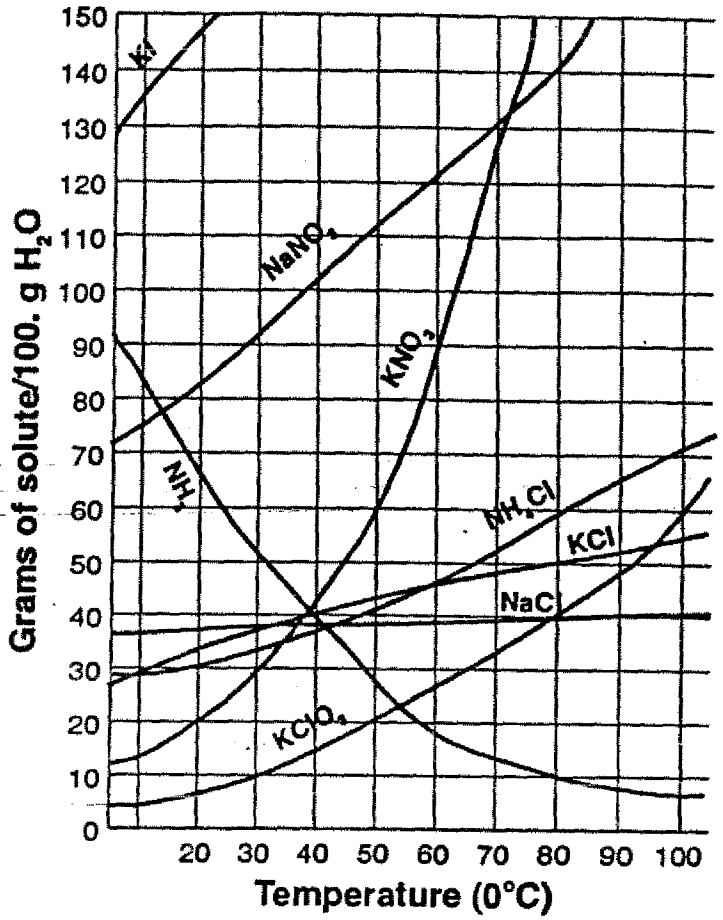
SOLUBILITY CURVES

Name _____

Answer the following questions based on the solubility curve below.



1. Which salt is least soluble in water at 20° C? $KClO_3$

2. How many grams of potassium chloride can be dissolved in 200 g of water at 80° C?
100 g

3. At 40° C, how much potassium nitrate can be dissolved in 300 g of water? 123 g

4. Which salt shows the least change in solubility from 0° – 100° C?
NaCl

5. At 30° C, 90 g of sodium nitrate is dissolved in 100 g of water. Is this solution saturated, unsaturated or supersaturated?
unsaturated

6. A saturated solution of potassium chlorate is formed from one hundred grams of water. If the saturated solution is cooled from 80° C to 50° C, how many grams of precipitate are formed? 40-20 g = 20 g

7. What compound shows a decrease in solubility from 0° to 100° C? NH_3

8. Which salt is most soluble at 10° C? KI

9. Which salt is least soluble at 50° C? $KClO_3$

Which salt is least soluble at 90° C? NH_3

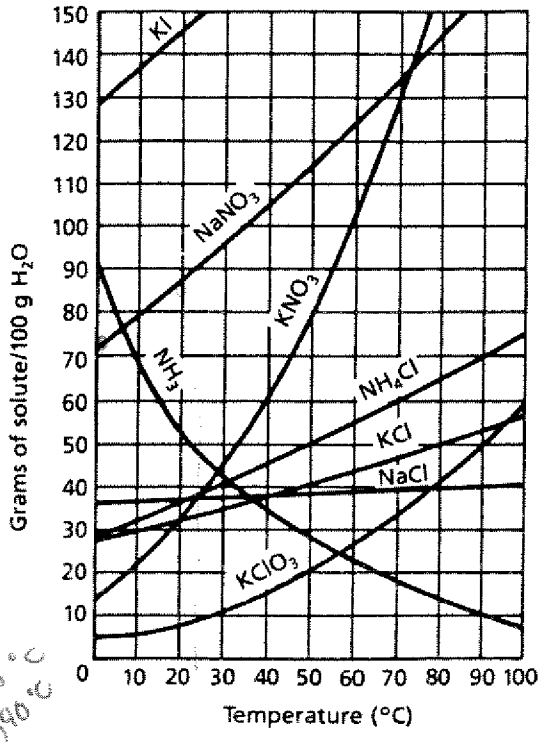
Name _____ Date _____ Class _____

CHAPTER 16 REVIEW ACTIVITY

Text Reference: Section 16-9

Solubility Curves

Study the solubility curves in the figure, and then answer the questions that follow.



1. What relationship exists between solubility and temperature for most of the substances shown?

2. **a.** What is the exception?

   b. What general principle accounts for this exception?

3. **a.** Approximately how many grams of $NaNO_3$ will dissolve in 100 g of water at 20°C?

   b. How many grams will dissolve at 60°C?

4. How many grams of NH_4Cl will dissolve in 1 dm^3 of H_2O at 50°C?

5. Ninety grams of $NaNO_3$ is added to 100 g of H_2O at 0°C. With constant stirring, to what temperature must the solution be raised to produce a saturated solution with no solid $NaNO_3$ remaining?

6. A saturated solution of $KClO_3$ was made with 300 g of H_2O at 40°C. How much $KClO_3$ could be recovered by evaporating the solution to dryness?

7. Five hundred grams of water is used to make a saturated solution of KCl at 10°C. How many more grams of KCl could be dissolved if the temperature were raised to 100°C?

8. A saturated solution of KNO_3 in 200 g of H_2O at 50°C is cooled to 20°C. How much KNO_3 will precipitate out of solution?

1. as temperature increases so does solubility
2. a. NH_3
   b. gases' solubility decreases with increasing temperature.
3. a. 87g
   b. 125g
4. 500g
5. 24°C
6. 45g
7. 135g
8. 94g

SCIENCE

Solubility Calculations

1. Calculate the maximum number of grams of each solute that can be dissolved:

a) potassium nitrate in 300 cm³ of water at 80° C.

$\frac{170\text{g } KNO_3}{100\text{g } H_2O} = \frac{x}{300\text{g}}$

510g KNO_3

b) sodium chloride in 1250 cm³ of water at 40° C.

$\frac{38\text{g } NaCl}{100\text{g } H_2O} = \frac{x}{1250\text{g}}$

475g NaCl

c) sodium nitrate in 50 cm³ of water at 0° C.

$\frac{70\text{g } NaNO_3}{100\text{g } H_2O} = \frac{x}{50\text{ } H_2O}$

35g $NaNO_3$

2. Calculate the minimum volume of water needed to dissolve:

a) 500 g of sodium chloride in water at 100° C.

$\frac{500\text{g NaCl}}{x} = \frac{40\text{g NaCl}}{100\text{g } H_2O}$

1250g H_2O

b) 10.0 g of potassium nitrate in water at 0° C.

$\frac{10.0\text{g } KNO_3}{x} = \frac{15\text{g } KNO_3}{100\text{g } H_2O}$

67g H_2O

c) 1.00 kg of sodium nitrate in water at 50° C.

$\frac{1000\text{g } NaNO_3}{x} = \frac{114\text{g NaN}}{100\text{g } H_2O}$

877g H_2O

3. Calculate the temperature the water must be to just dissolve:

a) 80.0 g of potassium nitrate in 200 cm³ of water.

$\frac{80.0\text{g } KNO_3}{200\text{g } H_2O} = \frac{x}{100\text{g } H_2O}$

$\frac{40\text{g } KNO_3}{100\text{g } H_2O}$ 27°C

b) 60.0 g of potassium nitrate in 50 cm³ of water.

$\frac{60.0\text{g } KNO_3}{50\text{g } H_2O} = \frac{x}{100\text{g } H_2O}$

$\frac{120\text{g } KNO_3}{100\text{g } H_2O}$ 64°C

c) 500.0 g of sodium nitrate in 500 cm³ of water.

$\frac{500\text{g } NaNO_3}{500\text{g } H_2O} = \frac{x}{100\text{g } H_2O}$

$\frac{100\text{g } NaNO_3}{100\text{g } H_2O}$ 35°C

4. Calculate the mass of precipitate in each case below;

a) a saturated solution of sodium nitrate in 400 cm³ of water at 100° C is made. The temperature is then changed to 13° C.

$\frac{180\text{g}}{100\text{g } H_2O} = \frac{x\text{g}}{400\text{g } H_2O}$

720g $NaNO_3$

$\frac{80\text{g}}{100\text{g } H_2O} = \frac{x\text{g}}{400\text{g } H_2O}$

320g $NaNO_3$

720g $NaNO_3$ - 320g $NaNO_3$

b) a saturated solution of potassium nitrate in 250 cm³ of water at 80° C is made. The temperature is then changed to 8° C.

$\frac{170\text{g}}{100\text{g } H_2O} = \frac{x}{250\text{g } H_2O}$

425g KNO_3

$\frac{20\text{g}}{100\text{g } H_2O} = \frac{x}{250\text{g } H_2O}$

50g KNO_3

425g - 50g = 375g

3. The dissolving of both salt and sugar involves the solid separating into particles too small to see. The salt solution contains ions of sodium and chlorine and will conduct a current, while the sugar dissolves to release sugar molecules, so its solution will not conduct electricity.

Try This Activity: Substances in Water

(Page 265)

(a) The potassium permanganate, sugar, and ethanol dissolve.
(b) Sugar and ethanol are certainly soluble, as they disappear completely. The solubility of potassium permanganate is less certain, as some of it remains undissolved.
Note: Students may be uncertain about any substance that does not "disappear" completely upon dissolving, because they rarely encounter this. Expect discussion about potassum permanganate, if they had some remain in solid state. Students may be uncertain if they speculate about whether some calcium carbonate or vegetable oil dissolves, even though there is no visible reduction of the original phase. They have only visible evidence of sample "shrinking" to go on, where no colour change is involved.
(c) The calcium carbonate and vegetable oil do not dissolve.
(d) We cannot be entirely certain, as a small amount may have dissolved.
(e) Properties are different: solutions are visibly homogeneous. Some other properties that might differ include electrical conductivity, acidity, melting/freezing points, viscosity, and so forth.
(f) Acidity could be tested with pH paper or conductivity with a multimeter.
Note: Tests listed by students should be consistent with their answers to (e).

6.1 DEFINING A SOLUTION

PRACTICE

(Page 269)

Understanding Concepts

1. (a) Heterogeneous: different substances are visible.
   (b) Homogeneous: only one phase is visible.
   (c) Homogeneous if it has been decanted; if not, there may be sediment in the bottle and the red wine would then be considered heterogeneous.
   (d) Heterogeneous if corroded; if clean, bronze appears homogeneous.
   (e) Homogeneous: the metal looks all the same throughout.
   (f) Heterogeneous if corroded; otherwise it is homogeneous.
   (g) Humid air is usually homogeneous; however, when cloud, fog, or rain forms, the solution is heterogeneous.
   (h) Heterogeneous: the suspended droplets of water make it opaque.
   (i) Heterogeneous: the water is not clear.
2. The solutions are (b), (d), (h) and (i).
   (a), (c), (e), (f) and (g) are not solutions.
3. Solutions may be classified by type of solvent, by electrical conductivity, by acidity, by colour, or by physical state at room conditions. Even categories such as viscosity, volatility, etc., can be used to classify substances.
4. (a) An aqueous solution is one in which the solvent is water.
   (b) Aqueous solutions found around the home will be substances such as shampoo, vinegar, syrup, clear fruit juices, tea, bleach, drain cleaners.
5. Methanol is a nonelectrolyte (it is a nonacidic molecular substance); sodium chloride is an electrolyte (it dissolves to release ions); hydrochloric acid is an electrolyte (acids are the only molecular substances to conduct electricity); and potassium hydroxide is an electrolyte (it is ionic).
6. (a) Electrolyte solutes include soluble ionic compounds (including ionic hydroxides) and acids.
   (b) electrolyte: a substance that dissolves in water to form a conducting solution
7. (a) Acidic solutions have acid solutes.
   (b) Basic soutions have ionic hydroxide solutes.
   (c) Neutral solutions have molecular solutes (other than acids) or ionic solutes (other than ionic hydroxides).
8. (a) Electrolytes: citric acid, salt (assume sodium chloride), sodium citrate, and monosodium phosphate (4 of the 11 substances listed).

Molarity Practice Problems – Answer Key

1) How many grams of potassium carbonate are needed to make 200 mL of a 2.5 M solution? 69.1 grams

2) How many liters of 4 M solution can be made using 100 grams of lithium bromide? 3.47 L

3) What is the concentration of an aqueous solution with a volume of 450 mL that contains 200 grams of iron (II) chloride? 3.51 M

4) How many grams of ammonium sulfate are needed to make a 0.25 M solution at a concentration of 6 M? 171.2 grams

5) What is the concentration of a solution with a volume of 2.5 liters containing 660 grams of calcium phosphate? 0.85 M

6) How many grams of copper (II) fluoride are needed to make 6.7 liters of a 1.2 M solution? 1081.4 grams

7) How many liters of a 0.88 M solution can be made with 25.5 grams of lithium fluoride? 1.11 L

8) What is the concentration of a solution with a volume of 660 mL that contains 33.4 grams of aluminum acetate? 0.25 M

9) How many liters of a 0.75 M solution can be made with 75 grams of lead (II) oxide? 12.6 grams

10) How many grams of manganese (IV) oxide are needed to make 5.6 liters of a 2.1 M solution? 1021.9 grams

11) What is the concentration of a solution with a volume of 9 mL that contains 2 grams of iron (III) hydroxide? 2.08 M

12) How many liters of a 3.4 M isopropanol solution can be made with 78 grams of isopropanol (C_3H_8O)? 0.41 L

13) What is the concentration of a solution with a volume 3.3 mL that contains 12 grams of ammonium sulfite? 31.3 M