|$

The force between two charges is equal to Coulomb's constant, times the product of the two charges, divided by the square of the distance between them.

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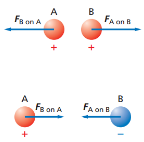
The rule for determining the direction of force is: like charges repel; unlike charges attract.



Comparing Electrical and Gravitational Forces

Compare and Contrast these two forces

$$F_{elect} = \frac{kq_a q_b}{d^2} \qquad F_{grav} = \frac{Gm_1 m_2}{d^2}$$

$k = 9.0 * 10^9 \ N * m^2 / C^2$ $\qquad G = 6.67 * 10^{-11} \ N * m^2 / kg^2$

Electrical Force Compared to Gravitational Force

Similarities

- Both are inverse square laws
- The mathematical form of both laws is the same

Differences

- Electrical forces can be either attractive or repulsive
- Gravitational forces are always attractive

$$F_e = k_C \frac{q_1 q_2}{r^2} \qquad F_g = G\frac{m_1 m_2}{r^2}$$

UNIT 14: In-Class Problems

1. **Coulomb's Law in Two Dimensions** Sphere A, with a charge of +6.0 μC, is located near another charged sphere, B. Sphere B has a charge of -3.0 μC and is located 4.0 cm to the right of A. What is the force of sphere B on sphere A?

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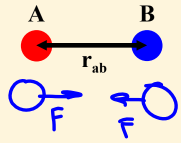
Known:
$q_A = +6.0\ \mu C$ $r_{AB} = 4.0$ cm
$q_B = -3.0\ \mu C$

Unknown:
$F_{B\ on\ A} = ?$



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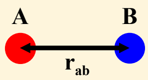

Find the force of sphere B on sphere A.

$$F_{B\ on\ A} = K\frac{q_A q_B}{r_{AB}^2}$$
$$= (9.0\times10^9\ N\cdot m^2/C^2)\frac{(6.0\times10^{-6}\ C)(3.0\times10^{-6}\ C)}{(4.0\times10^{-2}\ m)^2}$$
$$= 1.0\times10^2\ N$$

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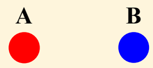
2. A third sphere, C, with a +1.5 μC charge, is added to the configuration. If it is located 3.0 cm directly beneath A, what is the new net force on sphere A?



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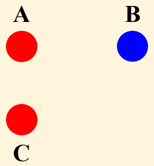

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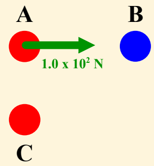

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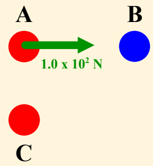

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$$= (9.0\times10^9\ N\cdot m^2/C^2)\frac{(6.0\times10^{-6}\ C)(1.5\times10^{-6}\ C)}{(3.0\times10^{-2}\ m)^2}$$
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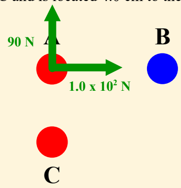

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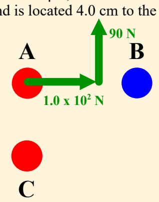

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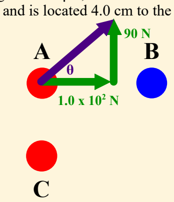

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$$= 9.0\times10^1\ N$$

$$F_{net} = \sqrt{F_{B\ on\ A}^2 + F_{C\ on\ A}^2}$$
$$= \sqrt{(1.0\times10^2\ N)^2 + (9.0\times10^1\ N)^2}$$
$$= 130\ N$$

$$\tan\theta = \frac{F_{C\ on\ A}}{F_{B\ on\ A}}$$
$$= 42°$$

Application of Electrostatic Forces

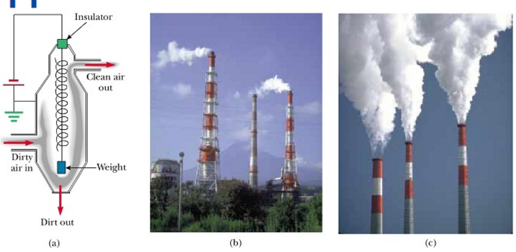


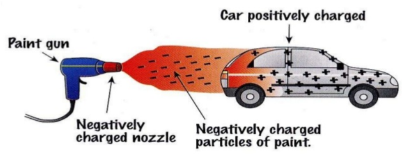
Figure 25.28 (a) Schematic diagram of an electrostatic precipitator. The high negative electric potential maintained on the central coiled wire creates an electrical discharge in the vicinity of the wire. Compare the air pollution when the electrostatic precipitator is (b) operating and (c) turned off.

Application of Electrostatic Forces

The paint is charged as it comes out of the nozzle.

The paint is attracted to the car.

The car must be earthed or connected to a positive voltage.



Application of Electrostatic Forces