Name: _____Date: _____Class_____

1. Name three factors that influence the rate at which a solute dissolves in a solvent

2. Define the following words
   a. solubility.

   b. Saturated

   c. Unsaturated

   d. Miscible

   e. Immiscible

   f. supersaturated

The graph below (on the next page) is known as a solubility curve and can be used to determine if a particular solution is saturated at a given set of conditions and how much of the solute is dissolved under those conditions.

Whenever you are given a graph to analyze the first thing you should do is look at each axis to determine what information the graph is showing.

X- axis – _____

Y-axis – _____

Each line represents the maximum amount of solute that can be dissolved in 100 g of H_2O at a particular temperature.

Below the line → the solution is unsaturated

On or above the line → the solution is saturated

Above the line and all the solute is dissolved→ the solution is supersaturated **(it must say that the solute is completely dissolved)**

Changing the amount of water (solvent) → The graph represents grams of solute per 100 g of water, if you change the amount of water the amount of solute changes proportionally (200 g, double the amount of solute can dissolve)

Sample Questions:

1. How many grams of KCl can dissolve in 100 g of water at 30ºC?

To answer this, find where the curve of KCl crosses 30°C. I have marked this point A on the graph. You then read across and determine the grams of solute which is 37 g.

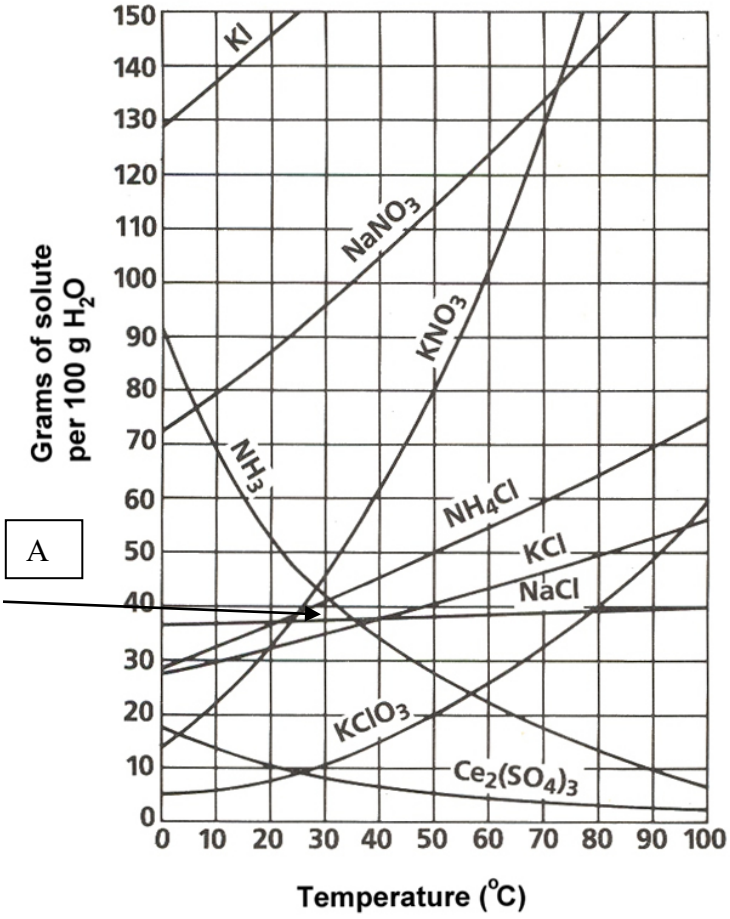
Solubility Curve Practice Problems Worksheet

For most substances, solubility increases as temperature increases. What are the exceptions on the graph below?_____

Part One: Reading Solubility Curves
Use the graph to answer the following questions. REMEMBER UNITS!

1. What mass of solute will dissolve in **100mL** of water at the following temperatures?
   a. KNO_3 at 70°C _____
   b. NaCl at 100°C _____
   c. NH_4Cl at 90°C _____
   d. Which of the **above** three substances is most soluble in water at 15°C. _____

2. What mass of solute will dissolve in **200 mL** of water at the following temperatures?
   a. KNO_3 at 70°C _____
   b. NaCl at 100°C _____
   c. NH_4Cl at 90°C _____



Part Two: Types of Solutions (saturated, unsaturated, supersaturated)

On a solubility curve, the lines indicate the concentration of a _____ **solution** - the maximum amount of solute that will dissolve at that specific temperature.

Values on the graph _____ (below, above, on) a curve represent **unsaturated solutions** - more solute could be dissolved at that temperature.

Use the solubility curve on the first page to label the following solutions as saturated or unsaturated. If unsaturated, write how much more solute can be dissolved in the solution.

Solution	Saturated or Unsaturated?	If unsaturated: How much more solute can dissolve in the solution?
a solution that contains 70g of $NaNO_3$ at 30°C (in 100 mL H_2O)		
a solution that contains 50g of NH_4Cl at 50°C (in 100 mL H_2O)		
a solution that contains 20g of $KClO_3$ at 50°C (in 100 mL H_2O)		
a solution that contains 70g of KI at 0°C (in 100 mL H_2O)		

Additional Practice:

1. a. At 90°C, you dissolved 10 g of KCl in 100. g of water. Is this solution saturated or unsaturated?

   b. How do you know?

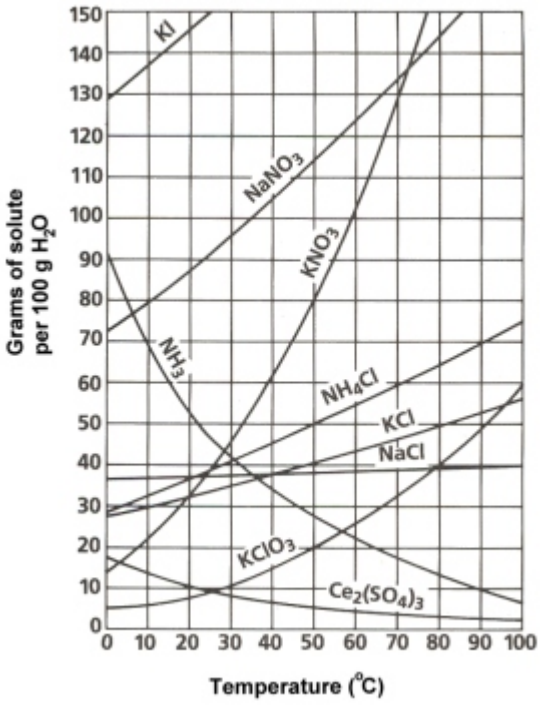
2. A mass of 100 g of $NaNO_3$ is dissolved in 100 g of water at 80ºC.

a) Is the solution saturated or unsaturated?

b) As the solution is cooled, at what temperature should solid first appear in the solution? Explain.

3. Use the graph to answer the following two questions:

Which compound is **most** soluble at 20 ºC? _____
Which is the **least** soluble at 40 ºC? _____
Which substance on the graph is **least** soluble at 10°C? _____



4. A mass of 80 g of KNO_3 is dissolved in 100 g of water at 50 ºC. The solution is heated to 70ºC. How many more grams of potassium nitrate must be added to make the solution saturated? Explain your reasoning.

Answers

1 Solubility Curves

There are charts and tables available that we can use to get an idea of how soluble a certain solute is in a certain solvent. We will take a look at two of them in these next two sections.

Solubility curves, like the one shown here, tell us what mass of solute will dissolve in 100g (or 100mL; **see note**) of water over a range of temperatures.

You'll want to have a copy of this figure handy - click on the graph to get a larger version, then print out the graph (or click for a **pdf version**).

You'll notice that for most substances, solubility increases as temperature increases. As discussed earlier **(Section 1.3)**, in solutions involving liquids and solids typically more solute can be dissolved at higher temperatures. Can you find any exceptions on the chart?

Here's an example of reading the chart. Find the curve for $KClO_3$.

At 30°C approximately 10g of $KClO_3$ will dissolve in 100g of water. If the temperature is increased to 80°C, approximately 40g of the substance will dissolve in 100g (or 100mL) of water.

Here are some for you to try.

What mass of solute will dissolve in 100mL of water at the following temperatures. Also determine which of the three substances is most soluble in water at 15°C.

1. KNO_3at 70°C
2. NaCl at 100°C
3. NH_4Cl at 90°C

Solution:

		Solubility
1.	KNO_3at 70°C	140g / 100mL
2.	NaCl at 100°C	40g / 100mL
3.	NH_4Cl at 90°C	72g / 100mL
4.	NaCl is the most soluble at 15°C	

On a solubility curve, the lines indicate the concentration of a **saturated solution** - the maximum amount of solute that will dissolve at that specific temperature. The molar concentration of the substance can be calculated, as shown by this example:

Determine the molarity of a saturated NaCl solution at 25°C.

Solution

We can see from the curve that about 38 g of NaCl dissolves in 100mL at 25°C. Molarity, M, has the units $mol \cdot L^{-1}$, so we want to convert $38g \cdot 100mL^{-1}$ to $mol \cdot L^{-1}$. We will use unit analysis to do this. First, however, let's convert mL to L:

$$\frac{38g}{100mL} \times \frac{10}{10} = \frac{380g}{1{,}000mL} = \frac{380g}{1L}$$

Since we need to convert from grams to moles, we will need to use the molar mass of NaCl, which is 58.5 $g \cdot mol^{-1}$

desired unit		**molar mass**		**answer**

$$\frac{mol}{L} = \frac{380\cancel{g}}{L} \times \frac{1\ mol}{58.5\cancel{g}} = \frac{6.5\ mol}{L} \text{ OR } \mathbf{6.5M}$$

answer

Values on the graph below a curve represent unsaturated solutions - more solute could be dissolved at that temperature. Values above a curve represent supersaturated solutions, a solution which holds more solute that can normally dissolve in that volume of solvent.

Some examples:

What term - saturated, unsaturated, or supersaturated - best describes:

- a solution that contains 70g of $NaNO_3$ per 100 mL H_2O at 30°C
- a solution that contains 60g of dissolved KCl per 100 mL H_2O at 80°C

Solution

- The $NaNO_3$ solution is **unsaturated**. At 30°C a saturated solution would be able to dissolve approximately 95 g of $NaNO_3$. Since there are only 70g in the solution, 25 more grams of $NaNO_3$ could be added and it would all dissolve.
- The KCl solution is **supersaturated.** At 80°C a saturated KCl solution contains 50 g KCl per 100 mL H_2O. This solution is holding 10 g of excess KCl.

If a small crystal of KCl is added to this supersaturated solution, the excess KCl will immediately come out of solution. **Have a look!**
