***EXERCISES:***

3. You rip a piece of paper into several pieces.
   a) What is CONSERVED with respect to the paper?
   b) What is NOT CONSERVED with respect to the paper?
   c) One piece of paper is taken away. What is now conserved and what isn't?
4. Which conservation laws are being broken in the following situations? (Note that conservation laws may not necessarily be broken in every case.)
   a) $Fe + S \longrightarrow CuS$
   b) 7.0 g of nitrogen gas are reacted with 8.0 g of oxygen gas to make 16.0 g of nitrogen monoxide.
   c) $Fe^{3+} + S^{2-} \longrightarrow FeS$
   d) $2\,Ag^{+} + SO_4^{2-} \longrightarrow Ag_2SO_4$
   e) $3\,Cr + O_2 \longrightarrow Cr_2O_3$
   f) At STP, 71.0 g of chlorine gas and 64.0 g of oxygen gas produce 135 g of chlorine dioxide gas.
5. Which of the following are conserved in a chemical reaction?
   (a) phase (b) numbers of atoms (c) volume (d) moles of molecules
6. Show that each of the following reactions obey the laws of conservation of atoms and of mass.
   (a) $CH_4 + 2\,O_2 \longrightarrow CO_2 + 2\,H_2O$ (b) $NaOH + HCl \longrightarrow NaCl + H_2O$

## VI.3. BALANCING CHEMICAL REACTION EQUATIONS

If a chemical equation is **BALANCED**, then **mass, atoms,** and **electrical charge** are **CONSERVED. In Chemistry 11, the act of balancing an equation will be confined to making sure that ATOMS ARE CONSERVED; that is, having the same number of each type of atom on each side of the equation.**

The following example shows the essential ideas behind the balancing process.

***EXAMPLE:*** **Balance the equation** $\_\_\,H_2S + \_\_\,PbCl_2 \longrightarrow \_\_\,PbS + \_\_\,HCl$.

Start with an atom which is involved in only **one species on each side of the equation** and assign coefficients which balance (give equal numbers of) the atom. In this equation, Pb, S, Cl and H occur only once on each side of the equation. Arbitrarily, start the balancing with ONE Pb.

$$\_\_\,H_2S + \mathbf{1}\,\mathbf{Pb}Cl_2 \longrightarrow \mathbf{1}\,\mathbf{Pb}S + \_\_\,HCl$$

This FIRST placement of coefficients is THE ONLY TIME you should have to write in TWO coefficients in order to balance an atom. From this point on, you should only need to place a single coefficient in the equation in order to balance another atom.

(We say that the Pb's have now been "balanced" because the same, definite number of atoms ("1") exists on both sides of the equation as a result of the coefficients used.)

The balanced atoms are part of molecules which involve other atoms. Select **ONE** of the "other atoms" which now occurs **ONCE MORE** in the equation without a coefficient in front of it. (S and Cl are atoms in molecules containing Pb.) For example, the "1" in front of PbS not only defines the number of Pb's but also the number of S atoms: 1 S is on the right so 1 S must be selected on the left. Add a single coefficient in front of the other molecule containing S.

$$\mathbf{1}\,H_2\mathbf{S} + 1\,PbCl_2 \longrightarrow \mathbf{1}\,Pb\mathbf{S} + \_\_\,HCl$$

Continue this "find an atom which occurs once without a coefficient in front of it and balance it" procedure. Arbitrarily, balance H by placing a coefficent in front of HCl.