SNC1D PHYSICS

THE CHARACTERISTICS OF ELECTRICITY

- Electric Charges (P.394-396,399)

Activity: Electric Charges

MATERIALS

Each group of 3 (or 4) will need:

- 1 ebonite rod
- 1 pith-ball electroscope
- 1 metal-leaf electroscope
- 1 petri dish of wood dust
- 1 petri dish of paper-punch dots
- 1 balloon
- 1 piece of fur
- 1 piece of plastic

Activity: Electric Charges

INSTRUCTIONS (Part 1)

A. Place the uncharged ebonite rod in the wood dust. What do you notice?
B. Charge the ebonite rod with the fur (hair) and then repeat step A.
C. Charge the ebonite rod with the plastic and then repeat step A.

NOTE!

Wipe any material off the ebonite rod after each use.

Activity: Electric Charges

INSTRUCTIONS (Part 2)

D. Bring a charged ebonite rod near but not touching the pith-ball electroscope. What do you notice?
E. Now take the rod away. What do you notice?
F. Now touch the rod to the pith ball. What do you notice? Separate them and them bring the rod back close. What do you notice?
G. Repeat Part 2 but this time use the metal-leaf electroscope.

Activity: Electric Charges

INSTRUCTIONS (Part 3)

H. Blow up the balloon, charge it, and then bring the charged spot near the paper-punch dots. What do you notice.
I. Try a spot that you didn't charge. What do you notice?

Electric Charges

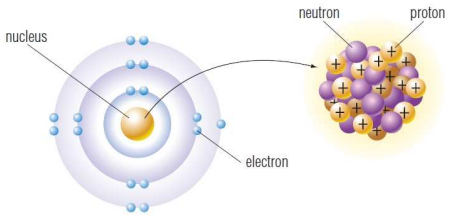
Have you ever walked across a carpet in stocking feet and reached for the doorknob only to be "zapped" by an unexpected shock? Or have you ever had your hair stand up after putting on, or taking off, a sweater? Have you perhaps noticed that a balloon placed near your head will attract your hair? Why does this happen?

Electric Charges

*They are both caused by **electric charges** – charged particles that exert an electric force on each other. These charged particles are very small. In fact, there are millions of them on each standing hair in the photos below. To understand what is happening, we need to look at the tiny particles that make up atoms of the carpet, the sweater, the socks, and us.*

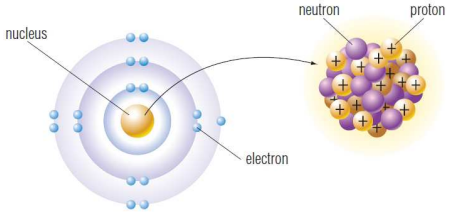
Atomic Structure & Electric Charge

*Recall that all matter is made up of tiny particles called atoms. Atoms contain smaller particles: protons, neutrons, and electrons. Some of these particles have an electric charge. **Protons** have a positive charge (+), **electrons** have a negative charge (-), and **neutrons** have no charge.*



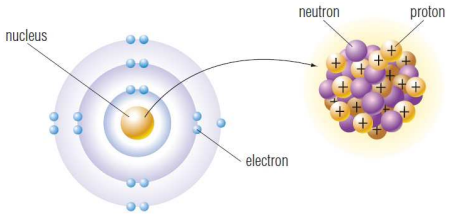
Atomic Structure & Electric Charge

Although they contain electrically charged particles, atoms are neutral. The number of protons in the nucleus equals the number of electrons around the nucleus, so the number of positive and negative charges is equal. This makes an atom neutral.



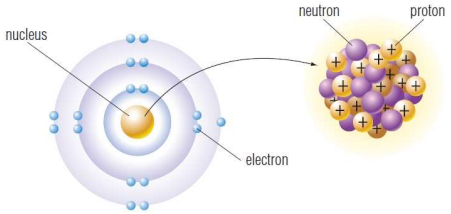
Atomic Structure & Electric Charge

According to the Bohr-Rutherford model of the atom, protons and neutrons are located in the nucleus, or centre, of the atom and are held in place by very strong forces. Under normal circumstances, they cannot be removed from an atom.



Atomic Structure & Electric Charge

Electrons, however, can move in the space surrounding the nucleus and can be added to or removed from atoms. If an atom does not have an equal number of protons and electrons, it has an electric charge. An atom that has an electric charge is called an ***ion****.*



Atomic Structure & Electric Charge

The following table summarizes the properties of the particles that make up an atom.

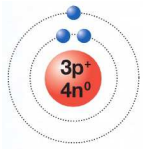
ATOMIC STRUCTURE & ELECTRIC CHARGE

Particle	Electric Charge	Location	Able to Move?
proton (p)	positive (+)	nucleus	no
neutron (n)	no charge	nucleus	no
electron (e)	negative (-)	outside nucleus	yes

Atomic Structure & Electric Charge

PRACTICE

1. Draw a Bohr-Rutherford diagram of the element lithium ($^{7}_{3}Li$). Label each particle with its name and whether it is positive (+), negative (–), or neutral.

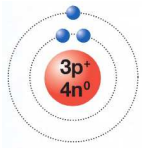


Atomic Structure & Electric Charge

PRACTICE

2. (a) Which particle(s) are difficult to add or remove from an atom?

(a) protons & neutrons

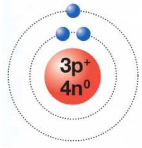


Atomic Structure & Electric Charge

PRACTICE

2. (b) Which particle(s) are easier to add or remove from an atom?

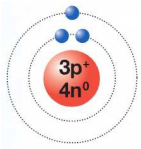
(b) electrons



Atomic Structure & Electric Charge

PRACTICE

2. (c) How do your answers to (a) and (b) explain the formation of positively and negatively charged objects?



(c) since electrons are easier to add or remove, if an atom gains electrons it becomes negatively charged and if it loses electrons it becomes positively charged

Charged & Neutral Objects

You can group objects according to three kinds of charge: positive, negative, and neutral. For example,

- *when an object that has an equal number of protons and electrons, it is said to be **neutral**,*

8 +
8 –
0

Charged & Neutral Objects

You can group objects according to three kinds of charge: positive, negative, and neutral. For example,

- *when an object that has more protons than electrons it is said to be **positively charged**,*

8 +
5 –
3 +

Charged & Neutral Objects

You can group objects according to three kinds of charge: positive, negative, and neutral. For example,

- *and when an object that has more electrons than protons it is said to be* ***negatively charged****.*

8 +
12 –
4 –

Charged & Neutral Objects

NOTE!

The outer electrons of some atoms can move from one atom to another. If a neutral object gains extra electrons, the object becomes negatively charged. If a neutral object loses electrons, the object becomes positively charged.

CHARGED OBJECTS

- neutral ☞ #e = #p (no overall charge)
- positive charge ☞ #e < #p (has lost electrons)
- negative charge ☞ #e > #p (has gained electrons)

Charged & Neutral Objects

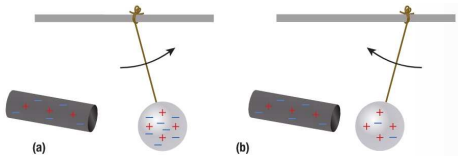
PRACTICE

3. Explain why this statement is false: "A neutral object contains no charge."

   a neutral object contains charges – the positive and negative charges just happen to be the same

Law of Electric Charges

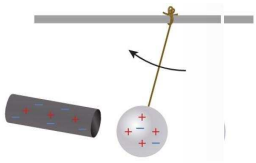
*Scientists studying the interaction of objects have observed that a charged object exerts an **electric force**, which can be either (a) a repulsive force (pushing apart) or (b) an attractive force (pulling together). This can be summarized in the **Law of Electric Charges**.*



Law of Electric Charges

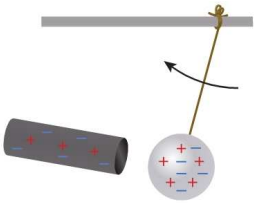
LAW OF ELECTRIC CHARGES

① objects with like charges repel each other
② objects with opposite charges attract each other
③ charged objects attract some neutral objects



Induced Charge Separation

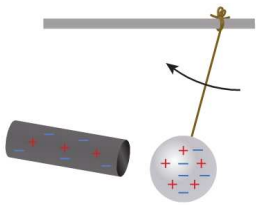
*Scientists studying the interaction of objects have also observed that a charged object will attract some neutral objects. Why? When a charged object is brought near a neutral object, it causes (induces) the electrons to shift in position – called an **induced charge separation**. The movement of electrons occurs according to the Law of Electric Charges.*



Induced Charge Separation

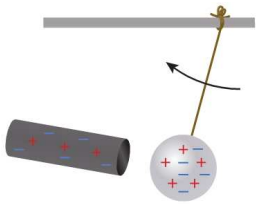
NOTE!

While the electrons can easily shift position the protons cannot. This is because the protons (and neutrons), which are located in the nucleus, are fixed in place in a solid and are unable to move.



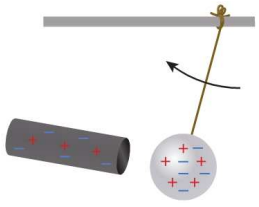
Induced Charge Separation

If the charged object is positively charged, it will induce electrons in the neutral object to move toward it. If the charged object is negatively charged (diagram below), it will induce electrons in the neutral object to move away from it.



Induced Charge Separation

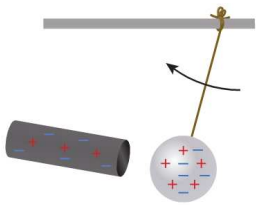
After the electrons shift position the side of the neutral object closest to the charged object will be oppositely charged. As a result, the neutral object is attracted to the charged object.



Induced Charge Separation

NOTE!

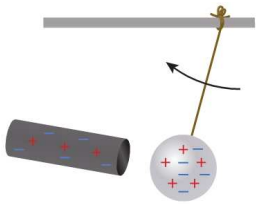
Although there is a shift in the positions of the electrons in the neutral object, it is still neutral – it did not gain or lose electrons. And once the charged object is moved away from the neutral object, the electrons return to their original positions.



Induced Charge Separation

INDUCED CHARGE SEPARATION (TEMPORARY)

- occurs when a charged object is brought near a neutral object
- electrons in neutral object shift position while protons stay fixed in place (object still neutral)
- near side becomes oppositely charged and attraction occurs



Induced Charge Separation

PRACTICE

4. Draw a diagram showing the induced charged separation that occurs in a neutral pith ball when:
   (a) a positively charged object is brought near it.
   (b) a negatively charged object is brought near it.

✔ Check Your Learning

1. The following observations are made of three objects A, B, and C. A is repelled by a positively charged object. A attracts B but repels C. The force between C and B is attraction. What are the possible charges on each object?

A +
B – or N
C +

✔ Check Your Learning

2. The following observations are made of four objects A, B, C, and D. A attracts both B and D but is repelled by a negatively charged object. The force between C and D is repulsion. What are the possible charges on each object?

A –
B + or N
C +
D + ~~or N~~

✔ Check Your Learning

TEXTBOOK
P.403 Q.1,3

WIKI (PHYSICS)
✎.... 1DPHYS - WS1 (Electrical Nature of Matter)