Lab: Solubility Curve of Magical Mystery Salt

Purpose: to identify an unknown salt by creating a solubility curve and comparing it to the solubility curves on Reference Table G.

Introduction:

Solutes are substances that are dissolved into a **solvent** to form a **solution**. Solvent molecules attach to and tear apart solute particles. The solute particles separate from each other and float throughout the solution. Once all of the solvent molecules are busy keeping solute particles apart, the solution will be **saturated**, and the solution will have reached its **solubility** point. Any more solute you add will simply fall to the bottom of the solution, as a precipitate.

Solubility is defined as the maximum quantity (grams) of solute than can be dissolved in a given amount of solvent (grams) at a given temperature. Different solutes dissolve to different degrees at different temperatures. For solid solutes, solubility in water solvent increases as the temperature increases. For gaseous solutes, the effect is opposite...the higher the temperature, the less gas solute can stay dissolved in water solvent.

The solubility of an ionic compound (salt), generally, increases as temperature increases. Based on this fact, the class will generate a solubility curve for a Magical Mystery Salt and use that curve to identify the salt.

How do we generate a solubility curve? First, measure out a mass of solute, then add it to a measured mass of water. You will be using 10.0 grams of water in this experiment. The salt doesn't dissolve entirely? No problem! Heat it up in a water bath. Eventually, the amount of precipitate will diminish until it's all gone! You then remove the test tube with your now unsaturated solution and let it cool. Once it cools past its solubility temperature, you will begin to see precipitate forming in the test tube. It will look like it's flurrying inside your test tube. Record the temperature that this happens! Heat it up again to dissolve the precipitate and then let it cool again to get a second temperature. Then you will average the two temperatures and report it to the class. Different groups in the class will be assigned different amounts of solute to use, but all groups will use 10.0 grams of distilled water as the solvent.

Once the solubility data for the class has been gathered, you will construct a graph based on the data on the front board. Compare your graph's shape and specific numbers with those on Reference Table G. The curve that matches yours the most is your salt!

Materials:

Balance	spoon	Bunsen burner	Test tube
Test tube holder	Test tube clamp	Test tube rack	Small beaker
400 mL beaker	Thermometer probe	Ring stand	Evaporating dish
Graduated cylinder	Wire gauze	Beaker tongs	goggles
Assigned mass of Mystery Salt		10.0 mL distilled H_2O	

Assigned # of Grams of Mystery Salt	

Procedure:

1.) Set up your equipment as shown on the diagram below.

2.) Fill the beaker half way with tap water. Set it on the ring stand and begin to heat it with the bunsen burner.

3.) Obtain a spoonful of the mystery salt and place it into the beaker.

4.) Weigh the evaporating dish and then set the balance ahead by the number of grams that you were assigned. Add mystery salt until the balance evens out.

5.) Place this salt into a DRY test tube.

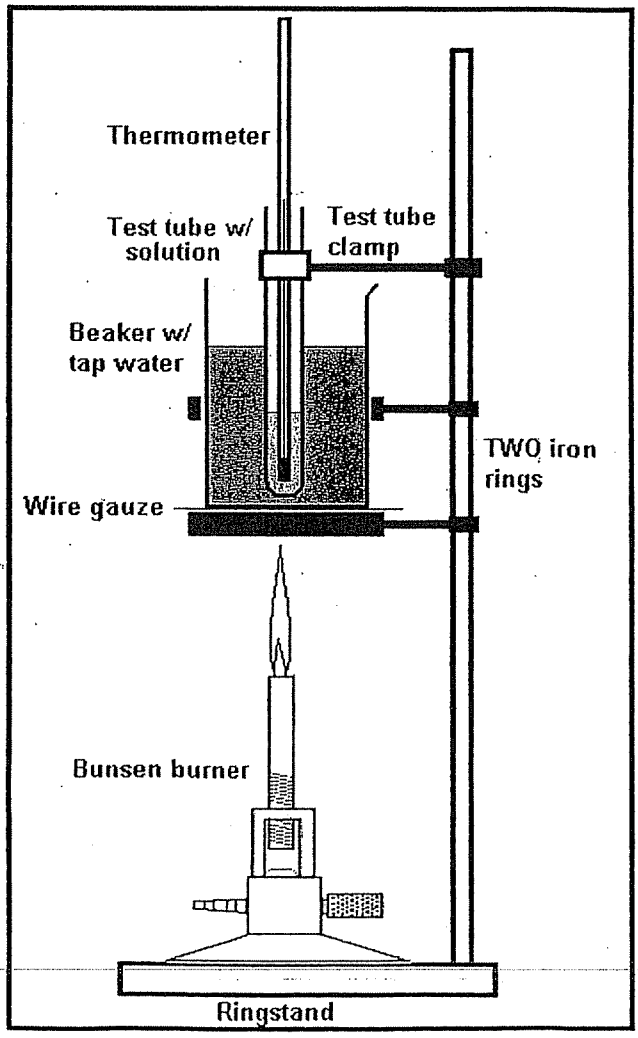
6.) Measure out 10.0 mL of distilled water using a graduated cylinder and adding it to the salt in the test tube. Remember, the density of water is 1.00 g/ml, so the volume in mL will be equal to the mass in grams. 10.0 mL will weigh 10.0 grams.

7.) Place a test tube holder at the top of the test tube and slide the test tube into the somewhat loose test tube clamp that is high up on the ring stand. Use the thermometer probe to stir the salt in the test tube, but do not poke! You might break a hole through the bottom of the test tube if you do. Just stir.

8.) The amount of undissolved salt will Steadily decrease until it's all gone. Once you can't see any undissolved salt (the solution is clear), remove the test tube from the hot water bath and let it cool.

see table for cooling instructions

9.) Turn off the bunsen burner.



Name:	Lab Period and Day:
Lab Partners:	Lab Teacher:
Date Due:	Class Teacher:

Solubility Curve of Magical Mystery Salt

This page will be turned in with your graph and completed questions on a separate sheet of paper stapled to the back.

Data:

Assigned grams of salt/10.0g of H_2O	Crystallization Temperature (°C) (x-axis on graph)	Grams of Salt / 100.0 grams of H_2O (y-axis on graph)
3.0 g		
4.0 g		
5.0 g		
6.0 g		
7.0 g		
8.0 g		

Analysis:

1) Calculate the quantity of mystery salt in 100. g of water for each quantity of the mystery salt used in the lab. Use a proportion. For example: (2.000 g / 10.0 g) = (x g / 100. g)

2) Graph the class data, placing the Temperature (starting at 0°C) on the X-axis and Solubility (starting at 0 g salt / 100 g H_2O) on the Y-Axis. Use all of the features that a good graph should have and connect the data points not with straight lines, but rather with a smooth curve.

3) Color your solubility curve, using one color to show the areas of the graph that represents a supersaturated solution and an unsaturated solution. Color lightly.

4) Create a key on the graph to indicate which color represents a supersaturated solution and which color represents an unsaturated solution.

5) Describe the relationship between the solubility of the mystery salt and the temperature based on your graph (complete sentences)

10.) Eventually the solution will cool enough that precipitate (solid) will start to form. Keep a close eye on the bottom of your test tube! (A strand of dust is not a precipitate) When you start to see what looks like flurries in your test tube, record the temperature. You now have a solution that is saturated

11.) Clean up by rinsing out all glassware, and bringing it back to where you obtained it from. Be sure that the bunsen burner is closed and the gas is turned off at your table.

12.) Gather the class data for the solubility data. Complete the lab graph and questions.

Given amount of salt	Cooling Method
3 g	Cool the bottom of the test tube by dipping it in an ice water bath. Cool for a few seconds while stirring with the thermometer, then check for the precipitate. As the temperature decreases, use the ice water less and less. Get a large beaker filled with ice and water!
4 g	
5 g	Cool the bottom of the test tube by running cold water from the tap over it. Cool for a few seconds while stirring with the thermometer, then check for the precipitate. As the temperature decreases, use the water less and less.
6 g	
7 g	Just let the solution air cool.
8 g	

Reference Table G gives solubility in grams of solute per 100 grams of water. You used 10.0 grams of water. Use a proportion to convert grams of solute per 10.0 grams of water to grams of solute per 100 grams of water.

Questions (Answer in complete sentences on another sheet of paper):

1) Based on your data, what is the identity of the magical mystery salt from reference table G?

2) Using your Solubility Curve for the mystery salt, classify the following solutions as **saturated, unsaturated or supersaturated.** Explain your answers.

a) 75 g of mystery salt / 100. g of H_2O at 40°C

b) 50 g of mystery salt / 100. g of H_2O at 50°C

3) Using **Reference Table G**:

a) How many grams of $NaNO_3$ will dissolve in 100.0 g of H_2O at 25°C?

b) How many grams of $NaNO_3$ will dissolve in 200.0 g of H_2O at 25°C?

4) Using **Reference Table G**:

a) How many grams of HCl will dissolve in 100.0 g of H_2O at 30°C?

b) How many grams of HCl will dissolve in 50.0 g of H_2O at 30°C?

5) Using **Reference Table G**:

a) Identify three compounds on this reference table, which become **more soluble** as the **temperature increases.**

b) In which phase of matter do these solutes exist?

6) Using **Reference Table G**:

a) Identify three compounds on this reference table, which become **less soluble** as the **temperature increases.**

b) In which phase of matter do these solutes exist?

7) Using **Reference Table G**:

a) A solution containing 50 grams of KNO_3 in 100 grams of water at 60°C is unsaturated. How many grams of KNO_3 can be added to make the solution saturated?

b) A solution containing 80 grams of KNO_3 in 100 grams of water at 30°C is supersaturated. How many grams of KNO_3 will precipitate out to make the solution saturated?

1) A dilute, aqueous potassium nitrate solution is *best* classified as a

A) heterogeneous mixture
B) homogeneous mixture
C) heterogeneous compound
D) homogeneous compound

2) A student prepares four aqueous solutions, each with a different solute. The mass of each dissolved solute is shown in the table below.

Mass of Dissolved Solute for Four Aqueous Solutions

Solution Number	Solute	Mass of Dissolved Solute (per 100. g of H_2O at 20.°C)
1	KI	120. g
2	$NaNO_3$	88 g
3	KCl	25 g
4	$KClO_3$	5 g

Which solution is saturated?

A) 1 B) 2 C) 3 D) 4

3) An unsaturated aqueous solution of NH_3 is at 90.DC in 100. grams of water. According to the *Solubility Curves* chemistry reference table, how many grams of NH_3 could this unsaturated solution contain?

A) 10. g B) 20. g C) 5 g D) 15 g

4) Which one of the following compounds is insoluble in water?

A) Na_2S B) $KClO_3$ C) $CaCrO_4$ D) $BaSO_4$

5) Which barium salt is insoluble in water?

A) $Ba(NO_3)_2$ B) $Ba(ClO_4)_2$ C) $BaCO_3$ D) $BaCl_2$

6) An aqueous solution has 0.0070 gram of oxygen dissolved in 1,000. grams of water. Calculate the dissolved oxygen concentration of this solution in parts per million. [*Your response must include both a correct numerical setup and the calculated result.*]