Chem 130
Exp. 3: Periodic Trends

Part I. Reactions of Halogens with Halide Ions

We are going to examine reactions between *halogens* (diatomic *elements* from group VIIA: F_2, Cl_2, Br_2, and I_2) and *halide ions* (the *anions* of the halogens: F^-, Cl^-, Br^- and I^-.) The halogens will be available in aqueous solutions of the halogens. The halide ions will be available in aqueous solutions of an appropriate ionic compound, such as NaCl, KI and KBr. Halide ions are present in the aqueous solutions of the compounds because most ionic compounds dissociate into separate, mobile ions when dissolved in water. For example, when NaCl (table salt) dissolves in water, it separates into $Na^+(aq)$ and Cl^-(aq) ions.

Halogens can react by taking an electron from a given halide ion (which returns to its neutral state by giving up its extra electron.) For example, suppose we mix the hypothetical halogen X_2 with an aqueous solution of the ionic compound MY—a solution containing $M^+(aq)$ and $Y^-(aq)$.We can express this as:

$$X_2(aq) + M^+(aq) + Y^-(aq) \longrightarrow ???$$

Any reaction that will occur in this experiment will be between the halogen and the halide. The metal cation (M^+) is referred to as a *spectator ion* because it is not involved in the reaction. We will leave all spectator ions out of our equations so that we can focus only on the reacting species (the halogen and halide ion.) A reaction written in this manner is called a **net ionic equation**:

$$X_2(aq) + Y^-(aq) \longrightarrow ???$$

We must then ask if halogen X_2 is strong enough to take electrons away from halide Y^- to form new products. If this reaction does occur then the atoms of the halogen, X_2, would take on negative charges and become $2X^-$. **Note that the halide ions are not diatomic; only neutral halogens are diatomic.** The halide, Y^-, would lose its negative charge to become neutral; two neutral halogen atoms would then pair up to form the diatomic elemental halogen, Y_2. The balanced net ionic reaction for this process can be represented by:

$$X_2(aq) + 2Y^-(aq) \longrightarrow 2X^-(aq) + Y_2(aq)$$

If halogen X_2 is not strong enough to take electrons away from halide Y^-, then reaction does not occur:

$$X_2(aq) + 2Y^-(aq) \longrightarrow \text{No Rxn}$$

To determine if a reaction has occurred, we need some evidence of a change. The change we will be looking for in this experiment is color change. To know that a change has occurred, it will be necessary to first know the color of each of the solutions we will use—the color of the aqueous halogens and the aqueous halide ions. For example, in the previous hypothetical reaction, suppose that $X_2(aq)$ were red, $Y^-(aq)$ were colorless, $X^-(aq)$ were colorless and $Y_2(aq)$ were green. If the reaction occurs, we would observe the color change from red to green. If the reaction does not occur we would observe the red solution become lighter red or pink due to dilution.

Part II. Properties of Group IA and IIA Metals

In Part II we will look at some simple physical and chemical properties of several metals in order to establish family similarities and general trends within the periodic table.

IMPORTANT SAFETY NOTICE: When handling the metals of sodium and potassium, use great caution because they may react **violently** if left too long in the air, or even more violently if exposed to water. Under no circumstance should these two metals come in contact with water until you are ready for them to do so. Make certain that the tongs that you handle then with are dry! All reactions should be run while you are **standing up**, with your face away from the reaction.

In this experiment you must know clearly the distinction between *physical properties* and *chemical properties*. *Physical properties* are those inherent characteristics that can be observed without changing the substances composition. Physical properties include color, hardness, density, melting point, boiling point, malleability, ductility etc. *Chemical properties* are those characteristics associated with a substance when it is undergoing a composition change such as flammability, solubility, or reactivity.

In some of the reactions in this experiment, the solution formed may be *acidic* (contain H_3O^+(*aq*)) or *basic* (contain OH^-(aq)); it will be necessary to test the solution to determine if it acidic or basic. This test will be done with *litmus paper*—a porous paper which is impregnated with a compound which changes color when in the presence of an acid or a base. Litmus paper will be red (or pink) in acid, and blue in base.

If blue litmus paper stays blue in a solution and red litmus paper turns blue in that solution, that solution is *basic*; it contains OH^-(aq). If blue litmus paper turns red (pink) in a solution and red litmus paper stays red in that solution, that solution is *acidic*; it contains H_3O^+(*aq*). If both papers stay their original color, then the solution is *neutral*; it contains an insignificant amount of OH^-(*aq*) and H_3O^+(*aq*).

Date: _______________ CHEM 130 NAME: ______________________

Exp. 3: Periodic Trends Prelab

1. In a few complete sentences, describe two important differences between a halogen and a halide:

2. Write the *net ionic equation* for reaction of aqueous Cl_2 with aqueous KI (assume the reaction occurs):

3. Which of the following observations are examples of physical properties and which are chemical properties?

   a) A sample of a metal has a lustrous silver color.

   b) A sample of liquid has a pungent odor.

   c) When exposed to flame, a sample burns.

   d) When immersed in water, a sample reacts vigorously and disappears.

4. List at least two safety considerations when working with sodium and potassium: