Diffusion

Introduction:

For chemical reactions to occur, materials must be allowed to come into contact. For example, even though vinegar and baking soda can react vigorously, if I place a bottle of vinegar next to a box of baking soda nothing will happen as long as the two remain separate. It is only when I physically mix baking soda with vinegar that reaction occurs.

The more efficiently materials mix together, the more rapidly they can react. The process by which material is moved from one place to another is called **mass transport**. You are probably most familiar with stirring, also known as **convection**, as a means of mass transport. Convective mass transport occurs due to the action of a force on a fluid, such as using a spoon to stir sugar into your coffee. Convection ovens work by circulating hot air (a fluid) through the oven to speed baking.

Diffusion is another mode of mass transport. Diffusion results from the movement of material from an area of high concentration to an area of lower concentration without agitation. If you add a drop of food coloring to a glass of water without stirring, you will first see that the food coloring is concentrated as a dark region where the drop entered the water. Over time, the food coloring will diffuse through the water, eventually making a uniform color throughout. There are several factors that influence the effectiveness of diffusion, you will explore these in this experiment.

Equipment and Supplies:

- KI crystals
- $Pb(NO_3)_2$ crystals
- 6 *M* HCl
- 6 *M* NH_3
- spatula for each bottle
- Petri dish with lid (also used as the plastic reaction surface)
- distilled water

Experimental Procedure:

A. Diffusion in a water drop

1. Place 1 crystal of KI and ~6 crystals of $Pb(NO_3)_2$ on a plastic surface. (To avoid contamination, wipe your metal spatula with a paper towel after using it to transfer each chemical.) Record any evidence of a reaction when they are placed together.
2. Add 1 drop of distilled water and stir. Again record your observations.
3. Write the molecular equations for the reaction that you observe. (Assume that the reactants are in solution before a reaction occurs.)
4. Since you probably concluded that the reaction occurred faster in aqueous solution, let's investigate further. Make a pool of water about 1.5 cm in diameter on the plastic; since the plastic is hydrophobic the water forms a nice pool.
5. Place 1 crystal of KI near the pool, but *not* in it. Place a few crystals of $Pb(NO_3)_2$ near the opposite side of the pool.
6. Timing and the order in which you dissolve the crystals is important, so record exactly what you do. Push the $Pb(NO_3)_2$ crystals into the edge of the pool, wait 5 seconds, and then push the KI crystals into the opposite edge of the pool. Record your observations.

7. Repeat steps 4-6 with different times and/or a different order for dissolving the crystals. You must perform at least 2 additional experiments. Which experiment was most visually exciting? Why?

B. Diffusion in air

1. Obtain a clean, dry Petri dish. Remove the lid and place 1 drop of 6 *M* HCl on the inside of the lid.
2. Place 1 drop of 6 *M* NH_3 on the inside of the bottom of the dish.
3. Gently turn the lid over without disturbing the HCl drop. (If you have trouble, your HCl drop may be too large.)
4. Put the lid on the dish and record your observations.
5. Repeat steps 1-4 with perhaps multiple drops on top and bottom, or perhaps just insure that the HCl and NH_3 drops are over top of one another.
6. Write the molecular equation for the reaction that you observe.