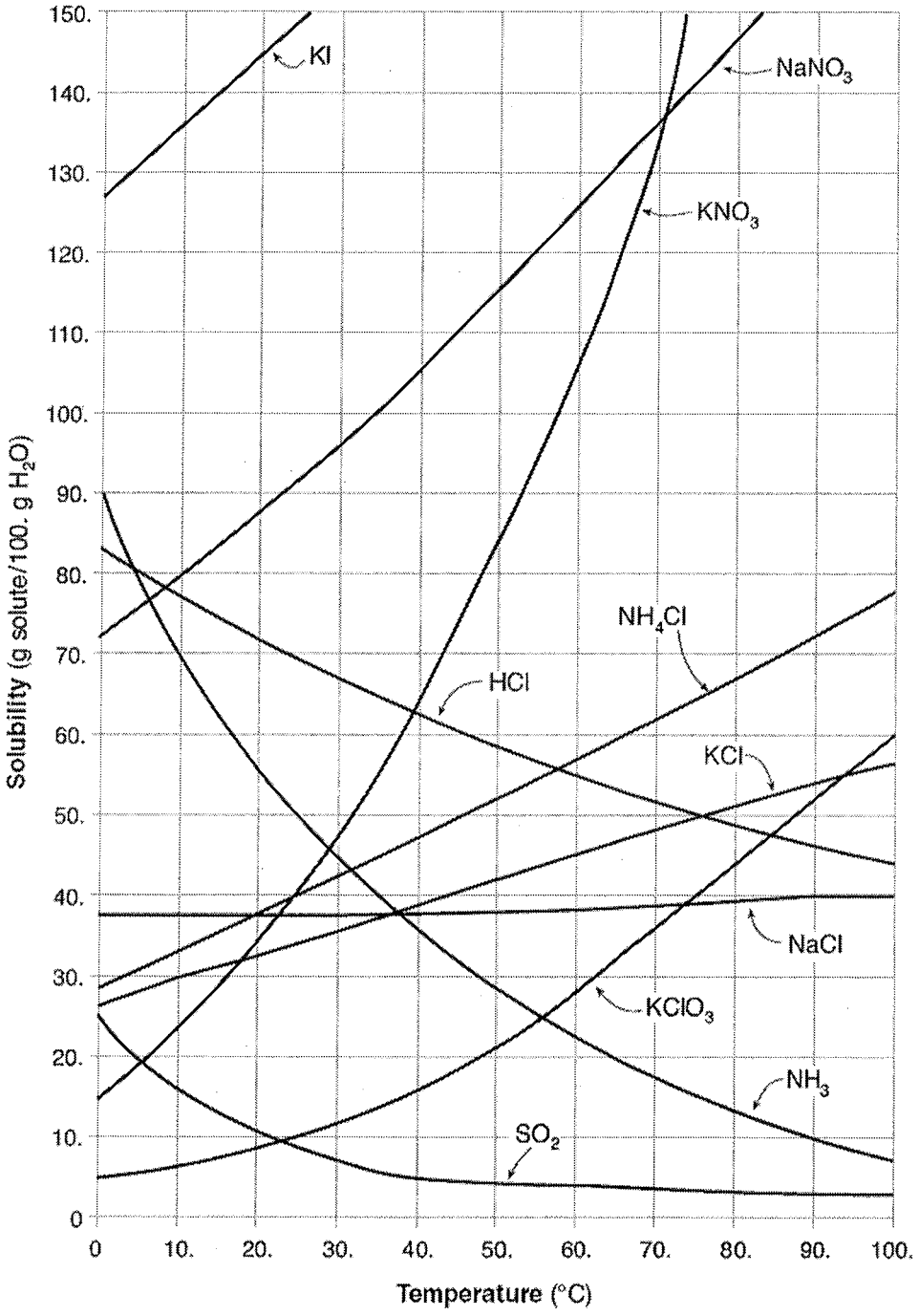
Name_____ Mr. GARDNER

Unit #7: Solutions



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Solutions Vocabulary

boiling point the temperature at which the vapor pressure of a liquid is equal to the atmospheric pressure

electrolyte a substance whose water solution conducts an electric current

homogeneous a substance in which the particles are uniformly mixed

miscible the ability of one liquid to be soluble in another liquid

molarity the concentration of a substance in moles per liter of solution

parts per million the ratio between the parts of solute per million parts of solution

percent by volume the concentration of a solution expressed as the ratio between the volume of the solute and total volume of the solution, expressed as a percent

percent mass the concentration of a solution expressed as the ratio between the mass of the solute and the total mass of the solution, expressed as a percent

saturated (in regard to a solution) a solution containing the maximum amount of solute that will dissolve at a given temperature

solubility a measure of how much solute will dissolve in a certain amount of solvent at a specific temperature

soluble material with a high solubility

solute the substance being dissolved

solution a homogeneous mixture of substances in the same physical state

solvent the substance that dissolves the solute

supersaturated a solution that contains more solute than would dissolve in a saturated solution at a given temperature

unsaturated (in regard to a solution) a solution in which more solute can be dissolved at a given temperature

vapor the gaseous state of a substance that is normally a liquid at room temperature

vapor pressure the pressure that a vapor exerts

vaporization the constant temperature process in which particles in the liquid phase gain enough energy to break away into the gaseous phase; also known as boiling; the reverse of the condensation process

Solutions Unit Objectives

- **Know the above terms/definitions**
- **Distinguish between and give examples of solutions, suspensions and colloidal dispersions**
- **Describe factors affecting solubility**
- **Interpret a solubility curve and solve problems using one**
- **Solve problems involving parts per million, percent, molarity and molality**
- **Describe how solutes affect boiling/freezing points of a solution**
- **Solve problems using freezing point depression and boiling point elevation**

Key Reference Tables for this Unit: F/G/H (p. 2-3)

1 **Solutions**

2 **Solutions**

- are homogenous mixtures of two or more substances in a single phase
  - Have a uniform composition throughout
- Have the same properties throughout
- All materials pass through a filter in the liquid phase
- May exists as all forms of matter
  - Gas = Air
  - Liquid = Salt water
  - Solid = 14K gold (actually a gold/silver mixture)

3 **Solutions continued**

- Solvent: → dissolving medium in a solution
- Solute: → material dissolved in a solution
  - (typically in lesser quality)

4 **Suspensions and Colloids**

- Suspensions: ex. Muddy water
  - Particles are big and will settle out if not agitated
  - Would be trapped in a filter
- Colloids: ex. Milk
  - Particles size between solution and suspension
  - Particles do not settle out
  - Would typically pass through a filter

5 **Electrolytes**

- Electrolyte: a substance that dissolves in water to give a solution that conducts an electric current
  - ex. Na^+ and Cl^- in water
  - Ionic and other highly polar molecules will dissolve in water and may be electrolytes
- Non-electrolyte: a substance that dissolves in water, but does not conduct an electric current (ex. sugar)

6 **Solubility**

- amount of solute that will form a saturated solution in a specific amount of solvent at a certain temperature (TABLE G)
  - Saturated= maximum dissolved solute in a solution
  - Unsaturated= less solute than a saturated solution under the same conditions (temperature/pressure)
  - Supersaturated= more solute than a saturated solution under the same conditions (ex. temp etc.)

7 **Supersaturated Solutions**

- heated to a high temperature to dissolve
- Solution is left undisturbed to cool
- Solution will hold more solute at the lower temperature than the saturated solution normally would
- Re-crystallization will eventually occur at the lower temperature as these are unstable solutions
  - Used to make rock candy!!! And other crystals

8 **Table G**

- Used to determine solubility based on temperature of water and amount of solute in grams

9 **Table G Questions**

- How much Potassium Iodide will dissolve in 100g of water at 10°C?
  - About 135gKI
- If I had a 40.0g sample of NaCl;
  - Would I be able to dissolve all of it in 100g of water at 75°C?
    - No
  - What temperature would I need to heat the water to, in order to dissolve this amount?
    - 85-90°C
- If I had a solution of 80g of KNO_3 in 100g of water at 65°C, how much KNO_3 would I need to add to make it a saturated solution?
  - ~40g minimum

10 **Solution Equilibrium**

- when dissolution/dissociation/dissolving and crystallization of the solute occur at equal rates
-
- <u>Factors affecting dissolution(dissolving) rates</u>:
  - Increased surface area→ granulated vs. powdered sugar
  - Agitation→ disperses particles and increases contact with fresh solvent
  - Heating→ movement of particles increases and collisions between solvent and solute are of higher energy

11 **Solute-Solvent Interactions**

- "like dissolves like" and the continuum of polarity
- NP Mod Polar High Polar Ionic
- 0.0 0.8 1.7 3.3
  - Based on Electronegativity differences between materials
  - Most materials will be soluble/miscible in materials of the same polarity
    - Ex. Non Polar Iodine (I_2) is soluble in Non Polar Hexane (C_6H_{14})
  - Similar polarities or being close on the continuum also works sometimes
    - Ex. Ionic Salt NaCl will be soluble in Polar H_20

12 **Pressure and Solubility**

- specifically for gases as little or no effect on solids/liquids in a liquid solvent
- Ex. CO_2 in soda→ do not see bubbles until the bottle is opened as they are dissolved in the liquid
  - As Pressure solubility will and vice versa
- When opened the pressure drops and the gas comes out of solution (5-10 atm → 1 atm)
- Effervescence = the rapid escape of a gas from a solution (Alka-Seltzer does this well)

13 **Temperature and Solubility**

-
- Gas in a liquid: in temp will cause a in solubility as the molecules will move faster and escape easier
- Solid in a liquid: in temp will generally cause an in solubility (though rates may vary depending on the solute)
  - Some solutes will have a in solubility, with temperatures

14 **Concentrations of Solutions**

-
- Dilute and concentrated are relative terms
  - Dilute = small amount of solute in a solution
    - Or you can add extra water to dilute a solution
  - Concentrated = large amount of solute in a solution
    - Or you can evaporate water from a dilute solution to make it more concentrated
  - No real measurement went into making solutions

15 **Molarity (M)**

- # of moles of a solute in one liter of solution
  - Ex. 1M NaOH is 1 mole(40g) of NaOH in 1L of solution
- M =
-
  - What is the molarity of a 60.0g sample of NaOH in 1L of solution?
-

16 **Molality(m)**

- # of moles of solute per kilogram of solvent
  - Ex. 1 molal NaOH = or
  -
- What is the molality of a solution containing 20.0g of NaOH in 2.0L of H2O? (2L = 2kg)

17 **Percent by Mass**

- *100

- ❑Must include solute and solvent mass together
- ❑

- What is the % by mass of a 2.5g NaCl sample that is dissolved in 50.0g of H2O?
-
- % NaCl = *100 → 4.8% NaCl

18 **Percent by Volume**

- *100
-
  - ❑Ex. Rubbing alcohol=Isopropyl alcohol 70% by volume

- What is the % by volume of 50.0mL ethanol dissolved into 250.0mL water?
-
- % Ethanol = *100 →16.7% C_2H_5OH

19 **Table F**

20 **Table F continued**

- Used to determine if a precipitate (ppt) will form when 2 aqueous solutions are mixed
- Will a ppt form if a silver nitrate solution and sodium chromate solution are mixed together?
  - ❑Write out the double replacement reaction
  - ❑Verify solubility's of all compounds
  - ❑
- Silver nitrate+sodium chromate→silver chromate+sodium nitrate
- $2AgNO_3 + Na_2CrO_4 \rightarrow Ag_2CrO_4 + 2NaNO_3$
- (soluble) (soluble) →(INSOLUBLE) (soluble)

21 **Table F continued**

- Will a ppt form in a mixture of sodium acetate and potassium phosphate?
-
- Sodium Acetate+Potassium Phosphate→Sodium Phosphate+Potassium Acetate
- $3NaC_2H_3O_2 + K_3PO_4 \rightarrow Na_3PO_4 + 3KC_2H_3O_2$
- (Soluble) (soluble) (soluble) (soluble)

22 **Dissociation**

- Separation of ions that occurs when an ionic compound dissolves
- $NaCl \rightarrow Na^{+1}(aq) + Cl^{-1}(aq)$
- 1 mole → 1 mole + 1 mole = (2 moles of ions)
-
- $CaCl_2 \rightarrow Ca^{+2}(aq) + 2Cl^{-1}(aq)$
- 1 mole → 1 mole + 2 moles =(3 moles of ions)
- Ionic Compounds have more particles/moles in solution compared to molecular structures such as sugar

- $C_{12}H_{22}O_{11}(s) \rightarrow C_{12}H_{22}O_{11}\ (aq)$
- 1 mole $\rightarrow$ 1 mole total

23 **Colligative Properties**

- presence of solutes will affect the properties of a solution
  - Vapor pressure
  - melting point
  - boiling point
- Properties are dependent upon the concentration of the solute particles (not the type of solute)

24 **Vapor Pressure: TABLE H**

25 **Vapor Pressure continued**

- Molecules on the surface of a liquid may have enough energy to escape into the gas phase (vapor)
  - H_2O vapor, gas vapor etc.
- As temperature ↑, KE of the particles will ↑ and more may escape to the gas phase
- These new gases will exert pressure on the materials below them = Vapor Pressure
- When solute is added, the concentration of solvent molecules near the surface ↓ (less can go into air)
  - Vapor pressure will be lowered
  - Pure water would exert more pressure than salt water based on this as more can go into air and exert pressure below

26 **Freezing Point Depression**

- Addition of solute will decrease the FP of a solvent
- For each mole of solute <u>particles</u> added per Kg H_2O, a constant ↓ will occur in the FP (-1.86°C)
- K*f* = molal FP constant
  - For H_2O = (-1.86°c/*m*)
    - *m*=molality→ moles solute/Kg H_2O
- Particles can be molecules or ions
- Electrolyte solutions have more moles of particles than starting amount of reactant (ex. salt)
- Non-electrolyte solutions (ex. sugar) have the same amount of particles as the starting reactant

27 **Freezing Point Depression continued**

- Ex. What is the new FP in a solution containing 3 moles of NaCl in 1Kg of H_2O?
  - 3.0 moles NaCl → 3.0 mole Na+ and 3.0 moles Cl-
  - thus 6.0 moles of particles are present
  - (6.0 moles/1Kg H_2O) (-1.86°c/*m*)=
  - -11°c lower

- This is the reason why roads are salted
  - Helps to prevent freezing until lower temps

28 **Freezing Point Depression continued**

- 1) A sample solution contains 360.0g of $C_6H_{12}O_6$ in 250.0g of H_2O. What is the freezing point depression in this solution?
  - Hint: Based on Kg H_2O
-
- (360.0g)(1mole/180.0g)(1/0.2500Kg) = 8.000*m*
- (-1.86°c/*m*)(8.000*m*) = -14.9°c

29 **Boiling Point Elevation**

- With addition of solute, more heat is needed to boil
- For each mole of solute <u>particles</u> added per Kg H_2O, a constant ↑ will occur in the BP (0.51°c)
- K*b* = molal BP constant (for water → 0.51°c/*m*)
- Determine molality(moles solute/Kg solvent)
- Multiply molality by K*b*
  - More E needed to raise the vapor pressure so that it equals atmospheric temperature
  - Salt potato's will boil at a higher temperature than pure water due to the addition of solute particles

30 **Boiling Point Elevation continued**

- A solution contains a 450.0g sample of $C_{12}H_{22}O_{11}$ in 250.0g of H_2O at STP. What is its <u>new</u> boiling point?
-
- → (450.0g)(1mole/342.0g)(1/0.2500Kg) = 5.263*m*
-
- → (0.51°c/*m*)(5.263*m*) = 2.684 increase
-
- → New BP = 100.0°c + 2.684°c = 102.7°c

31 **Boiling Point Elevation continued**

- What is the BP elevation of a electrolyte solution containing 200.0g of NaCl that was added to 600.0g of H_2O (where solute molar mass is 58.5g)?
- 1) moles of solute 200.0g * 1 mole/58.5g = 3.42moles
  - 3.42 Moles NaCl * 2moles ions/1 mole NaCl = 6.84 Moles ions
-
- 2) molality = 6.84 moles/0.600Kg H_2O = 11.4*m*
-
- 3) BP elevation→ 11.4*m* * 0.51°c/*m* = 5.81°c

Name _____ Class _____ Date _____

The Solvay Process

There are certain simple compounds that are used for many purposes in industry and in the home. One of the tasks of chemistry is to develop economical methods of producing such compounds on a large scale.

Sodium carbonate, Na_2CO_3, and sodium bicarbonate (also called sodium hydrogen carbonate), $NaHCO_3$, are examples of compounds with many uses. Sodium carbonate is involved in the manufacture of glass, soap, paper, and water-softening compounds. Hydrated sodium carbonate, $Na_2CO_3 \cdot 10H_2O$, is called washing soda and is widely used in household cleansers. Sodium bicarbonate is called baking soda and is an ingredient of most baking powders. It is also used as a medicinal antacid.

The method used for manufacturing sodium carbonate and sodium bicarbonate was developed around 1860 by the Belgian chemist Ernest Solvay. Called the Solvay Process, it is an excellent example of success in meeting the requirements of industrial chemistry.

The two raw materials that are consumed by the process are very common and inexpensive. One is limestone, in which the chief mineral is calcium carbonate, $CaCO_3$. The other is sodium chloride, NaCl, or common salt. Great quantities of both of these materials are found near the earth's surface and they are easily extracted.

A simple equation for preparing sodium carbonate from calcium carbonate and sodium chloride might be written as follows:

$$CaCO_3 + 2NaCl \rightarrow Na_2CO_3 + CaCl_2$$

The only trouble with this reaction is that it cannot be made to proceed. $CaCO_3$ is practically insoluble, and no significant amount of product can be obtained by this direct reaction. However, the Solvay Process achieves the same result by an indirect method. Limestone is first heated to produce lime and carbon dioxide:

$$CaCO_3 \rightarrow CaO + CO_2$$

The CO_2, together with ammonia gas, NH_3, are then bubbled through a saturated solution of NaCl. Ammonia, unlike limestone and salt, has to be manufactured by a relatively expensive process. However, the ammonia in the Solvay Process is recovered and reused.

The chemical steps of the process are:

(1) $CO_2 + H_2O \rightleftarrows H_2CO_3 \rightleftarrows H^+ + HCO_3^-$

(2) $NH_3 + H_2O \rightleftarrows NH_4^+ + OH^-$

Equations (1) and (2) can be combined:

(3) $CO_2 + NH_3 + H_2O \rightleftarrows NH_4^+ + HCO_3^-$

The sodium chloride, present as Na^+ and Cl^- ions, reacts with NH_4^+ and HCO_3^- as follows:

(4) $Na^+ + Cl^- + NH_4^+ + HCO_3^- \rightarrow NH_4^+ + Cl^- + NaHCO_3(s)$

Notice that $NaHCO_3$, being less soluble than NH_4Cl, precipitates out, so that the reaction proceeds to the right. Sodium carbonate can then be obtained by heating the dried sodium bicarbonate:

(5) $2NaHCO_3 \rightarrow CO_2 + H_2O + Na_2CO_3$

To recover the ammonia, the CaO obtained when the limestone was heated is combined with water:

(6) $CaO + H_2O \rightarrow Ca^{2+} + 2OH^-$

When this solution is combined with the filtrate from Equation (4) and heated, ammonia is released and calcium chloride is obtained:

(7) $Ca^{2+} + 2OH^- + 2NH_4^+ + 2Cl^- \rightarrow CaCl_2 + 2H_2O + 2NH_3(g)$

A review of the equations reveals that $CaCO_3$ and NaCl have been used to produce Na_2CO_3, with $CaCl_2$ as a by-product, just as the original simple equation predicted. The ammonia has also been recovered.

QUESTIONS

1. Calcium carbonate serves two functions in the Solvay Process. What are they?
2. What is meant by a by-product?
3. Ammonium chloride, produced by Equation (4), is a useful compound. Why not stop the process here and let ammonium chloride be the by-product?
4. Is ammonia a catalyst in this process, explain your answer.

8

NAME_____
DATE_____

INTERPRETING DATA FROM SOLUBILITY CURVES

DIRECTIONS: Use Table G in your reference tables to solve the following problems. Both sides!

_____1) What is the solubility of potassium nitrate in 100 grams of water at 65 °C ?

_____2) What is the solubility of potassium chloride in 100 grams of water at 50 °C ?

_____3)What is the solubility of sodium nitrate in 100 grams of water at 80 °C ?

_____4) What is the minimum temperature needed to dissolve 80 grams of potassium nitrate in 100 grams of water?

_____5) What is the minimum temperature needed to dissolve 35 grams of potassium chloride in 100 grams of water

_____6) At what temperature do potassium chloride and potassium nitrate have the same solubility ?

_____7)At what temperature do potassium nitrate and sodium chloride have the same solubility ?

_____8) If 50 grams of ammonium chloride are mixed with 100 grams of water at 20 °C, how much will *not* dissolve ?

_____9) If 250 grams of potassium nitrate are mixed with 100 grams of water at 65 °C, how much will *not* dissolve ?

_____10) If 50 grams of sodium chloride are mixed with 100 grams of water at 80 °C, how much will *not* dissolve ?

_____11) If 15 grams of potassium iodide are added to 100 grams of water at 20 °C, how much more must be added to saturate the solution?

_____12) If 70 grams of potassium nitrate are added to 100 grams of water at 70 °C, how much more must be added to saturate the solution ?

_____13) If 10 grams of sodium chloride are added to 100 grams of water at 100 °C, how much more must be added to saturate the solution ?

_____14) 100 grams of water are saturated with potassium chloride at 35 °C. If this solution is heated to 95°C, how much more can be dissolved ?

_____15) 100 grams of water are saturated with potassium nitrate at 20 °C. If the solution is heated to 50°C, how much more can be dissolved?

_____16) 100 grams of water at 50 °C are saturated with sodium chloride. If this solution is heated to 100 °C, how much more can be dissolved ?

_____17) 100 grams of water at 65 °C are saturated with potassium nitrate. If this solution is cooled to 35°C, how much of the solid will precipitate(change from the dissolved state to the solid state) ?

_____18) 100 grams of water at 90 °C are saturated with ammonium chloride. If this solution is cooled to 25°C, how much of the solid will precipitate?

_____19) How much potassium nitrate will dissolve in *50 grams of water* at 50 °C ?

_____20) How much potassium nitrate will dissolve in *200 grams of water* at 10 °C ?

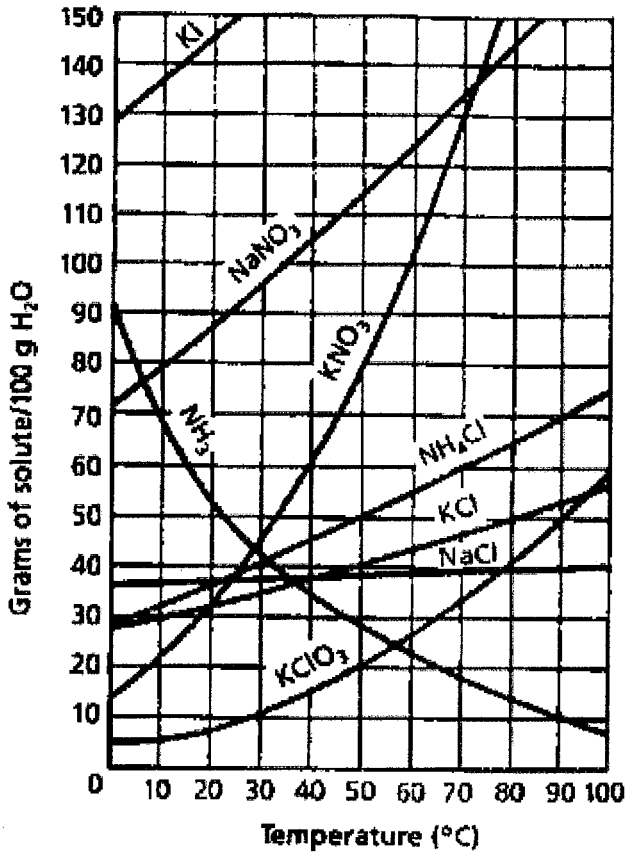
_____21) How much sodium chloride will dissolve in *10 grams of water* at 50 °C ?

_____22) How much potassium chloride will dissolve in *25 grams of water* at 80 °C ?

_____23) If 50 grams of water are saturated at 80 °C with sodium nitrate and then cooled to 40°C, how much will precipitate ?

_____24) What temperature is needed to dissolve twice as much potassium chloride as can be dissolved at 0 °C in 100 grams of water ?

_____25) What temperature is needed to dissolve twice as much potassium nitrate as can be dissolved at 10 °C in 100 grams of water ?



In case you forget TABLE G, you may find the answer to most of the questions with this similar table

Name _____

* complete the following by the end of class
* use Orange graphing rules sheet for guidance

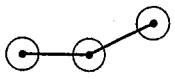
Base your answers to questions 71 through 74 on the data table below, which shows the solubility of a solid solute.

The Solubility of the Solute at Various Temperatures

Temperature (°C)	Solute per 100 g of H_2O(g)
0	18
20	20
40	24
60	29
80	36
100	49

71 On the grid provided *in your answer booklet,* mark an appropriate scale on the axis labeled "Solute per 100 g of H_2O(g)." An appropriate scale is one that allows a trend to be seen. [1]

72 On the same grid, plot the data from the data table. Circle and connect the points. [1]

Example: 

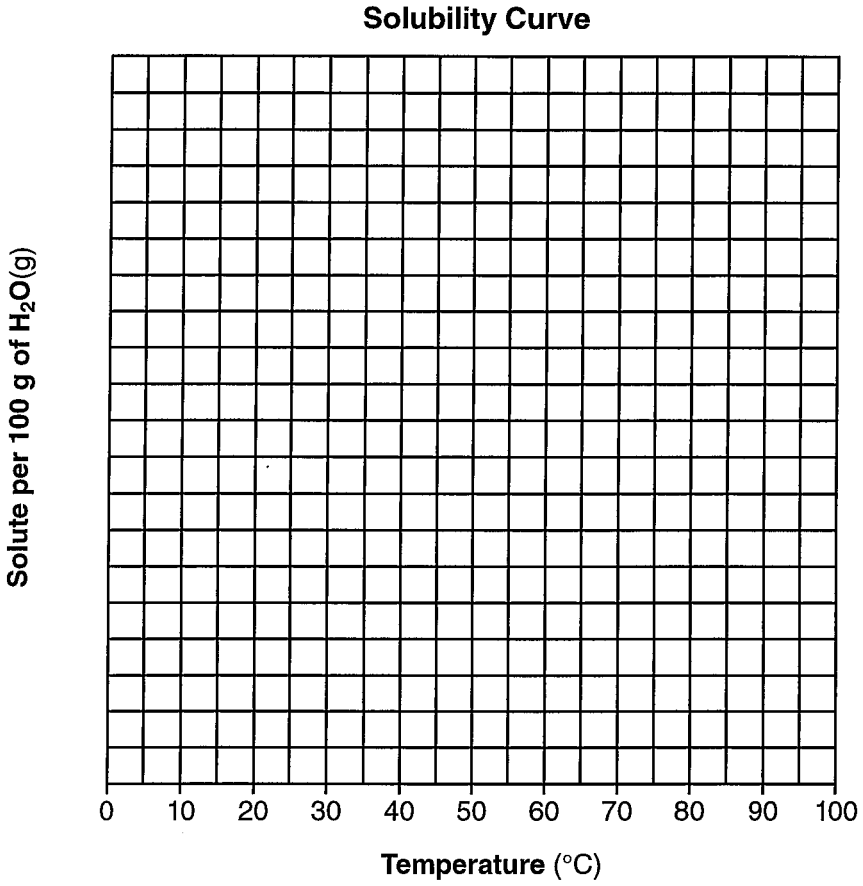
73 Based on the data table, if 15 grams of solute is dissolved in 100 grams of water at 40°C, how many *more* grams of solute can be dissolved in this solution to make it saturated at 40°C? [1]

74 According to Reference Table *G*, how many grams of $KClO_3$ must be dissolved in 100 grams of H_2O at 10°C to produce a saturated solution? [1]

_____

For Raters Only

71 and 72



71 ☐

72 ☐

73 _____ g

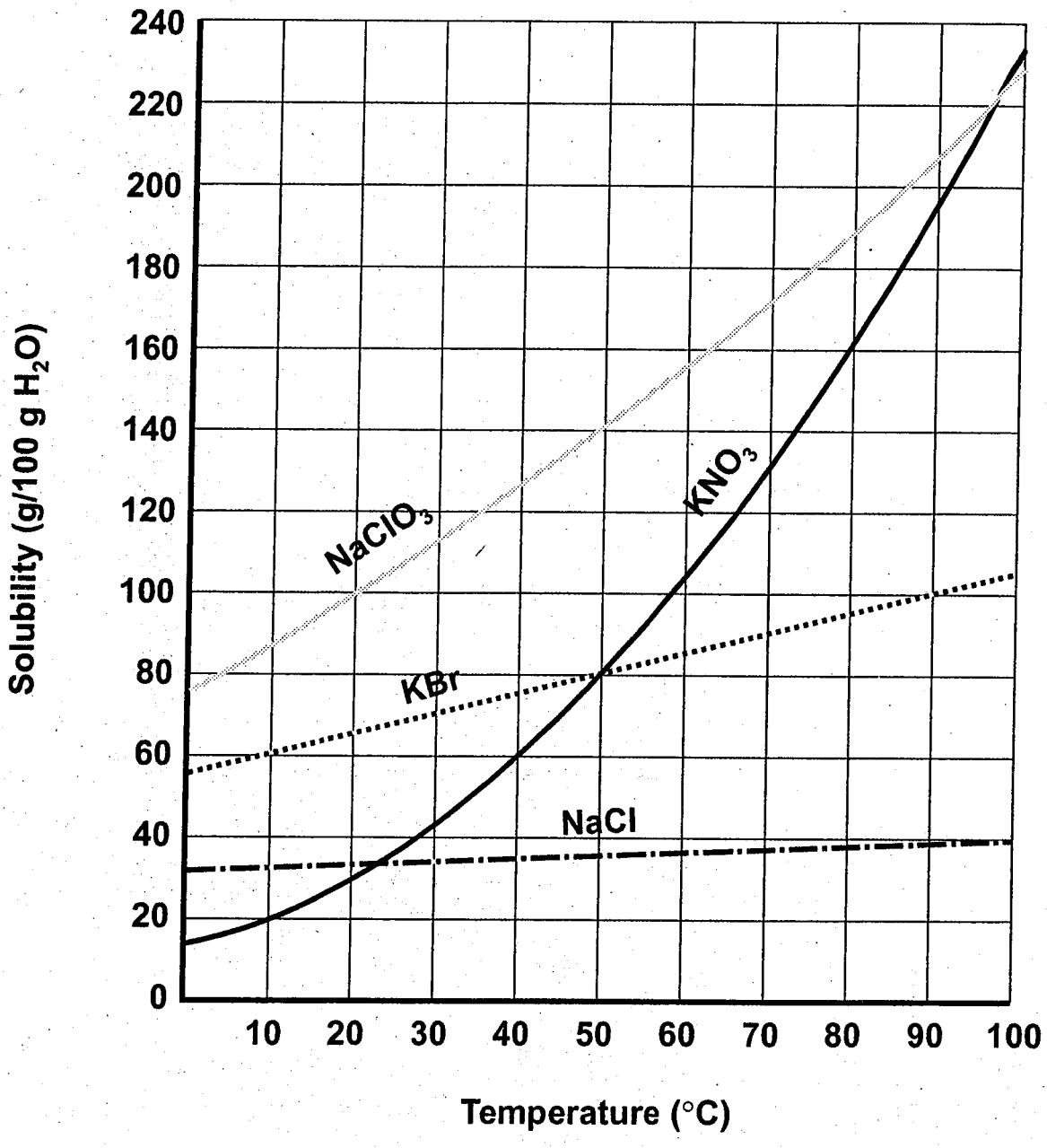
73 ☐

74 _____ g

74 ☐

12

4 SOLUBILITY CURVES



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Name_____ Solubility Curve Quiz

Directions: You will use the provided solubility curve to determine the following questions. Please put all answers in the space proved before each question. Good Luck ☺ You may write on this curve to help you determine points etc. if necessary, but they will be collected with the quiz and returned to you later.

_____1) How much sodium chlorate is required to form a saturated solution at 55°C in 100g H_2O?

_____2) If I have 20g of sodium chloride dissolved in 100g H_2O at 50°C, will my solute be unsaturated, saturated or supersaturated?

_____3) What is the solubility of potassium nitrate in 100g H_2O at 70°C?

_____4) How much potassium bromide could I dissolve to make a saturated solution in 50g H_2O at 90°C?

_____5) What is the solubility of NaCl in 100g H_2O at 100°C?

_____6) If 60g of sodium chlorate have been dissolved in 100g H_2O at 20°C, how much more can I add to make it a saturated solution?

_____7) At what temperature can I dissolve 130g potassium nitrate to make a saturated solution?

_____8) I have 200g sodium chlorate dissolved in 100g H_2O at ~86°C. If I was to cool this water down to 35°C, how much of the solute would precipitate out of solution?

_____9) At which temperature do potassium nitrate and potassium bromide have the same solubility?

_____10) Which chemical is the least soluble in 100g H_2O at 20°C?

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Name _____

1) As temperature rises, the solubility of all gases in water will_____.

2) Most ionic substances are soluble in water, because water molecules are _____.

3) Draw the ion-molecule attraction that occurs when NaCl is added to water. Show how the Na^+ ion attracts to the water and how the Cl^- ion attracts to the water.

4) Which material is the most soluble in 100g of water at 45°C.

5) If I had 100g of Ammonium Chloride dissolved in 100g of water at 100°C, it could be said that my solution is _____.

6) What is the molarity of 116g of KF in 500.mL of solution?

7) What is the percent by mass of 5.00g NaOH in 100.0g H_20?

8) If I add 10 moles of salt (NaCl) to 10L of water, what will its new boiling point be?

9) What is the vapor pressure of ethanoic acid at 90 °C?

10) If I mixed solutions of lead nitrate and potassium iodide:
Write out the word equation for the double replacement reaction that took place and tell me what the precipitate is.

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NAME_____

Solutions Quiz #1

1) Will a precipitate form in a reaction between solutions of magnesium chloride and ammonium sulfide?

2) If I had 130.0g of $NaNO_3$ dissolved at 60 c, I would have a _____ solution.

3) If I had an unsaturated solution with 25.0g of NH_4Cl at 65 c, How many more grams would I need to add to make it a saturated solution?

4) With the addition of a solute, the freezing point of a solution will be _____ than the original solvent's freezing point.

5) Define the following
   a. Solute

   b. Solvent

6) If a suspension were poured through filter paper, would all the material pass through?

7) Describe 2 factors that would increase the rate if dissolution of a solute into a solvent.

8) As the pressure of a system increases, the ability of a gas to become soluble will_____.

9) What is the molarity of a solution containing 186.5g KCl in 500.ml of solution (SHOW ALL WORK FOR CREDIT).

10) What is the percent by mass of 57g NaCl in 105ml H_2O?

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Name_____ [redacted]
Solutions Quiz #2

SHOW ALL WORK AND UNITS

1. How many moles of solute would 3 liters of a 2 molar solution contain?

2. A 20mL sample of 0.60M HCl is diluted to 40mL with water. What will the new concentration of the solution be? (Hint Try $M_1V_1=M_2V_2$)

3. How many grams of KCl must be dissolved in 200g of water to make a saturated solution at 60°c?

4. What is the boiling point elevation if 10.0 moles of sugar are added to 750.0ml of water?

5. If I had solutions of sodium phosphate and calcium chromate and mixed them, would a precipitate form? (Write out double replacement reaction and show all solubilities)

_____ + _____ → _____ + _____

( ) ( ) ( ) ( )

6. What is the molarity of a solution with 123.0g of $Ca(NO_3)_2$ in 3.0L of solution?

7. What is the percent by volume of 300.0mL of ethanol added to 200.0mL water?

8. Using Table H, What is the vapor pressure of propanone at 45°c?

9. If I had 0.00015g of gold in my pan that also contained 10mL of water, how many parts per million would that be?

10. Describe the process required to make a supersaturated solution:

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Name_____ Solutions Open Note QUIZ

SHOW ALL WORK AND UNITS

1. Complete the word equation for the following double replacement reactions and determine if a precipitate will form (use table F)…Circle the resulting precipitate if applicable.

   a. Mercury(II)chloride+ potassium sulfide→_____ + _____

   b. Sodium bicarbonate + calcium chloride→_____ + _____

   c. Copper(II)chloride + ammonium phosphate→_____ + _____

2. What is the molarity of a solution containing 82.0g of $Ca(NO_3)_2$ in 2.0 liters of solution.

3. If you had a solution of NaCl in water, how could you determine if it is:
   a. Unsaturated

   b. Saturated

4. What is the percent by mass of NaOH if 37.0 grams are added to 150ml of H_2O?

5. If I had 41% alcohol by volume in a 500ml solution, what was the original volume of the solute?

6. If I have a 250.ml of a 5.0M solution and it evaporates to 125ml, what will its new concentration be?

Bonus: What was Dave Matthews motion picture debut?

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Name_____ Solutions Quiz
General Chemistry

1. Compare/contrast solute and solvent

2. How many grams of KCl must be dissolved in 200g of water to make a saturated solution at 60°c?

3. If I had solutions of sodium sulfate and calcium chromate and mixed them, would a precipitate form? (Write out double replacement reaction and show all their solubility's in the parenthesis below)

_____ + _____ → _____ + _____

( ) ( ) ( ) ( )

4. Using Table H, What is the vapor pressure of propanone at 45°c?_____

5. As temperature rises, the solubility of all gases in water will_____.

6. Most ionic substances are soluble in water, because water molecules are _____.

7. Draw the ion-molecule attraction that occurs when NaCl is added to water. Show how the Na^+ ion attracts to the water and how the Cl^- ion attracts to the water.

8. Which material is the most soluble in 100g of water at 25°C. _____

9. If I had 100g of Ammonium Chloride dissolved in 100g of water at 100°C, it could be said that my solution is _____.

10. If you had a solution of NaCl in water, how could you determine if it is:
    a. Unsaturated

    b. Saturated

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11. Describe why using the terms dilute/concentrated and weak/strong are not the safest measures in a chemistry lab?

12. Consider the following: will all the contents of the material go through a filter
    a. Solutions _____
    b. Suspension _____
    c. Colloid _____

13. In regards to properties of water, if I add materials to it, the boiling point will go_____ while the freezing point will go _____.

14. Which will be better material to put on the roads during the winter: NaCl or $CaCl_2$ and explain why.

15. Explain how vapor pressure forms in a closed container

Bonus: Describe the process required to make a supersaturated solution:

(20)

Name: _____

1) Which must be a mixture of substances?

A) solid
B) liquid
C) solution
D) gas

2) Which of these contains only one substance?

A) sugar water
B) rainwater
C) distilled water
D) salt water

3) Recovering the salt from a mixture of salt and water could *best* be accomplished by

A) density determination
B) paper chromatography
C) evaporation
D) filtration

4) When a mixture of water, sand, and salt is filtered, what passes through the filter paper?

A) water and salt, only
B) water, sand, and salt
C) water, only
D) water and sand, only

5) What is the molarity of a solution of NaOH if 2 liters of the solution contains 4 moles of NaOH?

A) 80 M
B) 0.5 M
C) 8 M
D) 2 M

6) What is the molarity of a solution containing 20 grams of NaOH in 500 milliliters of solution?

A) 1 M
B) 0.5 M
C) 2 M
D) 0.04 M

7) How many moles of solute are contained in 200 milliliters of a 1 M solution?

A) 1
B) 200
C) 0.2
D) 0.8

8) What occurs when NaCl(s) is added to water?

A) The boiling point of the solution decreases, and the freezing point of the solution increases.
B) The boiling point of the solution decreases, and the freezing point of the solution decreases.
C) The boiling point of the solution increases, and the freezing point of the solution increases.
D) The boiling point of the solution increases, and the freezing point of the solution decreases.

9) Based on the *Solubility Curves* chemistry reference table, what is the maximum number of grams of KCl(s) that will dissolve in 200 grams of water at 50DC to produce a saturated solution?

A) 58 g
B) 42 g
C) 84 g
D) 38 g

10) According to *Solubility Curves* chemistry reference table, which solution is saturated at 30DC?

A) 30 grams of NaCl in 200 grams of water
B) 12 grams of $KClO_3$ in 200 grams of water
C) 12 grams of $KClO_3$ in 100 grams of water
D) 30 grams of NaCl in 100 grams of water

11) One hundred grams of water is saturated with NH_4Cl at 50DC. According to the *Solubility Curves* chemistry reference table, if the temperature is lowered to 10DC, what is the total amount of NH_4Cl that will precipitate?

A) 5.0 g
B) 17 g
C) 50. g
D) 30. g

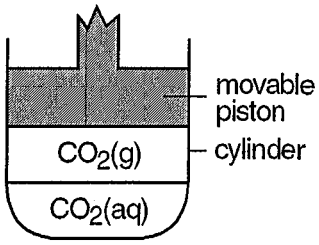
12) Based on the *Solubility Guidelines* chemistry reference table, which of these salts is the *best* electrolyte?

A) barium sulfate
B) sodium nitrate
C) magnesium carbonate
D) silver chloride

13) A solution that is at equilibrium must be

A) saturated
B) concentrated
C) unsaturated
D) dilute

14) Given the diagram below that shows carbon dioxide in an equilibrium system at a temperature of 298 K and a pressure of 1 atm:



Which changes must increase the solubility of the carbon dioxide?

A) decrease pressure and increase temperature
B) decrease pressure and decrease temperature
C) increase pressure and decrease temperature
D) increase pressure and increase temperature

15) As the pressure on the surface of a liquid decreases, the temperature at which the liquid will boil

A) increases
B) remains the same
C) decreases

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16) According to *Solubility Guidelines* chemistry reference table, which of these salts is *least* soluble in water?

A) RbCl
B) $FeCl_2$
C) $PbCl_2$
D) LiCl

17) Increasing the temperature increases the rate of a reaction by

A) lowering the frequency of effective collisions between reacting molecules
B) increasing the activation energy
C) lowering the activation energy
D) increasing the frequency of effective collisions between reacting molecules

18) In most aqueous reactions as temperature increases, the effectiveness of collisions between reacting particles

A) decreases
B) remains the same
C) increases

19) Given the reaction at 25DC:

$$Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$$

The rate of this reaction can be increased by using 5.0 grams of powdered zinc instead of a 5.0-gram strip of zinc because the powdered zinc has

A) more surface area
B) lower kinetic energy
C) more zinc atoms
D) lower concentration

20) According to *Vapor Pressure of Four Liquids* chemistry reference table, what is the vapor pressure of propanone at 45DC?

A) 98 kPa
B) 70. kPa
C) 22 kPa
D) 33 kPa

Questions 21 through 23 refer to the following:

A student uses 200 grams of water at a temperature of 60DC to prepare a saturated solution of potassium chloride, KCl.

21) Identify the solute in the solution described.

22) According to the *Solubility Curves* chemistry reference table, how many grams of KCl must be used to create the saturated solution described?

23) The solution described is cooled to 10DC and the excess KCl precipitates (settles out). The resulting solution is saturated at 10DC. How many grams of KCl precipitated out of the original solution?

Questions 24 and 25 refer to the following:

A safe level of fluoride ions is added to many public drinking water supplies. Fluoride ions have been found to help prevent tooth decay. Another common source of fluoride ions is toothpaste. One of the fluoride compounds used in toothpaste is tin (II) fluoride.

A town located downstream from a chemical plant was concerned about fluoride ions from the plant leaking into its drinking water. According to the Environmental Protection Agency, the fluoride ion concentration in drinking water cannot exceed 4 ppm. The town hired a chemist to analyze its water. The chemist determined that a 175-gram sample of the town's water contains 0.000 250 gram of fluoride ions.

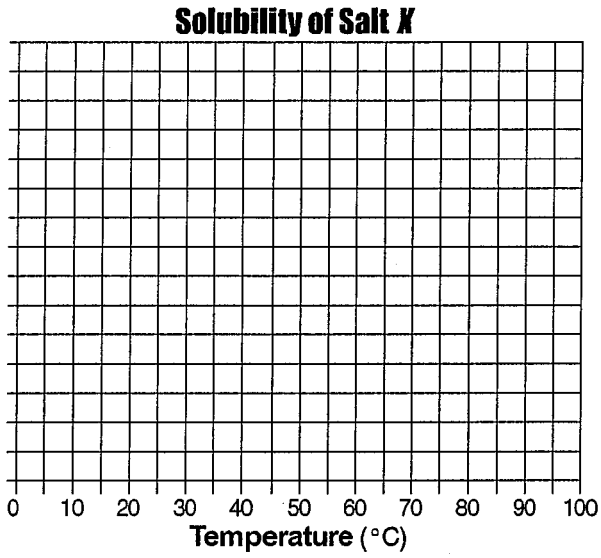
24) What is the chemical formula for tin (II) fluoride?

25) (a) How many parts per million of fluoride ions are present in the given analyzed sample?

(b) Is the town's drinking water safe to drink? [*Support your decision using information in the passage and your calculated fluoride level in part (a).*]

26) Given the data table below showing the solubility of salt *X*:

Temperature (°C)	Mass of Solute [per 100 g of H_2O (g)]
10	22
25	40.
30	48
60	107
70	135



(a) Which salt on the *Solubility Curves* chemistry reference table is most likely to be salt *X*?

(b) On the graph above, scale and label the y-axis including appropriate units.

(c) Plot the data from the data table. Surround each point with a small circle and draw a best-fit curve for the solubility of salt *X*.

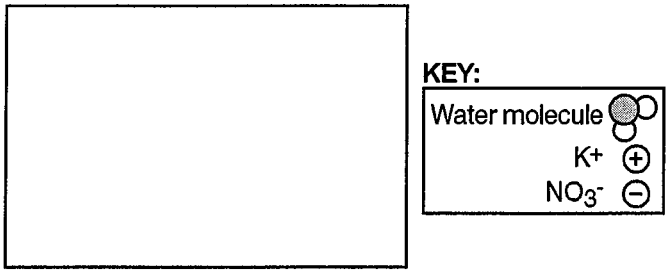
(d) Using the graph drawn in *part (b)*, predict the solubility of salt *X* at 50DC.

(e) If the pressure on the salt solution was increased, what effect would this pressure change have on the solubility of the salt?

27) The equation for the saturated solution equilibrium of potassium nitrate (KNO_3) is shown below.

$$KNO_3(s) + \text{energy} \underset{}{\overset{H_2O}{\rightleftharpoons}} K^+(aq) + NO_3^-(aq)$$

(a) Using the key below, diagram the products in the given box. [*Indicate the exact arrangement of the particles you diagram.*]



(b) Compare the rate of dissolving KNO_3 with the rate of recrystallization of KNO_3 for the saturated solution.

Name _____ Day/Period _____

Borax Crystal Ornaments

Objectives:
The objective of this lab is to learn how crystals are formed

Background:
Borax is sodium tetraborate ($Na_2B_4O_7$). It is used as a water softener, disinfectant, and laundry detergent. The Egyptians used borax in the mummification process. Beautiful, large crystals will form when borax is dissolved in water and allowed to crystallize.

Materials:
Large styrofoam cups, string, boiling water, borax, pipe cleaners, Popsicle sticks, safety goggles.

Procedure
1) Shape a pipe cleaner into a school-appropriate holiday shape. Make sure that it will fit into the cup without touching the sides of the cup.

2) Tie a piece of string to the pipe cleaner. Write your name on the Popsicle stick. Tie the string to the Popsicle stick so that the ornament does not touch the bottom of the container when the Popsicle stick is placed on top of the cup. The ornament should be below the level of the solution in the cup.

3) Take the ornament out of the cup. Obtain 80 cm^3 (approx 1/3 cup) of borax (one scoopful) in the cup. Add 240 mL of boiling water (approximately one cup) to the cup.

4) Stir until the borax dissolves completely. Place the ornament in the solution with the Popsicle stick across the top of the cup.

5) Place the cup in a place where it will not be disturbed for at least one day.

6) Remove the ornament from the solution and observe the crystals with a magnifying lens. Draw a picture of the crystal below.

7) The ornaments can be coated with clear nail polish to make them more durable. They are very fragile – be careful bringing them home!

Observations:

Draw a picture of a crystal of borax below:

Questions:
Look for answers in chemistry textbooks, reference books and the Internet. Do not look in a regular dictionary.

1) Define the following terms:
crystal –

crystallization –

solubility -

solute –

solvent –

unsaturated solution –

saturated solution –

supersaturated solution –

2) Why was hot water used to dissolve the borax? (Hint: How does temperature affect solubility?)

3) How are supersaturated solutions made?

4) Was the borax solution saturated, unsaturated, or supersaturated when it cooled down?

5) Why does the solute precipitate out of supersaturated solutions?

6) Why would crystallization eventually occur when an unsaturated solution in an open container is allowed to sit for a long time (days, weeks)?

Name_____ Brine Analysis Lab

Background: Syracuse is known as the "Salt City." During the 19th and early 20th centuries, the natural salt springs and wells in the Syracuse area were a major source of salt production in the United States

Assignment: You have been assigned the task of analyzing a brine (aqueous NaCl solution) sample taken from a well in the Tully, NY region. You need to determine the following information:

1. Density of the Brine sample
2. % composition of NaCl in the solution by mass
3. Moles of NaCl collected when done
4. Molarity of the Brine sample
5. Concentration is parts per million

Procedure:

Day One:

1. Obtain and put your name on a baby food jar with a sharpie marker.
2. Mass the dry empty food jar and record in data section below (to thousandths place).
3. Obtain exactly 25.0mL of the brine solution (use a graduated cylinder for this step first) and pour into the baby jar.
4. Mass the baby jar and it's contents(to thousandths place).
5. Place in the lab hood with the rest of your class

Day Two: (this will be more than a week or two later)

1. Mass your beaker and it's contents and record in the data section below (to thousandths place).
2. Scrape out your salt and place in the provided jar.
3. Scrub your beaker clean with soapy water and be sure to wash your name of the jar. Hang Jar to dry on the rack.

Data: Show all work here where necessary

Volume of brine used: _____

Mass Before: Mass of beaker and Brine:

-Mass of empty beaker: -_____

Mass of Brine:

Mass After: Mass of Beaker and salt:

-Mass of empty beaker: -_____

Mass of Salt remaining:

Name_____ Brine Analysis Lab

Calculations: PLEASE SHOW ALL WORK (all formulas are included here and are also located on the reference tables for Chemistry)

Original Volume of Brine: _____
Original Mass of Brine: _____

Mass of Salt remaining: _____

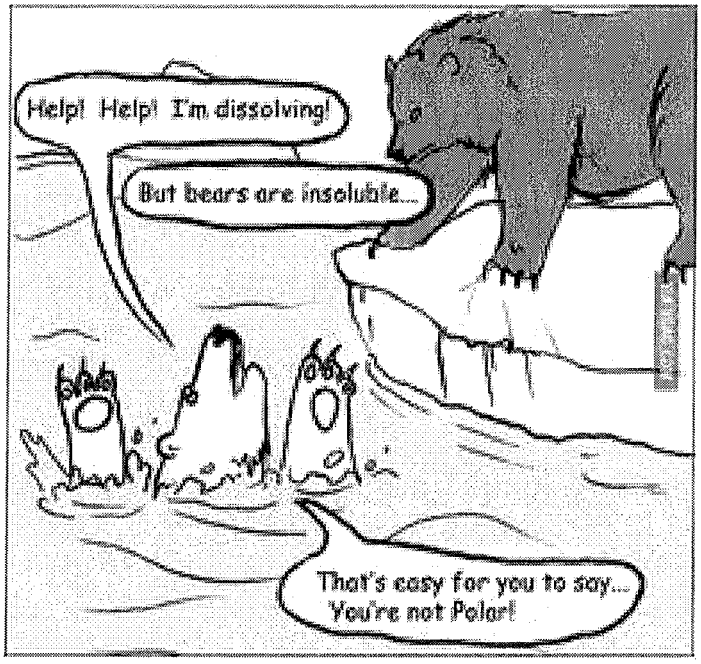
1. Density of Brine: (mass/volume)

2. %Composition of NaCl in solution by mass: (Part/whole)*100

3. Moles NaCl: (determined mass/gram formula mass)

4. Molarity of original brine sample: (Moles of solute/liters of solution)

5. Concentration is parts per million: (grams solute/grams solution) * 1,000,000



NOTE: Be sure you actually do study this year...Each night, put some time in and you will see the exponential growth of your knowledge that will help you on upcoming exams in this class.

Solutions

Mr. Gardner