Regents Chemistry: Dr. Shanzer

Practice Packet

Chapter 11: Solutions



Regents Chemistry VOCAB - Solutions

Name _

Chapter 7

- 1. Alloy a homogenous mixture/solution containing at least one metal. Ex: brass, steel, bronze
- 2. Aqueous a homogenous mixture/solution in which a solute is dissolved in water.
- **3.** Boiling Point the temperature at which a liquid undergoes a phase change from liquid to gas; the temperature at which the vapor pressure of a liquid is equal to the atmospheric pressure.
- **4.** Boiling Point Elevation the boiling point of a solution is higher than the boiling point of the pure solvent (colligative property)
- **5.** Colloid a heterogeneous mixture composed of tiny particles suspended in another material. The particles are larger than the particles in a solution but smaller than particles in a suspension. Ex: milk, blood
- 6. Concentrated Having a relatively large amount of substance present in a unit amount of mixture. For example, a 12 M HCl solution is more concentrated than an 0.001 M HCl solution.
- 7. Concentration A measure of the amount of solute present in a unit amount of mixture. (Ex: ppm = parts per million, molarity = moles solute/liter solution); the process of increasing the amount of substance in a given amount of mixture.
- 8. Dilute having a relatively low concentration of solute in a mixture.
- **9. Freezing Point Depression** the freezing point/melting point of a solution is lower than the freezing point/melting point of the pure solvent (colligative property)
- 10. Heterogeneous A sample of matter consisting of more than one pure substance and more than one phase
- 11. Homogeneous A sample of matter consisting of more than one pure substance with properties that do not vary within the sample
- 12. Insoluble Refers to a substance that does not dissolve in a solvent to any significant degree
- **13. Miscible** Two liquids are considered "miscible" or mixable if shaking them together results in a single liquid phase with no visible separation
- 14. Mixture two or more pure substance PHYSICALLY combined; a combination of two or more pure substances that can be separated by physical means
- 15. Molarity a measure of concentration; M = moles of solute/liters of solution
- 16. Parts Per Million a measure of concentration; ppm = parts of solute/million parts of solution
- 17. Percent Composition (by mass or volume) % comp = (part/whole) × 100
- **18. Precipitate** An insoluble substance that has been formed from a chemical reaction between substances dissolved in a solution
- **19. Saturated** a solution that has reached equilibrium; a solution which can not dissolve any more solute
- **20.** Solubility a measure of the concentration of a substance in a saturated solution; a measure of how much of a substance can dissolve in a given amount of solvent

- 21. Soluble capable of being dissolved in a solvent
- 22. Solution a homogenous mixture
- 23. Solute A substance dissolved in a solvent to make a solution
- 24. Solvent The most abundant component in a solution
- **25. Supersaturated** a solution in which the concentration of solute is higher than the solubility; more solute is dissolved than should be under a given set of conditions
- **26.** Suspension A heterogenous mixture in which relatively large particles are suspended in a liquid
- 27. Tyndall Effect Light passing through a colloid is scattered by suspended particles (the light beam becomes clearly visible)
- **28. Unsaturated** A solution with a concentration lower than its equilibrium solubility; a solution in which more solute can be dissolved

What are Solutions?

Chemistry 200 Video Lesson 11.1

Objective:

How do we recognize the parts of a solution, its characteristics and the difference between dissolving and dissociation?

Solution Chemistry

Solution - a homogeneous mixture of substances

- contains atoms, ions or molecules of one substance spread evenly throughout a 2nd substance

Homogeneous mixture

- a mixture whose composition is consistent throughout

Parts of a Solution:

1. <u>Solute</u> - substance being dissolved, present in a smaller amount

 $\begin{array}{c} 2. \ \underline{Solvent} \\ \text{ substance that dissolves the solute,} \\ \text{ present in a greater amount} \\ (\text{H}_2\text{O is a common solvent, Alcohol in H}_2\text{O}) \end{array}$

 $(aq) = an H_2 0$ solution

Tyndall Effect

• light scatters in a colloid but will not scatter in a true solution. This effect is used to determine whether a mixture is a true solution or a colloid.



Colloids are common materials with one material evenly distributed within another material on a very tiny scale.

Ex: milk, fog, jelly, styrofoam and whipped cream



Solution Characteristics

- 1. Solutions are homogeneous mixtures
- 2. Solutions are <u>clear</u> & <u>will not disperse light</u>
- 3. Solutions can have color
- 4. Solutions will not settle after standing
- 5. Solutions will pass through a filter

Dissolving vs. Dissociation

<u>Dissolving</u> - a general term used when a substance is placed into a solvent (H_2O) and broken down into smaller pieces; the substance may seem to not exist anymore.

<u>Dissociation</u> (ionization) - an ionic molecule separates into 2 or more ions; usually by dissolving an ionic compound in $H_2O \rightarrow$ no new substances formed

$$NaCl_{(s)} \xrightarrow{H_2O} Na^{+1}_{(aq)} + Cl^{-1}_{(aq)}$$

$$Al_2(SO_4)_{3(s)} \xrightarrow{H_2O} 2 Al^{+3}_{(aq)} + 3 SO_4^{-2}_{(aq)}$$

What is an electrolyte?

- Compounds that conduct electricity in solution due to mobile charged ions. They must dissociate!!
- This type of solution will cause a bulb to glow brightly.
- If the compound does not conduct in solution, it is called a *nonelectrolyte*.



Solute	<u>Solvent</u>	<u>Solution</u>	<u>Examples</u>
Gas	Gas	Gas	Air
Solid	Liquid	Liquid	Salt H ₂ O, Sugar H ₂ O
Liquid	Liquid	Liquid	Alcohol in H ₂ O
Gas	Liquid	Liquid	Carbonated H ₂ O Aquarium> O _{2(g)}
Solid	Solid	Solid	"Gold & Silver" Jewelry Steel, each is an Alloy







Different Cypes of Solutions Unsaturated Can dissolve more solute Saturated contain the maximum solute that will dissolve at a specified temperature A dynamic equilibrium. Rate of dissolving is equal to rate of precipitation Supersaturated contains more than the saturated amount of solute. Dissolve solute at elevated temps





















"Like Dissolves	Like"	
	Nonpolar Solvent	Polar Solvent
Nonpolar Solute	SOLUBLE	INSOLUBLE
Polar Solute	INSOLUBLE	SOLUBLE
*lonic Solute (charges)	INSOLUBLE	SOLUBLE































Objective:

How are physical properties such as boiling point, freezing point and vapor pressure effected by the number of solute particles in solution or solute concentration?



the greater the number of solute particles in a solvent, the lower the vapor pressure will be
 Atmospheric pressure pressure pressure pressure pressure for the vapor pressure of the vapor pressur





Counting Particles

- A. The influence of solute particles depends only on the number of particles.
- B. Molecular and ionic compounds will produce *different* numbers of particles per mole of substance.

1 mole of a molecular solid → 1 mole of particles C₁₂H₂₂O_{11(s)} → C₁₂H₂₂O_{11(aq)}
1 mole of an ionic solid → 2 moles of particles NaCl_(s) → Na⁺¹_(aq) + Cl⁻¹_(aq)
1 mole of an ionic solid → 3 moles of particles MgCl_{2(s)} → Mg⁺²_(aq) + 2 Cl⁻¹_(aq)
The more moles of particles produced, the more effect it has on F.P. and B.P.



Sketch Notes

Sketch Notes

Solubility of Gases

Guiding Question: How does a change in temperature affect the solubility of gases?

Figure 1.



Pre-Demonstration Questions

1. What substance makes Coca-Cola bubbly?

Demonstration/ Phenomenon: Record your observations as the soda is placed into different temperatures of water.

	Temperature in °C	Observations
Cold Water		
Room Temperature		
Hot Water		

Model: Model what you think is going on in the three beakers. Be sure to include labels, particles and/or energy flow arrows.

Video 11.1: What are solutions? Answer the following questions

	or energeneeting	ng questions			
1.	In an aq	ueous solutio	n of potassium	chloride, the solute is	
	1) K	2) Cl	3) KCl	4) H ₂ O	
	,	,	,	, _	
2.	Which s	ample of mat	ter is classified	as a solution?	
	$1) H_2(1)$	2) $H_2O(1)$	3) (.O ₂ (g)	4) $(0_2 (a_1))$	
	1) 1120 (0)	2) 1120 (1)	0) 002(6)	1) 002 (00)	
3.	Which f	ormula repres	sents a homog	eneous mixture?	
0.	$1) H_2(1)$	2) HCl (an)	3 NaH (s)	4) $H_{2}S(\sigma)$	
	1) 1120 (1)	2) 1101 (uq)	5) Hull (5)	1) 1120 (8)	
4	In a true	solution the	dissolved part	ticles	
1.	1 are vi	sible to the ev			
	$\begin{array}{c} 1. & \text{are vi}\\ 2 & \text{will } \end{array}$	ottle out on st	anding		
	2. will settle out on standing				
	3. are always solids				
	4. canno	t be removed	by intration		
-	1471 - 1	C 11 C 11 ·			
5.	Which o	f the followin	g is a solution:		
	1. tables	salt 2. s	teel 3. wa	ater 4. mercury	
6.	Give an e	example of a se	olution for eac	h of the following:	
	<u>Solute</u>		<u>Solvent</u>		
	1. gas		gas	\rightarrow	
	2. solid		liquid	\rightarrow	

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3.	liquid	liquid	\rightarrow
4.	gas	liquid	\rightarrow
5.	solid	solid	\rightarrow

- 7. How is dissociation different than dissolving? What type of substances dissociate?
- 8. Which of the following is considered an electrolyte? 1. H_2O 2. CH₃OH 3. $MgCl_2$ 4. CCl₄
- 9. On the line at the right, write the number of the definition that best matches each term.
 - a) solution _____
 - b) solute _____ 2) solution with water as the solvent
 - c) solvent _____ 3) substance that is dissolved in a solution d) soluble _____
 - 4) solid solution containing two or more metals

1) capable of being dissolved

- e) aqueous solution ____
 - 5) homogeneous mixture of two or more substances in a single physical state
- f) alloy _____
- 6) substance that does the dissolving in a solution

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Video 11.2: Factors that Affect Solubility & Table G The solubility of solid solutes generally increases as temperature increases, while the solubility of gaseous solutes generally decreases as temperature increases. A solution that holds as much solute as can dissolve at a given temperature is saturated. A solution that can dissolve more solute at a given temperature is unsaturated. A solution that holds more solute than can dissolve at a given temperature is supersaturated. The amount of solute that is needed to form a saturated solution at various temperatures can be graphed. This is what is shown in Table G. The values in Table G are based on solute dissolved in 100 g of water. Since water has a density of 1 g/mL, the graph can be based on 100 mL of water. A 200 mL sample of water would be able to dissolve twice as much at each temperature. Answer the questions below based on Table G. 1. The compound which is most soluble at 20°C 2. The compound which is least soluble at 10°C 3. The compound which is least soluble at 80°C 4. How many grams of potassium nitrate are needed to saturate 100 ml of water at 70°C? 5. Write the 3 formulas for the compounds that have an inverse relationship between temperature and solubility. _____, ____, _____& _____ 6. Which 2 salts have the same solubility at 71°C? _____ & _____ For each question an amount of solute is given and a temperature is stated. If all the solute could be dissolved in 100g of water at the stated temperature, would the resulting solution be unsaturated, saturated or supersaturated? 7. 70 g of KCl at 60°C 8. 90 g of KNO₃ at 70°C 9. 110 g of NaNO₃ at 45°C 10.5 g of KClO₃ at 10°C 11.60 g of NH₃ at 80°C For each question a solute and temperature are given. Tell how many grams of each solute must be added to 100g of water to form a saturated solution. 12. NaNO₃ at 40°C 13. KClO₃ at 80°C 14. KNO₃ at 45°C 15. KCl at 50°C

16. NaCl at 90°C

 $17.\,If\,50~g$ of $KClO_3$ are added to 100~g of water at $10^\circ C$, how many grams do not dissolve?

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1. Which compound becomes *less* soluble in water as 6. At room temperature, the solubility of which the temperature of the solution is increased? solute in water would be most affected by a change in pressure? 1) HCl 2) KCl 1) methanol 3) NaCl 4) NH₄Cl 2) sugar 3) carbon dioxide 4) sodium nitrate 2. An unsaturated aqueous solution of NH₃ is at 90°C in 100. grams of water. According to Reference 7. What is the total mass of KNO₃ that must be Table G, how many grams of NH_3 could this dissolved in 50. grams of H₂O at 60.°C to make a unsaturated solution contain? saturated solution? 2) 10. g 3) 15 g 4) 20. g 1) 32 g 2) 53 g 3) 64 g 4) 106 g 1) 5 g 3. According to your Reference Tables, which 8. What is the mass of NH4Cl that must dissolve in substance forms an unsaturated solution when 80 200. grams of water at 50.°C to make a saturated grams of the substance is dissolved in 100 grams solution? of H₂O at 10°C? 1) 26 g 2) 42 g 3) 84 g 4) 104 g 1) KI 2) KNO₃ 9. An unsaturated solution is formed when 80. grams 3) NaNO₃ 4) NaCl of a salt is dissolved in 100. grams of water at 40.°C. This salt could be 4. The solubility of KCl(s) in water depends on the 1) KCl 2) KNO₃ 1) pressure on the solution 2) rate of stirring 3) NaCl 4) NaNO₃ 3) size of the KCl sample 10. A solution contains 35 grams of KNO3 dissolved 4) temperature of the water in 100 grams of water at 40°C. How much more KNO₃ would have to be added to make it a 5. Under which conditions of temperature and saturated solution? pressure is a gas most soluble in water? 1) 29 g 2) 24 g 3) 12 g 4) 4g 1) high temperature and low pressure 2) high temperature and high pressure 3) low temperature and low pressure 4) low temperature and high pressure

131

18. What mass of NH₄Cl would be needed to form a saturated solution if the NH₄Cl was dissolved in 200 g of water at 50°C?

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- 19. What mass of NaCl would be needed to form a saturated solution at 30°C if the NaCl was dissolved in 35 g of water?
- 20. At what temperature would you need 100g of water to dissolve 70g NH₄Cl?
- 21. A supersaturated solution of NaNO₃ is created by adding 120 g of NaNO₃ to 100 g of water at 20^oC. If the solution is disrupted, how many grams of solid NaNO₃ will "fall out" (will not dissolve) of the solution?

Video 11.3: Double Replacement Reactions & Table F

- 1. Which barium salt is insoluble in water?
 - 1. BaCO₃
 - 2. BaCl₂
 - 3. Ba(ClO₃)₂
 - 4. $Ba(NO_3)_2$
- 2. Which compound is insoluble in water?
 - 1. Calcium bromide
 - 2. Potassium bromide
 - 3. Silver bromide
 - 4. Sodium bromide
- 3. Based on reference table F, which salt is least soluble?
 - 1. FeCO₃
 - 2. Na₂CO₃

Ions That Form Soluble Compounds	Exceptions	Ions That Form Insoluble Compounds*	Exceptions	
Group 1 ions (Li*, Na*, etc.)	1	carbonate (CO ₃ ²⁻)	when combined with Group 1 ions or ammonium (NH_4^+)	
ammonium (NH ₄ ⁺)		chromate (CrO42-)	when combined with Group 1 ions, Ca^{2+} , Mg^{2+} , or ammonium (NH ₄ ⁺)	
nitrate (NO ₃ ⁻)				
acetate ($C_2H_3O_2^-$ or CH_3COO^-)		phosphate (PO ₄ ³⁻)	when combined with Group 1 ions or ammonium (NH4+)	
hydrogen carbonate (HCO ₃ ⁻)	1	sulfide (S ²⁻)	when combined with Group 1 ions or ammonium (NH4 ⁺)	
chlorate (ClO ₃ ⁻)	And the second second second	hydroxide (OH ⁻)	when combined with Group 1	
halides (Cl ⁻ , Br ⁻ , I ⁻)	when combined with Ag^+ , Pb^{2+} , or Hg_2^{2+}		ions, Ca ²⁺ , Ba ²⁺ , Sr ²⁺ , or ammonium (NH ₄ *)	
sulfates (SO $_4^{2-}$)	when combined with Ag ⁺ , Ca ²⁺ , Sr ²⁺ , Ba ²⁺ , or Pb ²⁺	*compounds having very low	solubility in H ₂ O	

3. BaCl₂

4. $CaCl_2$

Table F Solubility Guidelines for Aqueous Solutions

11.3 Table F Practice

 1. Which compound is insoluble in water? 1) calcium bromide 		6	. The attraction ¹ ⁺ ion or a Cl ⁻ i	between on occurs	water molecules and s because water mo	nd an Na	
2) pota	sium bromi	de		1) linear	2) symmetrical	
3) silve4) sodi	im bromide			3) polar	4) nonpolar	
2. Which	parium salt is	sinsoluble in water?	7	. According to R	Reference	Table F, which co	mpound
1) BaC	O3	2) BaCl ₂		$1) \mathbf{D}_{\mathbf{a}} \mathbf{C} \mathbf{O}_{\mathbf{a}}$		$\frac{1}{2}$	
3) Ba(0	2103)2	4) Ba(NO ₃) ₂		 BaCO3 ZnCO3 	4	$\frac{1}{2} \operatorname{SO}_{4}$	
- 3. Which , forms	on, when con an insoluble	mbined with chloride ions, Cl- substance in water?	8	. Which compou	and is mo	st soluble in water	?
1) Fe ²⁺	2) Mg ²⁺	3) Pb ²⁺ 4) Zn ²⁺		 silver sulfat silver nitrat 	te 2 e 4	c) silver chloridec) silver hydroxide	2
4. Based of saturate	n Reference d solutions h	Table <i>F</i> , which of these as the lowest concentration of	9	. Which compou	and is ins	oluble in water?	
dissolve	d ions?			1) KOH	2	2) NH4Cl	
1) NaC	l(aq)	2) MgCl ₂ (aq) (A) $A = Cl(a = a)$		3) Na ₃ PO ₄	4) PbSO ₄	
5) NIC	2(aq)	4) AgCI(aq)	1	0. According to	Table F,	which ions combir	ne with
5. Accord	ng to Refere	nce Table F, which substance		chloride ions	to form a	in insoluble compo	ound?
is most	soluble?			1) Fe^{2+} ion		2) Ca^{2+} ions	
1) AgI		2) CaSO ₄		3) Li^+ ions		4) Ag ⁺ ions	
3) PbC	2	4) (NH4)2CO3					



Table F can also be used to write balanced equations for the following double replacement reactions. Complete, *balance and circle the precipitate in the following reactions.*

NOTE:

- A soluble compound is followed by the symbol (aq)
- The formation of an insoluble compound (precipitate) is indicated with a (s)
- If no precipitate forms, no reaction occurred between the ions dissolved in solution.

1. _____ Li₃PO_{4 (aq)} + ____NH₄Br_(aq) \rightarrow

2. ____ FeCl_{2(aq)} + ____ KOH (aq) \rightarrow

- 3. $__MgCl_{2(aq)} + __CsCl_{(aq)} \rightarrow$
- 4. ____ Al(ClO₃)_{3 (aq)} + ____ MgSO_{4 (aq)} \rightarrow
- 5. $Na_2CO_3_{(aq)} + Ba(ClO_3)_2_{(aq)} \rightarrow$
- 6. ____ Ca(OH)_{2(aq)} + ____ Al(NO₃)_{3 (aq)} -->
- 7. ____K_3PO_{4 (aq)} + ___Cs₂S_(aq) \rightarrow
- 8. $_$ CaCrO_{4 (aq)} + $_$ (NH₄)₂CO_{3 (aq)} \rightarrow



11.4 Molarity Practice:

Directions: Solve the following problems. Include the equation used and show all work. Please state the answer to the correct number of significant figures and box all answers with proper units.

1. What is the molarity of a solution that contains 0.40 moles of KBr in 0.50 L of solution?

2. If you have 5.0 moles of NaCl in a 2.0 L solution, what is the molarity of the solution?

3. If you have 60. moles of HCl, what should the total volume of the solution be to make a 10. M solution of HCl_(aq).

6. What is the molarity of a solution that contains 65.1 g of NH₄Cl in 3.50 L of solution?

Video 11.4: Concentration

Perform the following calculations and express your answers using the proper units and the correct amount of significant figures. Be sure to show work for credit.

- 1. What is the percent by mass of a solution that contains 47.8 g of KOH dissolved in enough water to produce 293 g of solution?
- 2. What is the percent by mass of a solution that contains 5.61 g of H_2SO_4 dissolved in 142 g of H_2O

3. How many grans of KNO_3 must be dissolved in 325 g of solution, if the solution contains 14% by mass of KNO_3

4. What is the concentration of a solution in parts per million that contains 0.118 g of $C_{12}H_{22}O_{11}$ dissolved in 237 g of solution?

- 5. What is the concentration of a solution in parts per million that contains 0.472 g of $\rm Li_3PO_4$ dissolved in 598 g of $\rm H_2O$
- 6. How many grams of MgF_2 must be dissolved in water to produce 306 g of a 14.5 ppm solution

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Name:

 1. The molarity of an aqueous solution of NaCl is defined as the 1) grams of NaCl per liter of water 2) grams of NaCl per liter of solution 3) moles of NaCl per liter of water 4) moles of NaCl per liter of solution 	 7. What is the total mass of solute in 1000. grams of a solution having a concentration of 5 parts per million? 1) 0.005 g 2) 0.05g 3) 0.5 g 4) 5g
 2. What is the molarity of 1.5 liters of an aqueous solution that contains 52 grams of lithium fluoride, LiF, (gram-formula mass = 26 grams/mole)? 1) 1.3 M 2) 2.0 M 4) 0.75 M 	 8. What is the concentration of O₂(g), in parts per million, in a solution that contains 0.008 gram of O₂(g) dissolved in 1000. grams of H₂O(l)? 1) 0.8 ppm 2) 8 ppm 4) 800 ppm
 3. A 3.0 M HCl(aq) solution contains a total of 1) 3.0 grams of HCl per liter of water 2) 3.0 grams of HCl per mole of solution 3) 3.0 moles of HCl per liter of solution 4) 3.0 moles of HCl per mole of water 	 9. What is the concentration of a solution, in parts per million, if 0.02 gram of Na₃PO₄ is dissolved in 1000 grams of water? 1) 20 ppm 3) 0.2 ppm 2) 2 ppm 4) 0.02 ppm
 4. How many total moles of KNO₃ must be dissolved in water to make 1.5 liters of a 2.0 M solution? 1) 0.50 mol 2) 2.0 mol 4) 1.3 mol 	 10. What is the molarity of a solution containing 20 grams of NaOH in 500 milliliters of solution? 1) 1 M 2) 2 M 4) 0.5 M
 5. What is the total number of grams of Nal(s) needed to make 1.0 liter of a 0.010 M solution? 1) 0.015 2) 0.15 4) 15 	
 6. Which unit can be used to express the concentration of a solution? 1) L/s 2) J/g 3) ppm 4) kPa 	

Video 11.5: Colligative Properties

Complete the following reactions and balance

- 1. How many particles are formed when 1 molecule of each of the following substances is dissolved in 1000g of H_2O ?
 - a) CaBr_{2(s)} \rightarrow
 - b) $C_6H_{12}O_{6(s)} \rightarrow$
 - c) Li₃PO_{4(s)} \rightarrow
 - d) NH₄NO_{3(s)} \rightarrow
 - e) $CH_3OH_{(l)} \rightarrow$
- 2. Which of the compound(s) above cause(s) the freezing point of water to decrease the most? Why?
- 3. Which of the compound(s) above cause(s) the boiling point of water to increase the least? Why?
- 4. Explain why do we put salt down on the roads when it snows instead of sugar?

Name:

 1. Which solution has the lowest freezing point? 1) 10. g of KI dissolved in 100. g of water 2) 20. g of KI dissolved in 200. g of water 3) 30. g of KI dissolved in 100. g of water 4) 40. g of KI dissolved in 200. g of water 	 5. As a solute is added to a solvent, what happens to the freezing point and the boiling point of the solution? 1) The freezing point decreases and the boiling point decreases. 2) The freezing point decreases and the boiling point increases. 3) The freezing point increases and the
2. 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	4) The freezing point increases and the boiling point increases and the boiling point increases.
 lower boiling point and a higher freezing point lower boiling point and a lower freezing point higher boiling point and a higher freezing point higher boiling point and a lower freezing point 	 6. Which sample, when dissolved in 1.0 liter of water, produces a solution with the <i>lowest</i> freezing point? 1) 0.1 mol of C₂H₅OH 2) 0.1 mol of LiBr 3) 0.2 mol of C₆H₁₂O₆ 4) 0.2 mol of CaCl₂
 3. Compared to a 0.1 M aqueous solution of NaCl, a 0.8 M aqueous solution of NaCl has a 1) higher boiling point and a higher freezing point 2) higher boiling point and a lower freezing point 3) lower boiling point and a higher freezing point 4) lower boiling point and a lower freezing point 	 7. Which aqueous solution has the <i>lowest</i> freezing point? 1.0 M C₆H₁₂O₆ 1.0 M C₂H₅OH 1.0 M CH₃COOH 1.0 M NaCl 8. Which solution has the highest boiling point? 1.0 M KNO₃
 4. At standard pressure when NaCl is added to water, the solution will have a 1) higher freezing point and a lower boiling point than water 2) higher freezing point and a higher boiling point than water 3) lower freezing point and a higher boiling point than water 4) lower freezing point and a lower boiling point than water 	2) 2.0 M KNO ₃ 3) 1.0 M Ca(NO ₃) ₂ 4) 2.0 M Ca(NO ₃) ₂

Name:

Solutions Review

1. Which barium salt is <i>insoluble</i> in water?	
1) BaCO3 3) Ba(ClO4)2 2) BaCl2 4) Ba(NO3)2	
 2. Based on Reference Table F, which of these saturated solutions has the lowest concentration of dissolved ions?	
1) NaCl(aq) 3) NiCl ₂ (aq) 2) MgCl ₂ (aq) 4) AgCl(aq)	
 3. According to Reference Table F, which substance is most soluble?	
1) Agl 3) PbCl2 2) CaSO4 4) (NH4)2CO3	
 4. Which compound becomes <i>less</i> soluble in water as the temperature of the solution is increased?	
1) HCI 3) NaCI 2) KCI 4) NH4CI	
 5. According to Table <i>F</i> which compound is soluble in water?	
 barium phosphate calcium sulfate silver iodide sodium perchlorate 	
6. Which compound is <i>least</i> soluble in water at 60. °C?	
1) KCIO3 3) NaCI 2) KNO3 4) NH4CI	
 According to your Reference Tables, which substance forms an unsaturated solution when 80 grams of the substance is dissolved in 100 grams of H₂O at 10°C? 	
1) KI 3) NaNO3 2) KNO3 4) NaCI	
8. The solubility of $KCIO_3(s)$ in water increases as the	
 temperature of the solution increases temperature of the solution decreases pressure on the solution increases pressure on the solution decreases 	
 According to Reference Table G, how many grams of KNO₃ would be needed to saturate 200 grams of water at 70°C? 	
1) 43 g 2) 86 g 3) 134 g 4) 268 g	
 10. Based on Reference Table <i>G</i> , what is the maximum number of grams of KCl(s) that will	
dissolve in 200 grams of water at 50°C to produce a saturated solution?	
1) 38 g 2) 42 g 3) 58 g 4) 84 g	

- 11. The solubility of KCl(s) in water depends on the
 - 1) pressure on the solution
 - 2) rate of stirring
 - 3) size of the KCI sample
 - 4) temperature of the water
- 12. Under which conditions of temperature and pressure is a gas most soluble in water?
 - 1) high temperature and low pressure
 - 2) high temperature and high pressure
 - 3) low temperature and low pressure
 - 4) low temperature and high pressure
- 13. 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 ₂ O at 20.°C)
1	KI	120. g
2	NaNO ₃	88 g
3	KCI	25 g
4	KCIO ₃	5 g

Which solution is saturated?

- 1) 1 2) 2 3) 3 4) 4
- 14. What is the total mass of KNO₃ that must be dissolved in 50. grams of H₂O at 60.°C to make a saturated solution?
 - 1) 32 g 2) 53 g 3) 64 g 4) 106 g
- 15. When 5 grams of KCl are dissolved in 50. grams of water at 25°C, the resulting mixture can be described as
 - 1) heterogeneous and unsaturated
 - 2) heterogeneous and supersaturated
 - 3) homogeneous and unsaturated
 - 4) homogeneous and supersaturated
- 16. A solution contains 35 grams of KNO₃ dissolved in 100 grams of water at 40°C. How much *more* KNO 3 would have to be added to make it a saturated solution?

1) 29 g 2) 24 g 3) 12 g 4) 4g

 17. A solution is formed by dissolving 45 grams of NH₄ Cl in 100 grams of H₂O at 70°C. Which statement correctly describes this solution? 	 26. What is the total mass of solute in 1000. grams of a solution having a concentration of 5 parts per million? 0.005 g 0.05g 57. What is the concentration of O2(g), in parts per million, in a solution that contains 0.008 gram of O2 (g) dissolved in 1000. grams of H₂O(l)? 0.8 ppm 8 ppm 8 ppm 8 00 ppm 28. What is the concentration of a solution, in parts per million, if 0.02 gram of Na₃PO₄ is dissolved in 1000 grams of water? 20 ppm 20 ppm 21. 20 ppm 22. Ppm 23. 20 ppm 24. 0.02 gram of Na₃PO₄ is dissolved in 1000 grams of water? 24. What is the concentration of a solution, in parts per million, if 0.02 gram of Na₃PO₄ is dissolved in 1000 grams of water? 20 ppm 21. 20 ppm 22. 20 ppm 23. 0.02 ppm 24. How do the boiling point and freezing point of a solution of water and calcium chloride at standard pressure compare to the boiling point and freezing point of water at standard pressure compare to the boiling point of the solution is higher and the boiling point of the solution is lower. 30. The freezing point of the solution is lower. 31. The freezing point of the solution is lower. 32. Which aqueous solution of KI freezes at the lowest temperature? 33. 0. of KI in 500. g of water 34. 20. mol of KI in 1000. g of water 35. 20. 0. of KI dissolved in 100. g of water 36. 0. of KI dissolved in 100. g of water 33. 0. g of KI dissolved in 100. g of water 33. 0. g of KI dissolved in 100. g of water 33. 0. g of KI dissolved in 100. g of water 33. 0. g of KI dissolved in 100. g of water 33. 0. g of KI dissolved in 100. g of water 33. 0. g of KI dissolved in 100. g of water 33. 0. g of KI dissolved in 100. g of water 34. 0. 8 M aqueous solution of NaCI has a 34. higher boil
 NH4Cl is the solute, and the solution is saturated. NH4Cl is the solute, and the solution is unsaturated. NH4Cl is the solvent, and the solution is 	
 4) NH4Cl is the solvent, and the solution is unsaturated. 18. The molarity of an aqueous solution of NaCl is defined as the 	
 grams of NaCl per liter of water grams of NaCl per liter of solution moles of NaCl per liter of water moles of NaCl per liter of solution What is the molarity of 1.5 liters of an aqueous solution that contains 52 grams of lithium fluoride, LiE (gram-formula mass = 26 grams/mole)? 	
LiF, (gram-formula mass = 26 grams/mole)? 1) 1.3 M 3) 3.0 M 2) 2.0 M 4) 0.75 M 20. Which phrase describes the molarity of a solution? 1) liters of solute per mole of solution 2) liters of solution per mole of solution 3) moles of solution per liter of solution 4) moles of solution per liter of solution 21. A 3.0 M HCl(aq) solution contains a total of 1) 3.0 grams of HCl per liter of water 2) 3.0 grams of HCl per mole of solution 3) noles of HCl per mole of solution 4) 3.0 moles of HCl per mole of water 22. How many total moles of KNO ₃ must be dissolved in water to make 1.5 liters of a 2.0 M solution? 1) 0.50 mol 3) 3.0 mol 23. What is the molarity of a solution of NaOH if 2 liters of the solution contains 4 moles of NaOH? 1) 0.5 M 2) 2 M 3) 8 M 4) 80 M 24. What is the total number of grams of Nal(s) needed to make 1.0 liter of a 0.010 M solution? 1) 0.015 2) 0.15 3) 1.5 4) 15 25. Which unit can be used to express the concentration of a solution?	
1) L/s 2) J/g 3) ppm 4) kPa	

Base your answers to questions **33** and **34** on

the information below and on your knowledge of chemistry.

Seawater contains dissolved salts in the form of ions. Some of the ions found in seawater are Ca^{2+} , Mg^{2+} , K^+ , Na^+ . Cl^- , HCO_3^- , and SO_4^{-2-}

An investigation was conducted to determine the concentration of dissolved salts in seawater at one location. A 300.-gram sample of the seawater was placed in an open container. After a week, all the water had evaporated and 10. grams of solid salts remained in the container.

- 33. At standard pressure, compare the freezing point of seawater to the freezing point of distilled water.
- 34. Determine the concentration, expressed as percent by mass, of the dissolved salts in the original sample of seawater.
- 35. Base your answer to the following question on the information below.

A total of 1.4 moles of sodium nitrate is dissolved in enough water to make 2.0 liters of an aqueous solution. The gram-formula mass of sodium nitrate is 85 grams per mole.

Determine the molarity of the solution.

36. A scientist makes a solution that contains 44.0 grams of hydrogen chloride gas, HCl(g), in 200. grams of water, H₂O(ℓ), at 20. °C. This process is represented by the balanced equation below.

$$\operatorname{HCl}(g) \xrightarrow{\operatorname{H}_2 O} \operatorname{H}^+(\operatorname{aq}) + \operatorname{Cl}^-(\operatorname{aq})$$

Based on Reference Table *G*, identify, in terms of saturation, the type of solution made by the scientist.

Base your answers to questions **37** through **40** on the information below.

In a laboratory, a student makes a solution by completely dissolving 80.0 grams of KNO₃(s) in 100.0 grams of hot water. The resulting solution has a temperature of 60.°C. The room temperature in the laboratory is 22°C.

- 37. Describe a laboratory procedure that can be used to recover the solid solute from the aqueous solution.
- 38. Describe the direction of heat flow between the solution made by the student and the air in the laboratory.
- 39. Compare the boiling point of the solution at standard pressure to the boiling point of water at standard pressure.
- 40. Classify, in terms of saturation, the type of solution made by the student.