Chemical Reactions and Properties

1.0 Introduction

Matter is the stuff that makes up the material universe. We often say that matter has mass and occupies space. **Mass** is often connected with an object's inertia or tendency to stay at rest if already at rest or to continue moving if already moving. **Volume** (the property of occupying space) is not always a good estimate of the mass contained in an object, since some very dense stars are estimated to have such great amounts of compressed matter that a small spoonful would weigh millions of tons We define **density** as the ratio of mass over volume and use it to help quantify the amounts of matter contained in known volumes of substances.

A **pure substance** is a material with a fixed, definite composition throughout the sample. We often try to catalog the **physical and chemical properties** associated with various pure substances. Once known, these properties often help us predict the properties of mixtures or solutions formed from the pure substances. The physical properties are "sense" properties that can be detected by senses such as feel, smell, taste or characteristic physical behaviors such as boiling or melting points. The chemical properties of a substance are basically its reactivity with other substances or its tendency to decompose. Flammability or reactivity with water are examples of chemical properties.

We often subject samples of matter to conditions which change the samples. Some of the changes are **physical changes** which change matter's form or appearance but not its chemical composition. Grinding wheat into flour, boiling water or melting butter are examples of changes which are merely physical. Other changes subject the substance to changes in chemical composition and are called **chemical changes**. Baking bread, getting a suntan and reacting oxygen and hydrogen to form water are all chemical changes. Notice that chemical changes often include physical changes as part of the process. In fact, it is often the appearance of a physical change that informs us that a chemical change has occurred.

A solid which dissolves in a liquid is soluble in that liquid and can form a solution or homogenous mixture in that liquid. If the solid does not dissolve it is said to be insoluble. A true solution will be clear but it may or may not be colorless. If a solution changes to a milky or cloudy appearance, this is a sign that a **precipitate** is forming. Remember that clear and colorless do not mean the same thing even though we often confuse them in everyday speech. Sunglasses are very clear (for good eyesight) but are seldom colorless. The opposite of clear is cloudy.

When two solutions are mixed, there may be a chemical reaction between them. If there is, we will often see the physical changes associated with the reaction. The original reactants had one set of physical properties, but upon changing to a new chemical product, a new set of characteristic physical properties is produced. Three typical physical changes that indicate the likelihood of a chemical reaction are;

1) **Formation of a precipitate**. If the solution turns cloudy or if a larger amount of solid settles out of the solution, a precipitate (often abbreviated ppt.) has formed. A cloudy solution will often settle if left to stand and the solid precipitate can be filtered from the solution with filter paper if a separation of the components is necessary.

2) **Formation of a gas**. If enough gas is produced, gas bubbles escape from the solution and the solution effervesces. The process is called effervescence. If only a small amount of gas forms, we may be able to smell it (if it has a characteristic odor) as happens when eggs decompose.

3) **Change of color**. When a substance changes color, we are often seeing the formation of a new chemical with a new characteristic color. When iron rusts we see the red-orange rust color appear on the iron surface. We often use color change chemical reactions to detect the presence of substances in medical tests such as glucose or pregnancy tests.

Remember that it is possible to mix two solutions and get no chemical reaction between them.

2.0 Procedure

PART 1: DISSOLVING A SOLID

For each part of this experiment where you are testing solubility, use a small amount of solid or about 4 mm on the tip of a spatula and add about 2 mL of water. You can measure 2 mL using a graduated cylinder into a test tube and note what this volume actually "looks like". Then use your mental reference to estimate 2 mL of water in each part. You may have to stir with a stirring rod to get a soluble salt to dissolve (just as you must stir sugar in coffee or tea).

A) Place a very small (but easily visible) amount of **$Ca(NO_3)_2$, calcium nitrate**, in a small test tube and add approximately 2 mL of deionized water. *Stir* with a stirring rod. Does the solid dissolve?

B) Place another small amount of **Na_2CO_3, sodium carbonate**, in another clean test tube and again add and *stir* in about 2 mL of deionized water. Does this solid dissolve ?

C) Mix the contents of **tubes A) and B)** and record your observations. **Set this mixture tube aside for use in Part 2.**

D) Place a small amount of **$CaCO_3$, calcium carbonate**, in another clean test tube and again add 2 mL of deionized water. Does this solid dissolve after stirring? **Save this tube for Part 2**.

PART 2: MIXING HOUSEHOLD SOLUTIONS - CHEMICAL REACTIONS

Use small amounts of each solution as directed and look for evidence of a chemical reaction occurring. Each test tube you use should be clean but it can be wet from a rinse with deionized water. After you mix the chemicals record whether a chemical reaction occurs or not and the evidence you use to decide on your report sheet.

E) Place **10 drops of laundry starch solution** in a small, clean test tube and add **5 drops of iodine solution** to it. Mix and record your observations.

F) Place **10 drops of table salt solution, NaCl**, in another clean tube and add **5 drops of vinegar solution**. Mix and record your observations.

G) Place **10 drops of baking soda, $NaHCO_3$, solution** into a clean test tube and **slowly** add **5 drops of vinegar solution** to it. Mix and record your observations.

H) Place **10 drops of Epsom salts solution, $MgSO_4$**, in another clean tube and add **5 drops of drain opener solution, NaOH**. Mix and record your observations.

I) Take the **tube from H) with the result of the Epsom salts and drain cleaner mixture** and slowly add **vinegar solution dropwise** (up to 10 drops) to the tube. What do you observe? Is this possible evidence for a chemical reaction? How could you prove the observation is not simply due to adding extra water?

J) Take a small piece of a **"TUMS" antacid tablet** (quarter tablet or less - break a tablet apart and share with others in the class) and place in a test tube. Add **10 drops of vinegar** and record your observations.

K) Take the test tube you set aside from **Part 1C** (mixture of tubes 1A and 1B) and gently discard most of the liquid above the solid in the tube. Add **10 drops of vinegar** and record your observations. How does this reaction compare with part J) ? Repeat this procedure on the **tube you saved from Part 1 D**. Check a TUMS bottle to see what the active ingredient in TUMS antacid is. Yum – chalk (purified limestone).

Lab clean-up and Waste Disposal

- Dispose of all chemical wastes into the waste container provided for your lab.
- Rinse off all used test tubes in the sink and let them air dry in your drawers

Report Sheet

Name:_____

PART 1: DISSOLVING A SOLID

A. Calcium nitrate : Soluble ( ) or Insoluble ( )

B. Sodium carbonate : Soluble ( ) or Insoluble ( )

C. Mixture of tubes A & B

Immediate appearance :

Appearance 5-10 minutes later;

D. Calcium carbonate : Soluble ( ) or Insoluble ( )

Based on your observations in Steps A, B and D, suggest an Explanation for the result of mixing tubes A & B in Step C .

PART 2: MIXING HOUSEHOLD SOLUTIONS - CHEMICAL REACTIONS

Step	Solutions Combined	Reaction: Yes or No	Evidence
E	Starch & Iodine		
F	Sodium chloride & Vinegar		
G	Baking soda & Vinegar		
H	Epsom salt & Drain opener		
I	Tube H results & Vinegar		
J	Tums tablet & Vinegar		
K	Tubes C + D & Vinegar		

Questions

1) Classify each of the following as a physical or a chemical change;

a) Melting ice

b) Burning gasoline

c) Acquiring a suntan

d) Copper and sulfur forming copper sulfide

2) Identify three forms of evidence that a chemical reaction has occurred:

a)

b)

c)

3) For each of these evidences give an example chemical reaction (in words not equations). Use examples from your real world experience not from this lab.