Name:_____**Period:**_____
Ms. Randall
Unit 8: Solutions Workbook

The **bold, underlined** words are **important vocabulary words** that you should be able to define and use properly in explanations. This is a study guide for what you will be tested on throughout the year. The objectives are divided into categories of "**Knowledge**" (**what you have to *know***) and "**Application**" (**what you have to be able to *do***).

PHYSICAL BEHAVIOR OF MATTER – *AQUEOUS SOLUTIONS*		
	Knowledge	**Application**
1.	○ Physical processes, such as a compound dissolving in a solution, can be exothermic or endothermic.	○ Interpret ΔH values for physical processes given in Table I
2.	○ A **solution** is a homogeneous mixture of a solute dissolved in a solvent.	○ Identify the **solute** and the **solvent** in a given solution ○ Give examples of different types of solutions
	○ The solubility of a solute in a given amount of solvent is dependent on the temperature, the pressure, and the chemical natures of the solute and solvent. ○ General rules: a. solubility of a solid increases as temperature increases (direct relationship) b. solubility of a gas decreases as temperature increases (inverse relationship) c. solubility of a gas increases as pressure increases (direct) d. "like dissolves like" – polar solvents dissolve polar solutes; nonpolar solvents dissolve nonpolar solutes	○ Predict the effect of temperature, pressure, and nature of solvent on solubility for a given solute ○ Use a **solubility curve** to distinguish among **unsaturated**, **saturated**, and **supersaturated solutions** ○ Calculate the amount of a specific solute dissolved at different temperatures using Table G
3.	○ Many chemical reactions happen in solution. When different ionic compounds are mixed together in the same solution, a double replacement reaction may occur and a stable **precipitate** (insoluble/solid compound) may form.	○ Use Table F (Solubility Guidelines) to determine a compound's solubility ○ Determine if a precipitate will form when ionic compounds are mixed in solution ○ Write and balance chemical equations for double replacement reactions
4.	○ The **concentration** of a solution may be expressed as: **molarity (M)**, percent by volume (%v/v), percent by mass (%m/v), or **parts per million (ppm).**	○ Calculate solution concentrations in molarity (M), percent by volume, percent by mass, or parts per million (ppm) ○ Describe how you would prepare a solution from scratch, given the desired molarity ○ Describe how you would **dilute** a solution of known concentration (must use the equation $M_1V_1 = M_2V_2$)
5.	○ The addition of a **nonvolatile** solute to a solvent causes the boiling point of the solution to increase and the freezing point of the solution to decrease. ○ The greater the concentration of solute particles, the greater the	○ Compare the freezing and boiling points of solutions of different concentration

	increase in b.p. and decrease in f.p.	

Goal setting: Based upon your learning style results and the information above list at least two techniques you plan to use to study during this unit.

1.
2.

What grade would you like to achieve on this unit based on your efforts? _____%

Lesson 1: Chapter 13 Diary

Objective: To summarize concepts related to solutions and their properties

Directions: After reading the chapter diary answer the following questions.

Use the following terms to fill in the blanks: homogeneous, concentration(used twice), supersaturated, solvent, polar, solute, molarity solubility, saturated, non-polar, Van der Waals forces

A solution consists of a _____ mixture of two or more substances. A solution is made of two parts. The substance that is doing the job of dissolving the other substance is called the solvent. The substance that is being dispersed, or dissolved, is called the solute. Intermolecular forces such as _____ forces or hydrogen bonds hold the _____and solvent together. The similarities of structure and bonding between the solute and _____ determine the degree of _____ of the pair. "Like dissolves like", therefore a polar solvent will dissolve a _____molecule. A _____solvent will dissolve a non-polar molecule. Most solutions will become_____ once the solubility of the solute in the solvent has been reached. Solutions can become _____and are able to dissolve extra solute when environmental or physical characteristics change. _____is the amount of solute in a solution, measured as_____, ppm, mg/L, or percent. Dilution is a process used to lower the_____ of a solution by increasing its volume.

List 10 facts from the reading

List any questions you may have from your reading:

Lesson 2: Types of Solutions **Date:_____**

Objective: To determine type of solution based on solubility curve (reference table G). To compare and contrast factors affecting solubility.

Check your understanding:

1. How many grams of NaCl will dissolve in 100 g of H_2O at 90°C?

2. How many grams of KCl will dissolve in **50 g** of H_2O at 30°C?

3. How many grams of KCl will dissolve in **200 g** of H_2O at 30°C?

4. Is a solution that is made up of 100 grams of H_2O and 70 grams of
   a. KNO_3 at 50°C saturated, unsaturated, or supersaturated? Why?

5. What happens to the solubility of most solids and liquids when the temperature of the solvent increases?

6. What happens to the solubility of most gases when the temperature of the solvent increases?

7. What happens to the solubility of most solids and liquids when pressure is increased?

8. State whether it is soluble or insoluble

	Nonpolar Solvent	**Polar Solvent**
Nonpolar Solute		
Polar Solute		
***Ionic Solute (charges)**		

Practice:

A. State whether each of the following solutions is *saturated, unsaturated, or supersaturated*.

1. 80 g $NaNO_3$ in 100 g H_2O at 10ºC _____
2. 75 g $NaNO_3$ in 100 g H_2O at 10ºC_____
3. 90 g $NaNO_3$ in 100 g H_2O at 10ºC_____
4. 40 g KCl in 50 g H_2O at 60ºC _____
5. 35 g $NaNO_3$ in 50 g H_2O at 10ºC _____
6. 5 g $KClO_3$ in 50 g H_2O at 5ºC _____
7. 5 g $KClO_3$ in 200 g H_2O at 5ºC _____
8. 40 g SO_2 in 200 g H_2O at 5ºC _____

B. Use Reference Table G to answer the following questions:

1. How many grams of sodium nitrate will dissolve in 100g of water at 20˚C?

2. How many grams of sodium nitrate will dissolve in 100 g of water at 60˚C?

3. How many grams of ammonium chloride will dissolve in 1000 mL of water at 50˚C?

4. Ninety grams of potassium nitrate is added to 100 grams of water at 0˚C. To what temperature must the solution be raised to produce a saturated solution?

5. A saturated solution of potassium chlorate was made with 300 g of water at 40˚C. How much potassium chlorate could be recovered by evaporating the solution to dryness?

6. Five hundred grams of water are used to make a saturated solution of potassium nitrate at 10˚C. How many more grams of potassium nitrate could be dissolved if the temperature was raised to 50˚C?

7. A saturated solution of ammonia gas in 200 grams of water at 20˚C is heated to 50˚C. How much gas will come out of solution?

Lesson 3: Solubility of Ionic Compounds **Date:_____**

Objective: To determine solubility of an ionic substance using reference Table F.

Check your understanding:

3. ____ $Ca_3(PO_4)_{2\,(s)} \rightarrow$ ___ $Ca^{+}_{(aq)}$ + ___ $PO_4^{-}{}_{(aq)}$

Using Table F, determine whether the following are SOLUBLE or INSOLUBLE. Make sure to write the chemical formula first when appropriate.

NaCl	**K_3PO_4**	**i. calcium hydroxide**
$PbBr_2$	**$MgCO_3$**	**j. copper (II) hydroxide**
$CaSO_4$	**NH_4NO_3**	**k. lead(II) sulfate**

Practice

Complete the following double replacement reactions and then circle the precipitate formed.

1. $CaBr_2 + Na_2CO_3 \rightarrow$

2. $(NH_4)_2CO_3 + BaCl_2 \rightarrow$

3. $AgNO_3 + LiCl \rightarrow$

4. $Zn(CH_3COO)_2 + 2\ NaOH \rightarrow$

5. Lead (II) acetate and magnesium chromate

6. Sodium carbonate and silver nitrate

7. Potassium sulfate and calcium chlorate

8. Calcium chloride and sodium sulfide

Lesson 4: Concentration **Date:_____**

Objective: To calculate concentration in terms of Molarity, PPM % composition.

Check your understanding:

1. Calculate the molarity: (show your work)

   2.5 mol of NaOH in 0.500 L of solution

2. Calculate the total moles of solute:(show your work)

   1.7 L of 0.35M NaOH

3. Calculate the total grams of solute: (show your work)

   500 mL of 3.3-molar KNO_3

4. A student dissolves 85.0 g of KCl in 925 grams of water. What is the percent by mass of the solution?

5. A student prepares a solution by dissolving 80. mL of pure ethanol in enough water to make 2500 mL solution. What is the percent by volume of the ethanol solution?

Practice:

1. A solution is created with 3.5 moles of NaCl in 250mL of solution. Calculate the molarity.

2. A solution is created with 25.0 grams of NaCl in 1.0L of solution. Calculate the molarity.

3. A solution is created with 150 grams of NaCl in 1250mL of solution. Calculate the molarity.

4. For questions 1-4 which was the most concentrated solution? _____ The most dilute? _____

Percent composition:

1. Calculate the percent by mass of 25.0 grams of NaCl in 150 grams of solution.

2. Calculate the percent by volume of 150mL of ethanol in 1250mL of water.

Parts Per Million:

1. Calculate the parts per million of 2.0 grams of NaCl in 15000 grams of solution.

2. Calculate the parts per million of 1.50 grams of NaCl in 8000 grams of water.

Fun to think about: If you are the only person who wins the Mega millions and 259 million people play, what is your part per million?

Lesson 5: Colligative Properties of Solutions **Date:_____**

Objective: To determine the effects of dissolved solute on boiling and freezing points.

Check your understanding:

1. A property that depends on the number of solute particles (concentration) is said to be a _____ property.

2. Which of the following 1 M solutions will have the lowest freezing point?
   a. KOH c. $C_6H_{12}O_6$
   b. $C_6H_{12}O_6$ d. $C_{12}H_{22}O_{11}$

3. Which would produce the greatest increase in boiling point?
   a. 1 mole of a nonelectrolyte dissolved in 500mL of water
   b. 2 moles of a nonelectrolyte dissolved in 500mL of water
   c. 1 mole of a electrolyte dissolved in 500mL of water
   d. 2 moles of a electrolyte dissolved in 500mL of water

4. Which salt, NaCl or $CaCl_2$, has a greater effect on freezing point? Explain why.

5. As the Molarity of a solution increases, the boiling point of the solution_____.(increases/decreases)

6. What colligative property is responsible for antifreeze keeping water from
   a. Freezing in a car's cooling system? _____(boiling point elevation/freezing point depression)

Practice:

1. Which solution has the highest boiling point?
   (a) 0.5 M NaCl
   (b) 0.5 M $CaCl_2$
   (c) 1.0 M $(NH_4)_3PO_4$
   (d) 2.0 M CH_3OH

2. Which solution has the highest boiling point?
   (a) 1.0 M KNO_3
   (b) 2.0 M KNO_3
   (c) 1.0 M $Ca(NO_3)_2$
   (d) 2.0 M $Ca(NO_3)_2$

3. Which solution has the *lowest* freezing point?
   (a) 10. g of KI dissolved in 100. g of water
   (b) 30. g of KI dissolved in 100. g of water
   (c) 20. g of KI dissolved in 200. g of water
   (d) 40. g of KI dissolved in 200. g of water

4. As water is added to a 0.10 M NaCl aqueous solution, the conductivity of the resulting solution
   (a) decreases because the concentration of ions decreases
   (b) decreases, but the concentration of ions remains the same
   (c) increases because the concentration of ions decreases
   (d) increases, but the concentration of ions remains the same

5. Which aqueous solution of KI freezes at the lowest temperature?
   (a) 1 mol of KI in 500. g of water
   (b) 2 mol of KI in 500. g of water
   (c) 1 mol of KI in 1000. g of water
   (d) 2 mol of KI in 1000. g of water

6. Compared to a 2.0 M aqueous solution of NaCl at 1 atmosphere, a 3.0 M aqueous solution of NaCl at 1 atmosphere has a
   (a) lower boiling point and a higher freezing point
   (b) lower boiling point and a lower freezing point
   (c) higher boiling point and a higher freezing point
   (d) higher boiling point and a lower freezing point

7. Based on Reference Table F, which of these saturated solutions has the lowest concentration of dissolved ions?
   (a) NaCl(aq) (b) $MgCl_2$(aq) (c) $NiCl_2$(aq) (d) AgCl(s)

8. Compared to a 0.1 M aqueous solution of NaCl, a 0.8 M aqueous solution of NaCl has a

   (a) higher boiling point and a higher freezing point
   (b) higher boiling point and a lower freezing point
   (c) lower boiling point and a higher freezing point
   (d) lower boiling point and a lower freezing point

9. Which of the following 1 molar aqueous solution will have the highest boiling point?

(a) NaCl (aq) (b) $C_6H_{12}O_6$ (c) K_3PO_4 (d) $Cu(NO_3)_2$

10. Which of the following 1 molar aqueous solution will have the lowest boiling point?

(a) NaCl (aq) (b) $C_6H_{12}O_6$ (c) K_3PO_4 (d) $Cu(NO_3)_2$

11. Which of the following 1 molar aqueous solution will have the highest freezing point?

(a) NaCl (aq) (b) $C_6H_{12}O_6$ (c) K_3PO_4 (d) $Cu(NO_{3)2}$

12. Which of the following 1 molar aqueous solution will have the lowest freezing point?

(a) NaCl (aq) (b) $C_6H_{12}O_6$ (c) K_3PO_4 (d) $Cu(NO_3)_2$

13. Which of the following aqueous solutions will have the highest boiling point?

(a) 500 g solute in 1000 g solvent (b) 500 g solute in 500 g solvent
(c) 1000 g solute in 500 g solvent (d) 1000 g solute in 1000 g solvent

14. Which of the following aqueous solutions will have the lowest boiling point?

(a) 500 g solute in 1000 g solvent (b) 500 g solute in 500 g solvent
(c) 1000 g solute in 500 g solvent (d) 1000 g solute in 1000 g solvent

15. Which of the following aqueous solutions will have the highest freezing point?

(a) 500 g solute in 1000 g solvent (b) 500 g solute in 500 g solvent
(c) 1000 g solute in 500 g solvent (d) 1000 g solute in 1000 g solvent

16. Which of the following aqueous solutions will have the lowest freezing point?

(a) 500 g solute in 1000 g solvent (b) 500 g solute in 500 g solvent
(c) 1000 g solute in 500 g solvent (d) 1000 g solute in 1000 g solvent

Real World Application **Due date: _____**

Directions: All answers are to be written **neatly** on a separate sheet of paper to be handed in.

1. 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.

a. Draw a Lewis electron-dot diagram for a fluoride ion.

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

c. How many parts per million of fluoride ions are present in the analyzed sample?

d. Is the town's drinking water safe to drink? Support and explain your decision using information in the passage and your calculated fluoride level in question c. (paragraph)

2. Lead is a heavy metal that is found in car batteries. If they are disposed of in the dump, they can leach the lead out and contaminate the ground water. The EPA has been called in to test the water around one particular dump and found that every 1000. g of groundwater tested contains 0.00027 grams of lead. The EPA's legal limit on lead concentration is 0.015 ppm. Does the dump site break the legal limit? Show your work.

3. The health of fish depends on the amount of oxygen dissolved in the water. A dissolved oxygen (DO) concentration between 6 parts per million and 8 parts per million is best for fish health. A DO concentration greater than 1 part per million is necessary for fish survival. Fish health is also affected by water temperature and concentrations of dissolved ammonia, hydrogen sulfide, chloride compounds, and nitrate compounds.

A student's fish tank contains fish, green plants, and 3800 grams of fish-tank water with 2.7×10^{-2} gram of dissolved oxygen.

a.) State how an increase in the temperature of the fish-tank water affects the solubility of oxygen in the water.

b.) Determine if the DO concentration in the fish tank is healthy for fish. Your response must include:

- a correct numerical setup to calculate the DO concentration in the water in parts per million and the calculated result
- a statement using your calculated result that tells why the DO concentration in the water is or is not healthy for fish.

Unit Study Guide

Law, Theories, BIG ideas	**Equations, Calculations, Reference Tables**
Laws:	Equation: (When to use & units)
Theories:	Calculations (When to use)
BIG ideas:	Reference Table (Hints & tricks)

Helpful tips, sayings, shortcuts

Things I always forget…

Unit Review: Solutions

Place a checkmark next to each item that you can do! If a sample problem is given, complete it as evidence.

_____1. I can still do everything from Unit 1.	
_____2. I can still do everything from Unit 2.	
_____3. I can still do everything from Unit 3.	
_____4. I can still do everything from Unit 4.	
_____5. I can still do everything from Unit 5.	
_____6. I can still do everything from Unit 6.	
_____6. I can still do everything from Unit 7.	
_____7. I can define: solute, solvent, solution, and solubility.	**Definitions:** solute solvent solution solubility
_____8. I can describe the trend in solubility for solids as the temperature changes.	As the temperature increases, the solubility of a solid _____.

_____9. I can describe the trend in solubility for gases as the temperature changes.	As the temperature increases, the solubility of a gas _____.
_____10. I can use Reference Table F to determine if a substance will be soluble in water.	Write "S" for **soluble** and "NS" for **not soluble**. Use Reference Table F to determine the solubility of the following compounds: _____potassium chlorate _____silver bromide _____lithium carbonate _____calcium carbonate
_____11. I can use Table G to determine how much solute to add at a given temperature to make a saturated solution.	How many grams of $KClO_3$ must be dissolved in 100 grams of water at 20^{o}C to make a saturated solution?
_____12. I can use Table G to determine if a solution is saturated, unsaturated, or supersaturated.	If 20.0 g of $NaNO_3$ are dissolved in 100.0 g of water at 25.0^{o}C, will the resulting solution be saturated, unsaturated, or supersaturated?
_____13. I can define: dilute, concentrated, concentration, and electrolyte.	**<u>Definitions:</u>** dilute concentrated concentration electrolyte

_____14. I can interpret Table G to determine which solution is the most concentrated or the most dilute.	Which solution is most concentrated? A) 125.0 g of KI dissolved in 100.0 g of water at 10^oC B) 70.0 g of NH_4Cl dissolved in 100.0 g of water at 70^oC C) 120.0 g of KNO_3 dissolved in 100.0 g of water at 70^oC D) 30.0 g of SO_2 dissolved in 100.0 g of water at 90^oC
_____15. I can use Reference Table T to calculate the concentration of a solution in ppm.	What is the concentration, in ppm, of a 2600 g of solution containing 0.015 g of CO_2?
_____16. I can use Reference Table T to calculate the concentration of a solution in molarity.	What is the molarity of 3.5 moles of NaBr dissolved in 500 mL of water?
_____17. I can determine how matter will be separated using filtration.	When a mixture of sand, salt, sugar, and water is filtered, what passes through the filter?
_____18.I can describe how matter can be separated using distillation.	Which physical property makes it possible to separate the components of crude oil by means of distillation?
_____19. I can state which separation process (decanting, filtering, distilling, chromatography, or evaporating) is best for a given situation.	To separate a mixture of salt and water, the best method of separation would be_____. To separate a mixture of ethanol and water, the best method of separation would be _____. To separate a mixture of food coloring dyes, the best method of separation would be _____. To separate a mixture of oil and water, the best method of separation would be_____.

___20. I can determine the effects of a solute on the melting and boiling points.	Compared to pure water, an aqueous solution of calcium chloride has a A) higher boiling point and higher freezing point B) higher boiling point and lower freezing point C) lower boiling point and higher freezing point D) lower boiling point and lower freezing point