

Unit 10: Solutions Review

Name: _____

- 1) Which of the following statements describes $KCl(aq)$?
- 1) KCl is the solute in a heterogeneous mixture.
 - 2) KCl is the solvent in a homogeneous mixture.
 - 3) KCl is the solute in a homogeneous mixture.
 - 4) KCl is the solvent in a heterogeneous mixture.

- 2) Ionic solids will *most* likely dissolve in
- 1) $CCl_4(l)$, which is a nonpolar solvent
 - 2) $H_2O(l)$, which is a polar solvent
 - 3) $H_2O(l)$, which is a nonpolar solvent
 - 4) $CCl_4(l)$, which is a polar solvent

- 3) Which solution is the *most* concentrated?
- 1) 0.4 mole of solute dissolved in 100 mL of solvent
 - 2) 0.3 mole of solute dissolved in 200 mL of solvent
 - 3) 0.2 mole of solute dissolved in 300 mL of solvent
 - 4) 0.1 mole of solute dissolved in 400 mL of solvent

- 4) What is the molarity of a solution that contains 112 grams of KOH in 2.00 liters of solution?
- $M = \frac{112g / 56.1g/mol}{2.00L}$
- 1) 1.00 M
 - 2) 2.00 M
 - 3) 3.00 M
 - 4) 4.00 M

- 5) What is the total number of moles of solute contained in 0.50 liter of 3.0 M HCl ? $3.0 M = \frac{x}{0.50}$
- 1) 1.0
 - 2) 1.5
 - 3) 3.0
 - 4) 3.5

- 6) What is the total number of grams of $NaOH$ (formula mass = 40.) needed to make 1.0 liter of a 0.20 M solution?
- 1) 80. g
 - 2) 20. g
 - 3) 2.0 g
 - 4) 8.0 g
- g = M x V x f.m.*

- 7) A 500. gram sample of an aqueous potassium chloride solution contains 0.025 grams of solute. What is the concentration of the solution in parts per million (ppm)?
- $ppm = \frac{0.025g}{500. g} \times 1,000,000$
- 1) 2.5×10^4 ppm
 - 2) 5.0×10^{-5} ppm
 - 3) 50. ppm
 - 4) 250. ppm

- 8) How many grams of KI are dissolved in 250 grams of a 20.% solution?
- $\frac{0.20}{1} = \frac{x}{250}$
- 1) 5.0 g
 - 2) 12.5 g
 - 3) 50. g
 - 4) 8.0 g

- 9) Which solution has the *highest* boiling point?
- 1) 1 mole of $NaNO_3$ in 500 g of water
 - 2) 1 mole of $NaNO_3$ in 1000 g of water
 - 3) 1 mole of $NaNO_3$ in 750 g of water
 - 4) 1 mole of $NaNO_3$ in 250 g of water
- most concentrated.*

- 10) Which solute, when added to 1,000 grams of water, will produce a solution with the *highest* boiling point?
- 1) 29 g of $NaCl$
 - 2) 58 g of $NaCl$
 - 3) 62 g of $C_2H_6O_2$
 - 4) 31 g of $C_2H_6O_2$
- } non-electrolytes*

- 11) Which solution would have the *lowest* freezing point?
- 1) 1 mole of $NaCl$ dissolved in 500 g of water
 - 2) 0.5 mole of $NaCl$ dissolved in 1,000 g of water
 - 3) 1 mole of $NaCl$ dissolved in 1,000 g of water
 - 4) 0.5 mole of $NaCl$ dissolved in 500 g of water
- most concentrated*

- 12) Why is salt ($NaCl$) put on icy roads and sidewalks in the winter?
- 1) It is ionic and lowers the freezing point of water.
 - 2) It is covalent and lowers the freezing point of water.
 - 3) It is ionic and raises the freezing point of water.
 - 4) It is covalent and raises the freezing point of water.

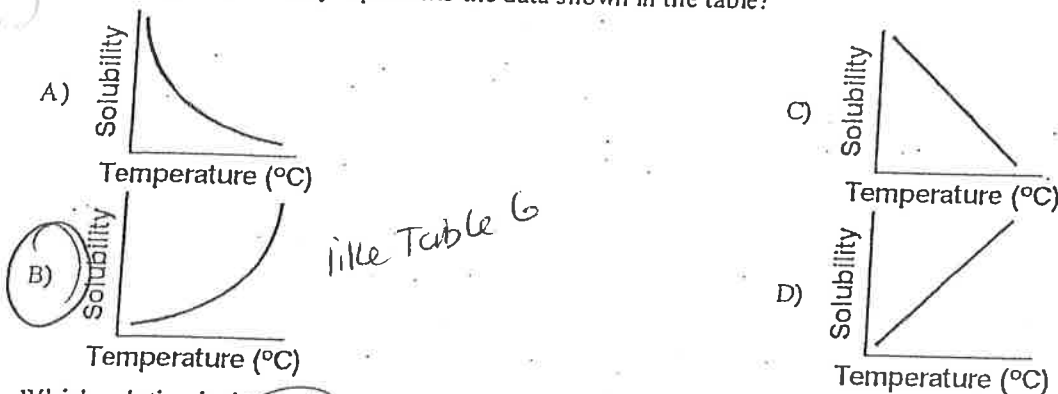
- 4 13) What occurs as a salt dissolves in water?
- 1) The number of ions in the solution increases, and the freezing point increases.
 - 2) The number of ions in the solution decreases, and the freezing point increases.
 - 3) The number of ions in the solution decreases, and the freezing point decreases.
 - 4) The number of ions in the solution increases, and the freezing point decreases.
- 1 14) Based on the *Solubility Curves* chemistry reference table, which salt solution could contain 42 grams of solute per 100 grams of water at 40°C?
- 1) an unsaturated solution of NH_4Cl
 - 2) a saturated solution of KCl
 - 3) a saturated solution of KClO_3
 - 4) an unsaturated solution of NaCl
- 2 15) A solution containing 55 grams of NH_4Cl in 100. grams of water is saturated at a temperature of
- 1) 67°C
 - 2) 57°C
 - 3) 47°C
 - 4) 77°C
- 4 16) How many grams of KNO_3 are needed to saturate 50. grams of water at 70.°C?
- 1) 160 g
 - 2) 30 g
 - 3) 130 g
 - 4) 65 g
- 3 17) Based on the *Solubility Curves* chemistry reference table, when 100 grams of water saturated with KNO_3 at 70°C is cooled to 25°C, the total number of grams of KNO_3 that will precipitate is
- 1) 45 g
 - 2) 30 g
 - 3) 95 g
 - 4) 80 g
- 2 18) Based on the *Solubility Curves* chemistry reference table, what change will cause the solubility of $\text{KNO}_3(\text{s})$ to increase?
- 1) decreasing the pressure
 - 2) increasing the temperature
 - 3) increasing the pressure
 - 4) decreasing the temperature
- 2 19) Which salt has the *greatest* change in solubility between 30°C and 50°C?
- 1) NaCl
 - 2) KNO_3
 - 3) NaNO_3
 - 4) KCl
- 1 20) Based on the *Solubility Curves* chemistry reference table, which substance is *most* soluble at 60°C?
- 1) NH_4Cl
 - 2) NaCl
 - 3) NH_3
 - 4) KCl
- 4 21) Based on the *Solubility Guidelines* chemistry reference table, which saturated solution would be the *least* concentrated?
- 1) lithium sulfate
 - 2) potassium sulfate
 - 3) sodium sulfate
 - 4) barium sulfate
- 4 22) Solutions of $\text{AgNO}_3(\text{aq})$ and $\text{KCl}(\text{aq})$ are mixed. Will a visible reaction occur?
- 1) No, because KNO_3 is soluble in water.
 - 2) Yes, because KNO_3 will precipitate out of solution.
 - 3) No, because AgCl is soluble in water.
 - 4) Yes, because AgCl will precipitate out of solution.
- 2 23) In the laboratory, a student mixes aqueous solutions of NiSO_4 and NaOH . What will be the result of this experiment?
- 1) Na_2SO_4 precipitates out of solution
 - 2) $\text{Ni}(\text{OH})_2$ precipitates out of solution
 - 3) SO_2 gas is released
 - 4) no visible reaction occurs

Practice Questions - SOLUTIONS

- 1) Ionic solids will most likely dissolve in
 A) $H_2O(l)$, which is a polar solvent
 B) $H_2O(l)$, which is a nonpolar solvent
 C) $CCl_4(l)$, which is a nonpolar solvent
 D) $CCl_4(l)$, which is a polar solvent
- 2) At which pressure would carbon dioxide gas be most soluble in 100 grams of water at a temperature of $25^\circ C$?
 A) 3 atm
 B) 2 atm
 C) 1 atm
 D) 4 atm
- 3) Solubility data for salt X is shown in the table below.

Temperature ($^\circ C$)	Solubility ($\frac{g \text{ salt X}}{100g H_2O}$)
10	5
20	10
30	15
40	20
50	30
60	35

Which graph most closely represents the data shown in the table?



- 4) Which solution is the most concentrated? most solute per solvent
 A) 0.2 mole of solute dissolved in 300 mL of solvent
 B) 0.3 mole of solute dissolved in 200 mL of solvent
 C) 0.4 mole of solute dissolved in 100 mL of solvent
 D) 0.1 mole of solute dissolved in 400 mL of solvent
- 5) Which solution contains the greatest number of moles of solute? $M \times L = \text{mol}$
 A) 2 L of 0.5 M 1 mol
 B) 0.5 L of 2 M 1 mol
 C) 0.5 L of 0.5 M 0.25 mol
 D) 2 L of 2 M 4 mol
- 6) What is the molarity of a solution of KNO_3 (molecular mass = 101) that contains 404 grams of KNO_3 in 2.00 liters of solution?
 $M = \frac{404/101}{2} = 2 M$
 A) 1.00 M
 B) 2.00 M
 C) 0.500 M
 D) 4.00 M
- 7) If a 12-molar solution is diluted to 1.0 liter, the molarity of the new solution is $M_1 V_1 = M_2 V_2$
 A) 2.4 M
 B) 2.4 M
 C) 12 M
 D) 0.0 M
- 8) What is the molarity of an H_2SO_4 solution if 0.25 liter of the solution contains 0.75 mole of H_2SO_4 ? half the conc.
 $M = \frac{\text{mol}}{L}$
 A) 3.0 M
 B) 0.75 M
 C) 0.33 M
 D) 6.0 M

$$g = m \times L \times g \cdot f \cdot m$$

$$20 = (1m)(0.5L)(x)$$

29) A 1 M solution contains 20 grams of solute in 500 milliliters of solution. What is the mass of 1 mole of the solute?
 A) 20 g B) 80 g C) 10 g D) 40 g

B 10) What is the molality of a solution of KNO_3 (formula mass = 101.1) that contains 202.2 grams of solute dissolved in 10 grams of water?
 A) 0.2 m B) 4 m C) 0.4 m D) 2 m
 $M = \frac{202.2 / 101.1}{0.5 \text{ kg}}$

11) How many grams of $MgCl_2$ are contained in 500 grams of a 1.0% solution?
 A) 0.20 g B) 1.0 g C) 5.0 g D) 0.0020 g
 $1.0 = \frac{x}{500} \times 100$

12) How many grams of KI are dissolved in 250 grams of a 20% solution?
 A) 12.5 g B) 5.0 g C) 8.0 g D) 50. g
 $20\% = \frac{x}{250} \times 100$

13) Which solute, when added to 1,000 grams of water, will produce a solution with the highest boiling point?
 A) 62 g of $C_2H_6O_2$ molecule
 B) 29 g of NaCl
 C) 58 g of NaCl
 D) 31 g of $C_2H_6O_2$ molecule

B 14) A student dissolves 1.0 mole of sucrose ($C_{12}H_{22}O_{11}$) in 1,000. grams of water at 1.0 atmosphere. Compared to the boiling point of pure water, the boiling point of the resulting solution is
 A) 1.86°C higher
 B) 0.52°C higher
 C) 1.86°C lower
 D) 0.52°C lower
 $K_b = 0.52^\circ C/m$

15) Based on the Solubility Curves chemistry reference table, which salt solution could contain 42 grams of solute per 100 grams of water at 40°C?
 A) an unsaturated solution of NH_4Cl
 B) a saturated solution of $KClO_3$
 C) a saturated solution of KCl
 D) an unsaturated solution of NaCl

16) How many grams of KNO_3 are needed to saturate 50. grams of water at 70.°C?
 A) 30 g B) 130 g C) 65 g D) 160 g

17) According to the Solubility Curves chemistry reference table, what is the maximum number of grams of NH_4Cl that will dissolve in 200 grams of water at 70°C?
 A) 100 g B) 85 g C) 62 g D) 124 g

B 18) A student tested the solubility of a salt at different temperatures and then used the Solubility Curves chemistry reference table to identify the salt. The students data table appears below.

Temperature (°C)	g of salt per 10 g of water
30	1.2
50	2.2
62	3.0
76	4.0

What is the identity of the salt?

- A) ammonium chloride
 B) potassium chlorate
 C) potassium nitrate
 D) sodium chloride

A 19) Solutions of $AgNO_3(aq)$ and $KCl(aq)$ are mixed. Will a visible reaction occur?
 A) Yes, because $AgCl$ will precipitate out of solution.
 B) No, because $AgCl$ is soluble in water.
 C) Yes, because KNO_3 will precipitate out of solution.
 D) No, because KNO_3 is soluble in water.

Name _____

Solubility Curves

Using Table G in your Reference Tables, answer the following questions:

Questions 1-5: For each question an amount of solute is given and a temperature is stated. If all of the solute could be dissolved in 100g of water at the stated temperature, would the resulting solution be unsaturated, saturated, or supersaturated?

- 1) 60 g KCl at 70°C
- 2) 90 g KNO₃ at 60°C
- 3) 110 g NaNO₃ at 45°C
- 4) 10 g KClO₃ at 10°C
- 5) 60 g NH₄Cl at 70°C

Supersaturated
unsaturated
Saturated
Supersaturated
unsaturated.

Questions 6-10: For each question a solute and temperature are given. Tell how many grams of each solute must be added to 100 g of water to form a saturated solution at the temperature given.

- 6) NaNO₃ at 30°C 96 g
- 7) KClO₃ at 70°C 36 g
- 8) KNO₃ at 45°C 75 g

- 9) KCl at 40°C 38 g
- 10) NaCl at 90°C 40 g

Questions 11-13: For each question, tell which solution is more concentrated.

11) At 50°C (A) a saturated solution of KNO₃ or (B) a saturated solution of NH₄Cl

12) At 50°C (A) a saturated solution of KNO₃ or (B) an unsaturated solution of NaNO₃ consisting of 100 g of the solute dissolved in 100 g of water.

13) At 50°C (A) a saturated solution of NaNO₃ or (B) a supersaturated solution of NH₄Cl consisting of 60 g of the solute dissolved in 100 g of water.

84g

115g

more solute/
solvent

Questions 14-18:

14) If 130 g KNO₃ are added to 100 g of water at 40°C, how many grams do not dissolve?

$$130 \text{ g} - 64 \text{ g} = 66 \text{ g}$$

15) If 20 g KClO₃ are added to 50 g of water at 10°C, how many grams do not dissolve?

$$40 \text{ g} - 7 \text{ g} = 33 \text{ g} = 16.5 \text{ g}$$

16) 90 g of KNO₃ are added to 100. g H₂O at 0°C. To what temperature must the solution be raised to produce a saturated solution? 53°C

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

$$52 \text{ g}(2) = 104 \text{ g}$$

18) A saturated solution of ammonia gas in 200 g H₂O at 20°C is heated to 50°C. How much gas will come out of solution?

$$20^\circ\text{C} - 55 \text{ g}(2) = 110 \text{ g}$$

$$50^\circ\text{C} - 28 \text{ g}(2) = -56 \text{ g}$$

54 g

Name: _____

Key

Calculate each of the following. Show all work, watch sig figs.

1. What is the molarity of a solution of
- $\text{Na}_2\text{C}_2\text{O}_4$
- containing 33.5 grams of solute in 100.0 mL of solution?

$$M = \frac{33.5 \text{ g} / 134.0 \text{ g/mol}}{0.100 \text{ L}} = 2.50 \text{ mol/L}$$

2. How many moles of NaOH are contained in 200 mL of a 0.1 M solution of NaOH?

$$0.1 \text{ M} = \frac{x}{0.200 \text{ L}} \quad 0.02 \text{ mol}$$

3. What is the percent by mass concentration of a solution where 5.0g of salt are dissolved in 80.0 g of water?

$$\% \text{ mass} = \frac{5.0 \text{ g}}{85.0 \text{ g}} \times 100 = 5.9\%$$

4. A solution of sodium chloride is prepared by dissolving 5
- ⁰
- g of salt in 550.0g of water. What is the concentration of this solution given as percent by mass?

$$\% \text{ mass} = \frac{5.0 \text{ g}}{555.0 \text{ g}} \times 100 = 0.90\%$$

5. What is the percent by mass of a solution prepared by dissolving 4.0g
- CH_3COOH
- in 35 g of water?

$$\% \text{ mass} = \frac{4.0 \text{ g}}{39 \text{ g}} \times 100 = 10.1\%$$

6. What is the percent by volume concentration of 10 mL of
- $\text{C}_2\text{H}_5\text{OH}$
- dissolved in 50. mL of water?

$$\% \text{ volume} = \frac{10. \text{ mL}}{60. \text{ mL}} \times 100 = 17\%$$

7. Find the concentration in ppm if 0.05 g of NaCl is dissolved in 1000
- ⁰⁰
- mL of water?

$$\text{ppm} = \frac{0.05 \text{ g}}{1,000.00} \times 1,000,000 = 50 \text{ ppm}$$

8. Find the concentration in ppm if 0.10 g of sugar is dissolved in 500
- ⁰⁰
- mL of water?

$$\text{ppm} = \frac{0.10 \text{ g}}{500.00} \times 1,000,000 = 2.0 \times 10^2 \text{ ppm}$$

9. What is the percent by volume concentration of 68 mL of
- H_2SO_4
- dissolved in 0.15 L of water?

$$\% \text{ volume} = \frac{0.068 \text{ L}}{0.068 \text{ L} + 0.15 \text{ L}} \times 100 = \frac{0.068 \text{ L}}{0.22 \text{ L}} \times 100 = 31\%$$

10. What is the concentration in ppm if 0.15g of
- NH_4Cl
- is dissolved in 600
- ⁰⁰
- g of water?

$$\text{ppm} = \frac{0.15 \text{ g}}{600.00 \text{ g}} \times 1,000,000 = 250 \text{ ppm}$$

11. Determine the percent by mass of a solution prepared by dissolving 32.5 g of glucose in 155g of water.

$$\% \text{ mass} = \frac{32.5 \text{ g}}{155 \text{ g} + 32.5 \text{ g}} \times 100 = \frac{32.5 \text{ g}}{188 \text{ g}} \times 100 = 17.3\%$$

Name: key

A 1. How many moles of H_2SO_4 are needed to prepare 5.0 L of a 2.0 M solution of H_2SO_4 ?

- a) 10.
- b) 2.5
- c) 5.0
- d) 20.

$$\frac{2.0 \text{ M}}{1} = \frac{x}{5.0 \text{ L}}$$

$$x = 10. \text{ mol } H_2SO_4$$

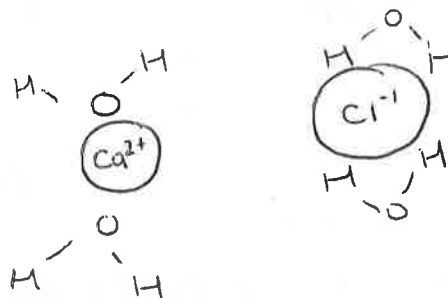
C 2. Which solution is most concentrated?

- a) 0.2 mole of solute dissolved in 300 mL of solvent
- b) 0.3 mole of solute dissolved in 200 mL of solvent
- c) 0.4 mole of solute dissolved in 100 mL of solvent
- d) 0.1 mole of solute dissolved in 400 mL of solvent

most solute in the least amount of solvent

C 3. When calcium chloride is dissolved in water, to which end of the adjacent water molecules will a calcium ion be attracted?

- a) the hydrogen end, which is the negative pole
- b) the hydrogen end, which is the positive pole
- c) the oxygen end, which is the negative pole
- d) the oxygen end, which is the positive pole



B 4. What is the total number of grams of solute in 500. mL of 1.0 M CH_3COOH ?

(formula mass of $CH_3COOH = 60. \text{ g/mol}$)

- a) 90. g
- b) 30. g
- c) 120. g
- d) 60. g

$$\text{grams} = M \times L \times \text{GFM}$$

$$\text{grams} = (1.0)(0.500 \text{ L})(60.) = 30. \text{ g}$$

D 5. What is the mass of KCl in 250. grams of a 5.0% solution?

- a) 5.0 g
- b) 2.0 g
- c) 1.25 g

$$5.0\% = \frac{x}{250. \text{ g}} \times 100$$

- d) 12.5 g

$$\frac{0.05}{1} = \frac{x}{250. \text{ g}}$$

$$\boxed{x = 12.5 \text{ g KCl}}$$

C 6. Which solution has the highest boiling point? → greatest conc. of ions

- a) 1 mol of NaNO_3 in 500 g of water
- b) 1 mol of NaNO_3 in 750 g of water
- c) 1 mol of NaNO_3 in 250 g of water
- d) 1 mol of NaNO_3 in 1000 g of water

C 7. What occurs as a salt dissolves in water?

- a) the number of ions in the solution increases, and the freezing point increases.
- b) the number of ions in the solution decreases, and the freezing point increases.
- c) the number of ions in the solution increases, and the freezing point decreases.
- d) the number of ions in the solution decreases, and the freezing point decreases.

C 8. A 200. gram sample of a salt solution contains 0.050 grams of NaCl . What is the concentration of the solution in parts per million (ppm)?

- a) 2.5×10^{-4} ppm
- b) 50. ppm
- c) 250. ppm
- d) 5.0×10^{-4} ppm

$$\text{ppm} = \frac{0.05 \text{ g NaCl}}{200. \text{ g}} \times 1,000,000$$
$$\text{ppm} = 250. \text{ ppm}$$

B 9. At which pressure would carbon dioxide gas be most soluble in 100. grams of water at a temperature of 25°C ?

- a) 3 atm
- b) 4 atm
- c) 2 atm
- d) 1 atm

solubility of a gas increases
as pressure increases and vice versa

A 10. Which sample, when dissolved in 1.0 liter of water, produces a solution with the lowest freezing point?

- a) 0.2 mol of CaCl_2
- ~~b) 0.1 mol of $\text{C}_2\text{H}_5\text{OH}$ non-electrolyte~~
- ~~c) 0.1 mol of LiBr (2 ions)~~
- ~~d) 0.2 mol of $\text{C}_6\text{H}_{12}\text{O}_6$ non-electrolyte~~

→ breaks up into the most ions (3 ions) and greatest molar amount

Concentration Calculations:

11. What is the molarity of a solution that contains 95.6 grams of KNO_3 in 3.40 L of solution?

$$\begin{aligned} & \text{KNO}_3 \\ & 39.1 + 14.0 + 48.0 = \\ & 101.1 \text{ g/mol} \end{aligned}$$
$$M = \frac{(95.6 / 101.1)}{3.40 \text{ L}} \xrightarrow{\text{GFM of KNO}_3}$$
$$= 0.278 \text{ mol/L}$$

12. What is the percent by mass of KCl in a solution that contains 42 g KCl in 250 grams of water?

$$\begin{aligned} \% \text{ mass KCl} &= \frac{42 \text{ g}}{42 \text{ g} + 250 \text{ g}} \times 100 \\ &= 14\% \end{aligned}$$

13. An aqueous solution of KOH has a concentration of 25. ppm. How many grams of KOH are there in 2,000. grams of the solution?

$$25. \text{ ppm} = \frac{x}{2,000. \text{ g}} \times 1,000,000$$

$$x = 0.050 \text{ g KOH}$$

14. To produce 4.00 L of a solution of 1.80 M solution of HCl, how many grams of HCl must be dissolved?

$$\text{grams} = M \times L \times \text{GFM}$$

$$\begin{aligned} \text{grams} &= 1.80 \text{ M} (4.00 \text{ L}) (36.5) \\ &= \boxed{263 \text{ g}} \end{aligned}$$

Complete/Net Ionic Equations:

15a) Write the complete ionic equation to represent the reaction between aqueous potassium sulfate and aqueous barium chloride.



b) what are the spectator ions?



c) Write the net ionic equation

