Part A: Introduction to Chemical Reactions

1) The *chemical reaction* and the *written description* below show two different ways of describing the same process:

Chemical Reaction: $NaCN(s) + HCl(aq) \rightarrow NaCl(aq) + HCN(g)$

Written Description: **"**Solid sodium cyanide reacts with an aqueous solution of hydrochloric acid to produce an aqueous solution of sodium chloride and bubbles of hydrogen cyanide gas."

a) Complete the following table by comparing the *chemical reaction* and the *written description* from above:

Symbol	What It Represents
NaCN	
(s)	
+	
HCl	
(aq)	
$\rightarrow$	
NaCl	
(aq)	
+	
HCN	
(g)	

b) Draw a circle around each *reactant* and a box around each *product* in the table above.

c) What is the difference between NaCl(l) and NaCl(aq)? As part of your answer, explain how each could be made starting with NaCl(s).

2) You may have learned as a child that vinegar and baking soda react to form a gas that can be used to fill a balloon or launch a small toy boat or rocket. The chemical reaction for the underlying process is shown below. Translate the chemical reaction into a written description using question 1 above as a model.

$$HC_2H_3O_2(aq) + NaHCO_3(s) \rightarrow H_2O(l) + NaC_2H_3O_2(aq) + CO_2(g)$$

Part B: Balancing Chemical Reactions

3) Balancing chemical reactions requires practice, and sometimes trial and error. Begin by balancing elements that only occur in one place on each side of the equation. Typically, this means leaving oxygen and/or hydrogen to balance last. The following questions will give you some practice.

a) _____ $C_4H_{10}(g)$ + _____ $O_2(g) \rightarrow$ _____ $CO_2(g)$ + _____ $H_2O(g)$

b) _____ $Ba(OH)_2(aq)$ + _____ $Na_3PO_4(aq) \rightarrow$ _____ $NaOH(aq)$ + _____ $Ba_3(PO_4)_2(s)$

c) _____ $Cl_2(g)$ + _____ $C_2H_6(g) \rightarrow$ _____ $C_2HCl_5(g)$ + _____ $HCl(g)$

d) _____ $Ag_2S(s)$ + _____ $H_2O(l) \rightarrow$ _____ $Ag(s)$ + _____ $H_2S(g)$ + _____ $O_2(g)$

e) _____ $Al(s)$ + _____ $HCl(aq) \rightarrow$ _____ $AlCl_3(aq)$ + _____ $H_2(g)$

f) _____ $NH_3(g)$ + _____ $O_2(g) \rightarrow$ _____ $NO(g)$ + _____ $H_2O(g)$

g) _____ $NH_4NO_3(s) \rightarrow$ _____ $N_2(g)$ + _____ $O_2(g)$ + _____ $H_2O(l)$

h) _____ $KClO_3(s)$ + _____ $C_{12}H_{22}O_{11}(s) \rightarrow$ _____ $KCl(aq)$ + _____ $CO_2(g)$ + _____ $H_2O(l)$

Part C: Translating and Balancing Chemical Reactions

For the remaining problems, begin by translating the written description into a chemical formula. Finish by balancing the chemical formula. [Hint: remember that certain elements are diatomic. For example, "hydrogen gas" would be translated as "$H_2(g)$." Most other pure elements are simply written as a single atom. For example, "solid copper" would translate as "Cu(s)."]

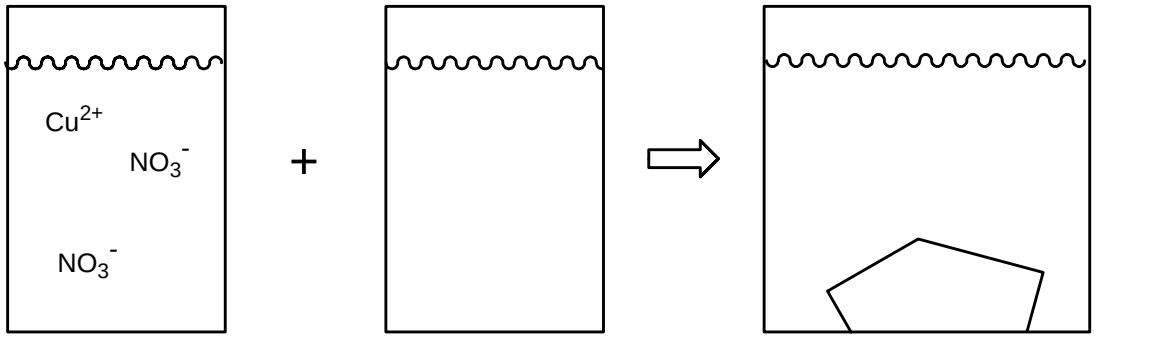
4) Solid iron(IV) sulfide reacts with gaseous oxygen to produce solid iron(III) oxide and gaseous sulfur dioxide. Write the balanced chemical reaction for this process.

5) Write the balanced chemical reaction that occurs in a car battery where solid metallic lead and solid lead(IV) oxide react with aqueous sulfuric acid to produce solid lead(II) sulfate and liquid water.

6) In our bodies, carbohydrates and other sugars can be broken down or converted to glucose ($C_6H_{12}O_6$) and used as fuel. Write the balanced chemical reaction for the combustion of glucose.

7) When an aqueous solution of copper(II) nitrate is mixed with aqueous sodium carbonate, the result is the formation of solid copper(II) carbonate and aqueous sodium nitrate.
   a) Write the balanced chemical reaction for the written description above.

   b) Assuming that all of the aqueous ionic compounds in question 9a exist broken up into their ions in water, fill in the boxes below with drawings that indicate what is present in each of the corresponding beakers. The first beaker has been drawn for you. Note that the ions have their correct charges and are drawn in the correct ratio indicated by their formulas. For clarity, water molecules have not been shown but are indicated by the squiggle line.



copper(II) nitrate sodium carbonate copper(II) carbonate and sodium nitrate

   c) Based on the balanced reaction and the drawing, what would you expect to actually be able to see if you carried out the above reaction?