Atomic Structure: Movement of Charge

# **Purpose**: To make a simple model of the atom, showing transfer of charge during an electrostatic reaction.

**Discussion**: We will assume that the atom is made up of electrons, protons and neutrons. For this exercise we will only consider the protons and electrons and how they interact during electrostatic (and chemical) reactions. Through investigations we believe that no electrons are created or destroyed, but are simply transferred from one material to another. This is called the Principle of Conservation of Charge *(that is, if one material gains electrons, some other material must have lost the same number of electrons*).

**Materials**: 8 ½” x 12” colored paper Marking Pen Small Yellow Post It Notes

**Procedures**:

1. Fold the sheet of 8.5 x 11” paper in half. At the bottom, label one side “Material A” and the other side “Material B” (see diagram below).
2. Draw 10 small rectangles as shown below (used to represent protons). Use a marking pen to write “+1” on each of the rectangles. Draw 6 rectangles to Material A and 4 rectangles on Material B as shown.

+1

+1

+1

+1

+1

+1

+1

+1

+1

+1

Material A

Material B

a. Why are the “protons” labeled “+1”?

b. Why are the protons in a more or less “permanent” position (*do not move*)?

1. Obtain ten (10) yellow Post It Notes (*or cut out 10 small pieces of paper*) to represent electrons. On one side of each token, write “-1.” The electrons only have a small amount of “stick ‘em” on them, not the entire opposite side. Place one electron on each of the ten protons in Materials A and B.
2. Why are the “electrons” labeled “-1”?
3. Why are the “electrons” NOT glued down as the protons?
4. What is the NET charge on Material A and on Material B? (*Net charge is the remaining charge after all the +1 charges and –1 charges have been combined*.)
5. One way of moving electrons from one material to another is by FRICTION (rubbing materials together). Pretend that Material A and Material B are rubbed together and one electron moves from Material A to Material B (see diagram below).

X

X

X

X

X

X

X

X

**+1**

X

-1

Material B

Material A

1. What is the NET charge on Material A and on Material B?
2. Move the extra “-1” from Material B back to Material A.

## Conclusions and Questions

1. Assume you begin with a “neutral” material, how many electrons must be added to give Material B a “net” charge of –3?
2. Again, assume you begin with a “neutral” material, how can you give Material A a “net” charge of +4?
3. Which part of an atom is moved to produce a negatively charged material?
4. What part of an atom is moved to produce a positively charged material?
5. If material A gains electrons to acquire a “net” negative charge, what must be true concerning material B?
6. What is the Principle of Conservation of Charge? How does it apply to this lab?

Answer Key

2a. Why are the “protons” labeled “+1”?

 **Protons possess a positive charge**

2b. Why are the protons in a more or less “permanent” position (*do not move*)?

 **Nuclear binding energy holds the protons together … protons are all positively charged so they should repel strongly. Therefore, NBE is extremely large (nuclear reactions).**

3a. Why are the “electrons” labeled “-1”?

 **Electrons possess a negative charge**

3b. Why are the “electrons” NOT “permanent” as the protons?

 **Electrons are the subatomic particle that are transferred in chemical reactions.**

3c. What is the NET charge on Material A and on Material B?

 **Material A has +6 (protons) and –6 (electrons) … net charge of 0**

 **Material B has +4 (protons) and –4 (electrons) … net charge of 0**

4a. What is the NET charge on Material A and on Material B when one e- is transferred?

 **Material A has +6 (protons) and –5 (electrons) … net charge of +1**

 **Material B has +4 (protons) and –5 (electrons) … net charge of -1**

+1

-1

+1

-1

+1

-1

+1

-1

+1

-1

+1

-1

+1

-1

+1

-1

+1

-1

+1

**-1**

1 e-

Material B

Material A

## Conclusions and Questions

1. Assume you begin with a “neutral” material, how many electrons must be transferred to give Material B a “net” charge of –3? What is the charge on Material A now?

 **3 electrons are transferred from Material A to Material B**

 **Material A has +6 (protons) and –3 (electrons) … net charge of +3**

 **Material B has +4 (protons) and –7 (electrons) … net charge of -3**

+1

-1

+1

-1

+1

-1

+1

-1

3 e-

+1

-1

+1

-1

+1

+1

-1

**-1**

**-1**

+1

+1

**-1**

Material A

Material B

2. Again, assume you begin with a “neutral” material, how can you give Material A a “net” charge of +4? What is the charge on Material B now?

 **4 electrons are transferred from Material A to Material B**

 **Material A has +6 (protons) and -2 (electrons) … net charge of +4**

 **Material B has +4 (protons) and –8 (electrons) … net charge of -4**

+1

+1

-1

+1

-1

+1

-1

+1

-1

4 e-

+1

-1

+1

-1

+1

+1

-1

**-1**

**-1**

+1

+1

**-1**

**-1**

Material A

Material B

3. Which part of an atom is moved to produce a negatively charged material?

##### Electrons are gained by a material to create a negatively charged material

4. What part of an atom is moved to produce a positively charged material?

##### Electrons are lost by a material to leave a positively charged material

5. If material A gains electrons to acquire a “net” negative charge, what must be true concerning material B in terms of electrons and charge?

##### It is assumed that we are only dealing with Material A and B. If so, then, Material B must lose the electrons that Material A gained. Therefore, material B will take on a positive charge.

6. What is the Principle of Conservation of Charge? How does it apply to this lab

**The Principle of Conservation of Charge shows that no charges are lost or gained overall, but only transferred *(that is, if one material gains electrons, some other material must have lost the same number of electrons) In this lab, whenever material A lost an electron, it was gained by material B and vice versa.***