Laboratory Experiment #10 SINC 0500-01
Chemical Reactions and The Atomic Theory

Name: ___________________

Partner: ____________________

Part I - Atomic Theory - Electron Clouds and areas of Probability

Purpose

In this activity, we will attempt to concretize the ideas of quantum mechanics, orbitals, and probability models.

Background

We have seen that Bohr was oh-so-close to explaining the true nature of the electron. However, Bohr's theories were too simplistic for multi-electron systems. It was evident that a new type of thinking would be needed to describe the what's and where's of the electron. Luckily, some pretty famous scientists (including one named Einstein) were already on the task. Quantum Mechanics basically threw out Newtonian physics and applied completely different rules to describe things. The important thing to remember is that quantum describes things that are really small and really fast.

Materials

40 ml of white beans
Funnel
Target

Procedure

1. Position the target so that the funnel is directly over the center of the target.
2. Separate the beans into equal volumes in the two beakers.
3. Have one member of the group place a finger over the end of the funnel and then add 20 ml of the beans into the funnel.
4. Release the beans so that they fall onto the target.
5. Use the rules below to count how many beans are in each area of the target.
6. After completing the counting, repeat steps 1-5 with all 40 ml of beans.
7. Record all data on the data table.
8. When done, place all of the beans in a beaker and return them to the front lab bench.

<u>Rules for counting:</u>

- If a bean is completely within an area, it belongs to that area.
- If the bean is on a line, it belongs to the area that the greater portion of its volume occupies.
- If the bean is on a line, and seems to be equally in two areas, it belongs to the area nearest the center.
- Any part of a bean counts as a bean.

Data Table:

Run 1			Run 2		
Area #	# of peas	% of total	Area #	# of peas	% of total
1			1		
2			2		
3			3		
4			4		
5			5		
6			6		
Total		100%	Total		100%

Part II

Purpose

In this experiment, you will perform chemical reactions, and observe the changes that take place during them.

Background

Chemical reactions are all around us. Combustion reactions help release energy to heat our homes and move our vehicles. Oxidation-reduction reactions keep the batteries in our cell phones and laptops functioning. Acid-base reactions take place when cleaning your oven or removing a clog from a drain. Reactions involve **reactants**, the starting materials that will be used up, and **products**, the substances formed during the process.

Understanding and identifying what takes place when two substances interact with one another is a vital aspect of chemistry. Chemists are able to identify unknown substances by observing how they react with a known substance. For example, we can bubble an unknown gas through a solution of limewater ($Ca(OH)_2$, a base, dissolved in water). If the limewater becomes cloudy, we can say that the gas is probably carbon dioxide (CO_2) based on our knowledge that the calcium ion (Ca^{2+}) forms an insoluble carbonate compound ($CaCO_3$); if the limewater does not become cloudy, we can't identify the gas without further tests, but we can say that the gas is not carbon dioxide. It is through testing and deductive reasoning that the chemist operates.

Evidence of a chemical reaction or change can often be observed when two different solutions are mixed together. Chemical reactions may often be detected visually by the following manifestations: the formation of a **precipitate** (insoluble, solid substance), **effervescence** (gas bubbles), **colour** changes, **texture** changes, or **energy** changes (system gains or loses heat). Sometimes a precipitate does not immediately settle out, thereby causing a "cloudiness" to appear in the solution. You can interpret "cloudiness" as the formation of a precipitate. Note that chemical reactions can occur even if there are no apparent visible changes; for the purpose of this lab, though, if you do not observe a change you can assume that no reaction took place.

In today's experiment, you will be mixing different solutions in various combinations and observing if a reaction takes place. You will record your observations, and in some cases, be asked to identify the products.

Safety

- Your goggles and lab coat must be worn at all times!
- Tie back long hair
- Do not wear shorts or open-toed shoes
- Even though small quantities of chemicals are being used, spills can occur. Wash the areas where spills occur with water and paper towels.
- When chemicals are spilled on the skin, wash with lots of water to dilute any chemical remaining.
- The solutions in **Part A** may be rinsed down the sink as they are ordinary household chemicals.
- The solutions used in **Parts B** are to be disposed of in the appropriate waste containers.
- Waste from **Part C** can go in the garbage
- Rinse out your test tubes and spot plates with plenty of water and scrubbing.
- Wash your hands before leaving the lab.

Materials

- goggles
- splint and lighter

- lab coat
- 4 test tubes
- test tube rack
- spot plate
- small plastic cup
- popsicle stick
- wash bottle
- chemicals provided in the lab

Procedure and Results

PART A: Acids and Bases [#1 – 6 should be completed in the lab]

Acids are substances that taste sour, corrode metals, and have a low pH. Bases are substances that taste bitter, feel slippery, are caustic (*i.e.* will burn your skin), and have a high pH. Acids and bases react with one another to neutralize each other; that is, they will produce neutral water as a product. Acids and bases can be found in common products you use throughout your household.

Red cabbages contain a chemical that reacts with both acids and bases. When this chemical is extracted, it can be used as an indicator for both acidic and basic (alkaline) solutions. Note its dark purple-red colour. When reacted with acids, it will turn bright pink or red; when reacted with bases, it will turn blue (for weak bases), green (for stronger bases), or yellow (for very strong bases).

1. Add a dropper full of cabbage juice to **four** different test tubes. Then add a dropper full of water to each.
2. To the **first** test tube, add one dropper full of Liquid Plumr; swirl.
3. To the **second** test tube, add one dropper full of lemon juice; swirl.
4. To the **third** test tube, add one dropper full of dishwashing liquid; swirl.
5. To the **fourth** test tube, add one dropper full of vinegar; swirl.
5. Record the colour and appearance of each solution below:

Test tube (cabbage juice with..)	Observations
1 - liquid plumber	
2 - lemon juice	

3 - dish washing liquid	
4 - vinegar	

6. In which test tube(s) do you think a reaction took place? What is your evidence for your conclusion?

7. Based on your answer to #6, which of the four substances are acidic? Basic?

Acidic:

Basic:

<u>PART B: Precipitation Reactions</u> [#1 – 7 should be completed in the lab]

When two chemical solutions react to form a solid, it is called a precipitation reaction. This is because the solid is called a precipitate; it does not dissolve in water, and thus we say it is insoluble. Such reactions are useful in the laboratory, because the solid product can easily be separated from the solution (by filtering it off, for example).

1. Refer to **Table 1** below to help you determine which chemicals should go into the depressions of the spot plate.
2. Carefully place **3 drops** of copper(II) sulfate, $CuSO_4$, in each of the **two** depressions in the **first column** (going down) of the spot plate.

3. Repeat this with **8 drops** of calcium chloride, $CaCl_2$, in the second column, and with **3 drops** of cobalt(II) chloride, $CoCl_2$, in the third column.
4. Record the initial appearance of:

   $CuSO_4$:

   $CaCl_2$:

   $CoCl_2$:

5. Carefully add **3 drops** of sodium hydroxide, NaOH, into each of the three depressions of the **first row** (going across) of the spot plate.
6. Repeat this with **8 drops** of sodium carbonate, Na_2CO_3, in the second row. Your spot plate layout should now correspond to Table 1.

7. Record all observations as descriptively as possible in Table 1 below, such as colour or texture changes. You may use a spatula to investigate the contents of each spot (use one KimWipe (**only**) to wipe the spatula, so as not to cross-contaminate the mixtures).

Table 1. Observations when mixing pairs of chemicals in a spot plate.

	$CuSO_4$	**$CaCl_2$**	**$CoCl_2$**
NaOH	1	2	3
Na_2CO_3	4	5	6

8. In which spots do you believe a precipitation reaction took place?

9. What are the environmental benefits of doing chemical reactions on a small-scale, using medicine droppers and spot plates, as opposed to on a large-scale (using large vessels and quantities of milliliters or litres)?

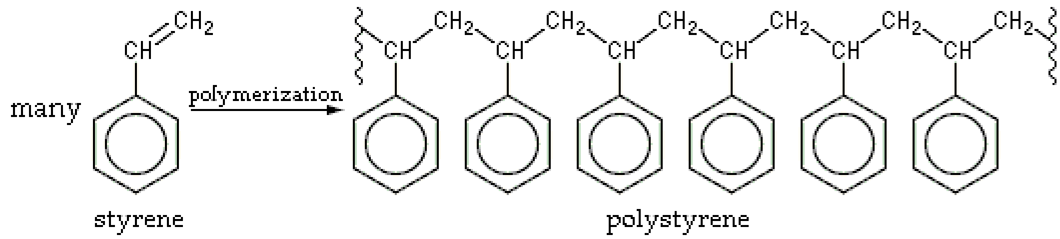
10. One of the products you made was calcium carbonate, $CaCO_3$. Use the internet to find out what this chemical is used for .

11. Another product formed was copper(II) carbonate, $CuCO_3$.
a) Use the internet to determine a common example of where this chemical is found outside, and state it below .

11. b) What colour is $CuCO_3$? Which numbered spot do you think it was formed in?

PART C: Polymers [#1 – 6 should be completed in the lab]

A polymer is a substance made of a chemical unit joined together repeatedly to form a long chain. Examples include rubber, DNA, plastics, and nylon. For example, polystyrene, also known as Styrofoam, consists of styrene units (C_8H_8) linked together to make chains of $(C_8H_8)_n$, where *n* represents a large number (see diagram below).



Polymers have widely varying properties, but in general, are quite durable and difficult to break down. You will create a polymer below.

1. Collect about one-third of a Dixie cup worth of the white glue solution. Record the appearance of this solution:

2. Record the appearance of the Borax solution (Borax is used as a cleaner or laundry booster) at the station:

3. Add one dropper-full of the Borax solution to the glue, and stir rapidly with a popsicle stick or straw. Record any changes:

4. Repeat step 3.

5. What evidence do you have that a chemical reaction took place?

6. You can take the product of your reaction out of the cup. Observe and note its appearance:

Cleanup [put a checkmark next to each point after it has been done]

____ Waste from **Part A** can go down the drain

____ Waste from **Part B** should be rinsed, with your wash bottle, into the waste beaker labelled **B.** It must NOT go down the drain

____ Waste from **Part C** may be discarded in the garbage

____ The spot plate should be rinsed under running water, then with your wash bottle

____ The test tubes should be washed with the test tube brush, then rinsed with your wash bottle, and put back upside-down on your test tube rack

____ Your lab bench should be wiped down with a wet paper towel

Questions

Answer the following questions in complete sentences.

1. In the first run of part I, which area did the most peas land in?

2. Did this change for the second run?

3. If you were to do part I again, only you had to predict where 90% of the peas would fall, what would your prediction be?

4. Does your 90% prediction mean that every pea will fall where you think?

5. Explain how your results in part 1 results mimic the orbitals described in the quantum mechanical model of
the atom.

7. Use the Internet to look up, very generally, what raw material is needed to make synthetic plastics. List it below.

Conclusion part II

List, generally, the different types of visual/tactile clues that were observed in this lab to indicate that a chemical reaction occurred (refer to introduction). Were there any possible indicators of a reaction that you did *not* observe today?