Name: _____

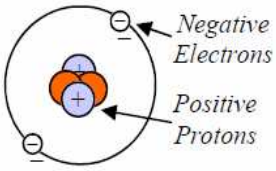
Period: _____

Electric Charge

9.1

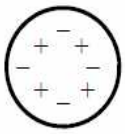
Electricity Electricity is moving electrons; Protons can't move.

Electrons can move, but protons are held together in the nucleus by the ***strong nuclear force***, the strongest force in nature.

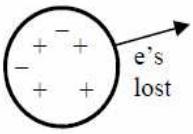


Electricity comes from electrons moving between atoms.

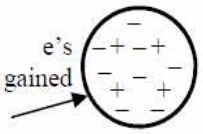
Charge Objects can be positive, negative, or neutral. The unit of charge is the ***coulomb*** (C).



A neutral object has an **equal number** of protons and electrons.



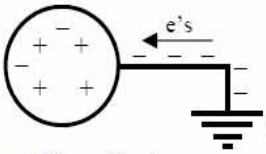
A positive object has **lost electrons**, so it has more protons than electrons.



A negative object has **gained electrons**, so it has more electrons than protons.

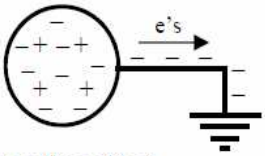
Ground Ground (the earth) can take or give an infinite number of electrons. Ground is electrically neutral. Both positive and negative charges will neutralize when grounded.

To ground something you can often touch it to a pipe. Metal pipes are good electrical conductors and usually connected to other pipes and eventually to the actual ground.



Symbol for ground

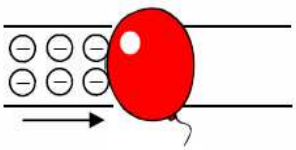
A positive object **will take electrons** from ground and become neutral.



A negative object **will give electrons** to ground and become neutral.

Insulator vs. Conductor A good insulator is a bad conductor, and vice versa. The better the conductor, the easier electrons can flow thru the material.

Insulators resist the flow of electrons.

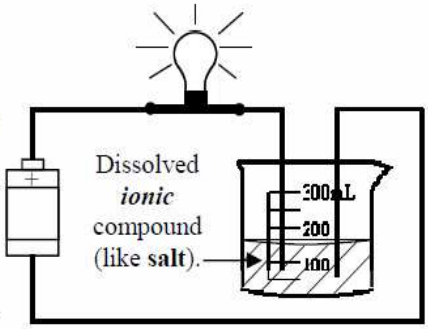


Electrons can be forced thru an insulator by enough force (called "breakdown voltage").

Conductors allow the flow of electrons.

Metals tend to be good conductors because their outer electrons are free to move.

Dissolved ionic compounds are conductors and are called electrolytes. The salt in our diets allows electricity to flow in our bodies, like in our nerves and muscles.



Electric Charge The unit of charge is a fundamental quantity and is measured in Coulombs (C).

Electron Charge

1 electron =

-1.602×10^{-19} *Coulombs*

The smallest units of charge are the proton and the electron. You cannot have part of an electron, because it would lose its negative charge. Therefore, you cannot have less than -1.602×10^{-19}C of charge and any amount of charge must be multiples of this number. You can have 12 or 13 electrons, but not 12.2 or 12.5 electrons!

The charge of a proton is the same as an electron, only positive: **1 proton = $+1.602\times10^{-19}$C.**

1e 1e ½e ← *Not possible*

Electric charge is quantized, meaning the amount of charge must always be in multiples of e. You can never have part of an electron or proton.

Ex: What is the charge of an object that gains 1.2×10^8 electrons?

Do a conversion :

$$\left(\frac{1.2\times10^{8}\,\text{e}}{1}\right)\left(\frac{-1.602\times10^{-19}\,\text{C}}{1\,\text{e}}\right)=-1.92\times10^{-11}\,\text{C}$$

Ex: How many electrons are gained or lost if an object has a charge of 4.6μC (microcoloumbs)?

$$\left(\frac{4.6\times10^{-6}\,\text{C}}{1}\right)\left(\frac{1\,\text{e}}{-1.602\times10^{-19}\,\text{C}}\right)=-2.87\times10^{13}\,\text{e}$$

The negative means it lost e's (+ object).

Electric Charge and Force Skills Sheet

Prefixes:
Mega (M) = $\times 10^{6}$
Kilo (k) = $\times 10^{3}$
Centi (c) = $\times 10^{-2}$
Milli (m) = $\times 10^{-3}$
Micro (μ) = $\times 10^{-6}$
Nano (n) = $\times 10^{-9}$

1. Prepare these numbers for calculations by putting them into standard units:
   A. 15 μC B. 4.9 nm C. 8 MHz D. 6 mm E. 7 centicoulombs

   15×10^{-6} C

2. How much charge does 1,200 electrons have?

3. An object has a charge of 2.4 μC.
   A. Is it positive or negative?
   B. Did it gain or lose electrons?
   C. How many electrons were gained or lost?

Electron Charge

$1\ electron = -1.602\times10^{-19}\ C$

4. How many electrons were gained or lost by a 4.5 milliC charge?

5. Possible or impossible:
   A. 12 electrons B. 15.5 electron C. 6.3 electrons D. 1,507 electrons

6. A 3 C charge is 4 mm away from a 6 C charge.
   Find the force between them.

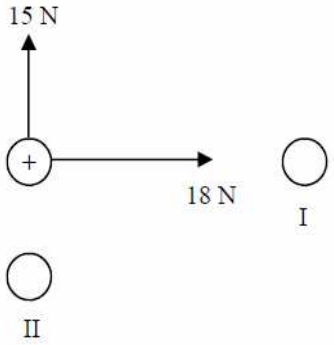
7. A 7.2 μC charge is 20 cm away from a 3.8 μC charge. Find the force.

Coulomb's Law

Charge 1 (*in Coulombs*) and Charge 2 (*in C*)

Electric Force (*in N*) $\rightarrow F_e = k_c \frac{q_1 q_2}{r^2}$ ← Distance between the two charges (*in m*)

Coulomb's Constant = $9\times10^{9}\ Nm^2/C^2$



8. How does the electric force change?
   A. If one of the charges is tripled?
   B. If the distance doubles?
   C. If one of the charges is halved?
   D. If the distance is halved?

9. Two electric forces are acting on a positive charge, as seen at the right.
   A. Using the ideas of attraction and repulsion, decide whether the two blank charges are positive or negative.

   B. Calculate the net force on the charge (*including magnitude and direction*).

   C. If the positive charge has a mass of 0.65 kg, what is its acceleration?

   D. How much force is acting on charge I?