The Magic of Matter!

Phases of Matter and Chemical Reactions

2/3/2012

Friday Funday Laboratory Notebook

Name:

Team:

Experiment #1: Silver Crystal Synthesis

Background: A chemical change occurs when compounds react to form new substances. In this experiment we will be investigating the reaction of silver nitrate ($AgNO_3$) and copper metal (Cu). In order to visualize the chemical changes taking place, chemical reactions are often written as equations with chemical formulas.

$$2\ Ag(NO_3) + Cu \rightarrow Cu(NO_3)_2 + 2\ Ag$$

This could also be written using the chemical names:

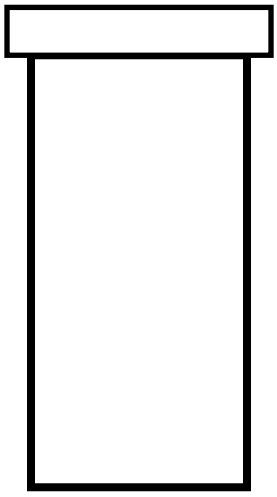
Silver nitrate + copper → copper nitrate + silver

What this tells us is that copper is changing form, going from the solid metal and entering the solution as copper nitrate. At the same time, silver nitrate from the solution is chemically changed and deposits on the surface of the copper metal. As time goes on, more and more silver forms on the copper, producing needle-like crystals!

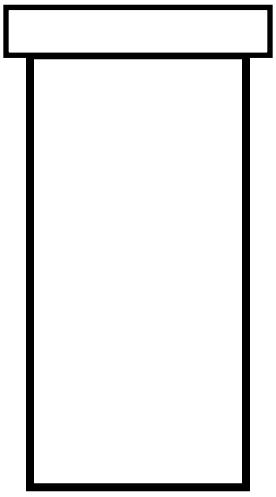
Procedure:

- Individually acquire a length of copper wire and a vial.
- With a marker, write you initials and team on the vial cap.
- Next, bend the end of the copper wire into your favorite shape. Make sure that it can still fit into the vial.
- Give your labeled vial with the wire to a graduate student to be filled with 0.1M silver nitrate. **SAFETY ALERT!** Silver nitrate is **toxic** and **corrosive**! Do not open the vial!
- Illustrate your initial observations below:
- After about 1 hour, we will look at the vial again. Record your observations:

Initial Observation:



After ~1 Hour:



Analysis: Is the silver undergoing a physical or chemical change?

Experiment #2: Sublimation of Carbon Dioxide ("Dry Ice")

Background: Most of the time we think of carbon dioxide (CO_2) as a gas, but if you cool it below -78.5C (-109.5F) it freezes into a solid. Unlike water, carbon dioxide does not melt (unless it is under high pressure) which is why it's called "dry ice." Instead of melting, CO_2 undergoes *sublimation* which means it turns directly from solid to gas.

In this experiment we will put solid CO_2 in a bottle, as it sublimes we will capture the gas inside a balloon and calculate the rate.

Procedure:

- Use the scoop and funnel to cover the bottom of your bottle with 1~2cm of dry ice.
- Stretch the balloon over the top of the bottle, record the time.
- Every 30 seconds measure the diameter of your balloon using a piece of string and laying it on the yard stick, record the time and the diameter.
- Plot your results putting time on the X-axis and diameter on the Y-axis.
- Repeat the experiment at different temperatures.

Data Table:

ice water						
hot water						
air						

Analysis:
At the end of the experiment what was the balloon filled with?

Why does the balloon expand?

Compare your 3 graphs. How does temperature affect the expansion rate? What about the graph helped you answer this question?

Experiment #3: Chemical Reaction of Acetic Acid and Sodium Bicarbonate

Background: Matter cannot be created or destroyed, but it can change forms. One way that matter can be transformed is through a chemical reaction. In a chemical reaction, the things you start with (called "reactants") come together and react to make new things (called "products"). Scientists write chemical reactions in formulas like the one below:

$$\underset{\text{Reactants}}{CH_3COOH\ (l) + NaHCO_3\ (s)} \longrightarrow \underset{\text{Products}}{CH_3COO^{-}\ ^{+}Na + CO_2\ (g) + H_2O\ (l)}$$

(l) = liquid

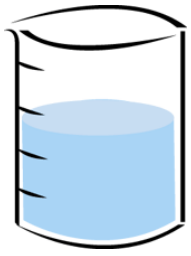
What do you think (s) and (g) stand for?

(s) = _____
(g) = _____

The amount of products you get out of reaction depends on the amount of reactants you put in. Since each atom has a different mass, scientists use the term "moles" when talking about amounts of atoms or molecules.

What is a mole?

1 mole = 6.022×10^{23} atoms (or molecules)



1 mole of water molecules
=18.02 g

1 mole of copper atoms
=63.57 g

1 mole of $NaHCO_3$
=83.98 g

In this experiment, you will be investigating the reaction of CH_3COOH (acetic acid, or "vinegar") and $NaHCO_3$ (sodium bicarbonate, or "baking soda") coming together and forming carbon dioxide gas and water.

Procedure:

- Get a soda bottle and a balloon. The soda bottle will have ~250 mL of an acetic acid solution in it.
- Record the mass of your balloon and bottle together on the balance. (Be sure to take turns using the balance!)
- Put the funnel into your balloon. Scoop some sodium bicarbonate into the balloon.
- Remeasure the total mass of your balloon and soda bottle.
- Carefully stretch your balloon over the lid of your soda bottle. (If you need to, get a graduate or high school student to help you!)
- Once secure, shake your balloon to empty the sodium bicarbonate into the bottle.
- Shake the bottle to get as much of the reactants to mix as you can.
- Once the reaction stops, leave your balloon on your bottle and measure the total mass.
- Measure the diameter of your balloon using a piece of string and a meter stick.

Mass of bottle and balloon filled with baking soda: _____

Mass of bottle and empty balloon: – _____

Mass of baking soda: = _____

Mass of bottle with inflated balloon: _____

Diameter of inflated balloon: _____

Analysis:

Plot your data on the group chart! Do you see any trends in the data?

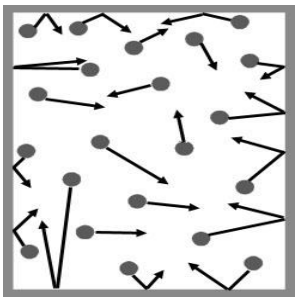
Why does the balloon inflate during the reaction?

During the reaction, bubbles are formed. What are the bubbles made of?

Compare the mass of bottle and balloon filled with baking soda to the mass of the bottle with the filled balloon. Did the total mass change during the reaction? Why or why not?

Experiment #4: Absolute Zero

Background: Absolute zero is the coldest temperature that can exist. It is impossible to cool something below absolute zero. All atomic motion stops at absolute zero. We may not be able to get something to absolute zero, but we can make measurements that will allow us to calculate what this temperature is.



The molecules of a gas trapped inside a container push outward (this is called pressure) on the container as they bounce around inside. At absolute zero, when all motion stops, the gas particles stop moving and stop pushing on the container, this is equal to zero pressure.

Safety: The dry ice and ethanol bath (-72C) and liquid nitrogen bath (-196C) are extremely cold and can cause frost bit and permanent tissue damage if contacted. Do not touch any of the cold temperature baths, carefully lower the monometer into the baths. Do not stick the thermometer in the dry ice and ethanol bath or the liquid nitrogen bath.

Procedure: Members of the group will each get to take measurements of one of the temperature baths.

- Place monometer in the warm water bath.
- Record the pressure on the monometer.
- Record the temperature of the bath.
- Repeat for the room temperature bath, the ice bath, the ethanol and dry ice bath and the liquid nitrogen bath.
- The thermometer will break in the dry ice and ethanol bath and the liquid nitrogen bath. You can record -72C for the dry ice and ethanol bath and -196C for the liquid nitrogen bath.

Data:

Measurement	Temperature in Celsius	Pressure in PSI
Warm Water		
Room Temperature		
Ice Water		
Dry Ice and Ethanol		
Liquid Nitrogen		

Value of Absolute Zero: _____°C

Experiment #5: Determination of Density

Background: Density is defined as the amount of mass per unit volume. The Greek letter "rho" (ρ) is often used as a symbol for density.

$$\rho = density = \frac{mass}{volume}$$

For example, lead is more dense than aluminum. This means if we had two equal sized blocks of lead and aluminum, the lead block would have greater mass. In addition to solids, we can also compare densities of liquids and gases. In this experiment, you will work with your team to calculate the density of water and vegetable oil.

Procedure:

- As a team, measure the mass of the empty volumetric flask and record the value in the data section below.
- Next, pipette 5mL of H_2O into the flask. Filling to the white line yields 5mL accurately.
- Re-weigh the flask and H_2O and record the value below.

Mass of Flask + H_2O: _____

Mass of Empty Flask :_____

(Mass of Flask + H_2O) – (Mass of Empty Flask) = Mass of H_2O:_____

Volume of H_2O :_____

Density of Water = (Mass of H_2O) / (Volume of H_2O) = _____

Density of Water:_____

- Repeat the above procedure for vegetable oil

Mass of Flask + Oil: _____

Mass of Empty Flask :_____

(Mass of Flask + Oil) – (Mass of Empty Flask) = Mass of Oil:_____

Volume of Oil :_____

Density of Oil = (Mass of Oil)/ (Volume of Oil): _____

Density of Oil:_____

Analysis: Compare the densities of water and oil with your teammates. If the two liquids were added to a vial, would they mix or separate? (Hint: think of salad dressing!) If they were to separate, which liquid would be on top? Work with your group to form a hypothesis!

Now test your hypothesis:

- Pipette approximately 2mL of oil into a vial.
- Then pipette about 2mL of water into the same vial

Which liquid is on top? Illustrate your observations below. Does what you observe match your team's hypothesis?