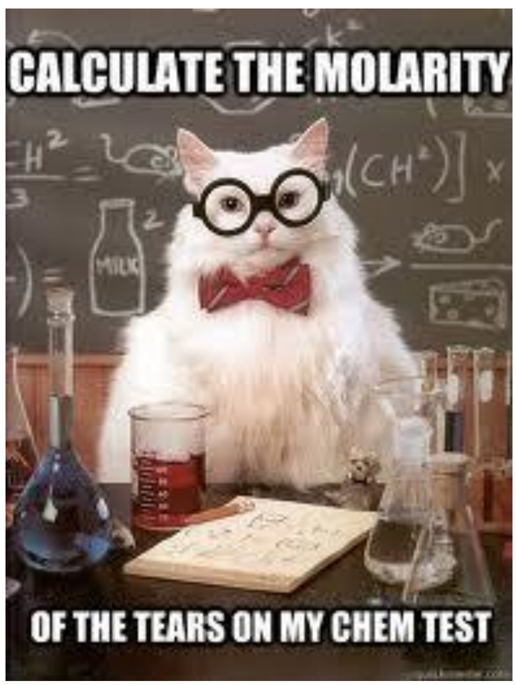
Name:

Regents Chemistry:

Practice Packet Unit 9: Solutions



Name:

Vocabulary: Define in your own words!!

Word	**Definition**
Aqueous	
Colligative property	
Concentration	
Electrolyte	
Mixture	
Molarity	
Nonelectrolyte	
Parts per million	
Percent by mass	
Percent by volume	
Precipitate	
Saturated	
Solubility	
Solute	
Solution	
Solvent	
Supersaturated	
Unsaturated	

Name:

Matter Review

1. Draw the following descriptions:

Pure element	Pure compound	Mixture of two elements	Mixture of an element & a compound	Mixture of two diatomic elements & a compound

2. Classify each of the following with the combination of terms listed below.

pure substance – element *mixture – homogeneous*
pure substance – compound *mixture – heterogeneous*

a. HCl (aq)
b. Cl_2 (g)
c. Hg (l)
d. sugar ($C_{11}H_{22}O_{11}$)
e. water
f. iron(II) oxide
g. KBr (s)
h. $CH_2(OH)_2$ (aq)
i. NH_3 (l)
j. Soil
k. Sodium
l. salt water

3. Matter that is composed of two or more different elements chemically combined in a fixed proportion is classified as (1) a compound (2) an element (3) a mixture (4) a solution

4. A compound differs from an element in that a compound
(1) is homogeneous
(2) has a definite composition
(3) can be decomposed by a chemical reaction
(4) has a definite melting point

5. A compound differs from a mixture in that a compound always has a
(1) homogeneous composition
(2) maximum of two elements
(3) minimum of three elements
(4) heterogeneous composition

6. A heterogeneous material may be
(1) an element (2) a compound (3) a pure substance (4) a mixture

7. Which statement is an identifying characteristic of a mixture?
(1) a mixture can consist of a single element
(2) a mixture can be separated by physical means
(3) a mixture must have a definite composition by weight
(4) a mixture must be homogeneous

8. Which must be a mixture of substances? (1) solid (2) liquid (3) gas (4) solution

9. Which substance can be decomposed by chemical means? (1) aluminum (2) octane (3) silicon

10. Two substances, A and Z, are to be identified. Substance A cannot be broken down by a chemical change. Substance Z can be broken down by a chemical change. What can be concluded about these substances?

(1) Both substances are elements.
(2) Both substances are compounds.
(3) Substance A is an element and substance Z is a compound.
(4) Substance A is a compound and substance Z is an element.

11. Which terms are used to identify pure substances?

(1) an element and a mixture
(2) an element and a compound
(3) a solution and a mixture
(4) a solution and a compound

12. Two different samples decompose when heated. Only one of the samples is soluble in water. Based on this information, these two samples are

(1) both the same element
(2) two different elements
(3) both the same compound
(4) two different compounds

13. Tetrachloromethane, CCl_4, is classified as a

(1) compound because the atoms of the elements are combined in a fixed proportion
(2) compound because the atoms of the elements are combined in a proportion that varies
(3) mixture because the atoms of the elements are combined in a fixed proportion
(4) mixture because the atoms of the elements are combined in a proportion that varies

14. Fill in the tables below.

Solution Formula	**Solute Name**	**Solvent Formula**
$MgBr_2(aq)$		
$K_2SO_4(aq)$		
$FeCl_3(aq)$		
$CuSO_4(aq)$		
$Ba(NO_3)_2\ (aq)$		
$(NH_4)_2CO_3(aq)$		

Solution Name	**Solute Formula**
aqueous potassium nitrate	
aqueous sodium acetate	
aqueous ammonium hydroxide	
aqueous lithium bromide	
aqueous magnesium hypochlorite	
aqueous iron (II) nitrate	

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LESSON 1: SOLUTIONS AND SOLUBILITY

Objective:

- ***Use Table F to determine solubility***
- ***Compose double replacement reactions and determine the precipitate***

1. Explain what happens when an ionic compound dissolves in water. Compare and contrast this to how a molecular compound (like sugar) dissolves in water.

2. What is an electrolyte? Why do they conduct electricity?

3. Why do molecular solutions not conduct electricity?

Use Table F to determine if the following compounds are soluble or insoluble.

a. NaCl	e. K_3PO_4	i. calcium hydroxide
b. $PbBr_2$	f. $MgCO_3$	j. copper (II) hydroxide
c. $CaSO_4$	g. NH_4NO_3	k. lead(II) sulfate
d. potassium chromate	h. sodium hydrogen carbonate	l. ammonium sulfide

Use Table F to determine if the following compounds are soluble or insoluble.

Key: ***I – Insoluble*** ***S – Soluble***	**Acetate**	**Bromide**	**Carbonate**	**Chlorate**	**Chloride**	**Chromate**	**Hydroxide**	**Hydrogen Carbonate**	**Iodide**	**Nitrate**	**Phosphate**	**Sulfate**	**Sulfide**
Aluminum													
Ammonium													
Barium													
Calcium													
Copper II													
Iron II													

Name:

Double Replacement Reactions and Table F

1. Double replacement reactions require the cations to switch with the anions. Using Table F determine which product is the precipitate then fill in the states of matter of the products formed.

a. $(NH_4)_3PO_4(aq) + AlCl_3(aq) \rightarrow AlPO_4 + 3NH_4Cl$

b. $NaCl(aq) + AgNO_3(aq) \rightarrow AgCl + NaNO_3$

d. $K_2SO_4(aq) + BaI_2(aq) \rightarrow BaSO_4 + 2KI$

e. $CaCl_2(aq) + Li_2CO_3(aq) \rightarrow 2LiCl + CaCO_3$

2. Complete the following double replacement reactions and use table F to determine the states of matter of the products formed.

a. $CaBr_2 + Na_2CO_3 \rightarrow$ _____________________ + ______________________

b. $ZnCO_3 + BaCl_2 \rightarrow$ _____________________ + ______________________

c. $AgNO_3 + LiCl \rightarrow$ _____________________ + ______________________

3. Write the **balanced** chemical equation for each of the following descriptions.

- Use Table F to determine the state of the reactants and products **(s) or (aq).**
- Write "soluble" or "insoluble" under each reactant and product.
- Square off the *precipitate*.

(a) Solutions of sodium carbonate and silver nitrate are mixed to form sodium nitrate and silver carbonate.

(b) $AgC_2H_3O_2$ (aq) is mixed with NaCl (aq) to form AgCl and $NaC_2H_3O_2$.

(c) Solutions of potassium sulfate and calcium chlorate are mixed to form potassium chlorate and calcium sulfate.

(d) $CaCl_2$ (aq) and Na_2S (aq) are mixed to form CaS and NaCl.

(e) What do all the above double replacement reactions have in common?

Name:

REGENTS PRACTICE:

Lesson 1

In an aqueous solution of potassium iodide, the solute is

A) I B) K C) KI D) H_2O

2. According to Table *F*, which substance is most soluble in water?

A) AgCl B) $CaCO_3$
C) Na_2CO_3 D) $SrSO_4$

3. Which salt is *least* soluble?

A) $FeCO_3$ B) Na_2CO_3
C) $BaCl_2$ D) $CaCl_2$

4. Which substance is most soluble?

A) AgI B) $CaSO_4$
C) $PbCl_2$ D) $(NH_4)_2CO_3$

5. According to Table *F*, which ions combine with chloride ions to form an insoluble compound?

A) Fe^{2+} ion B) Ca^{2+} ions
C) Li^+ ions D) Ag^+ ions

6. Which barium salt is *insoluble* in water?

A) $BaCO_3$ B) $BaCl_2$
C) $Ba(ClO_4)_2$ D) $Ba(NO_3)_2$

7. Which compound is insoluble in water?

A) $BaSO_4$ B) $CaCrO_4$
C) $KClO_3$ D) Na_2S

LESSON 2: FACTORS THAT AFFECT SOLUBILITY

Objective:

- ***Identify the factors which affect solubility of a solute in a solvent.***
- ***Identify factors that affect the rate of dissolving.***

1. Why do oil and water not mix?

2. What type of substance would dissolve in CCl_4?

3. The bends is a condition suffered by deep sea divers who surface quickly. Operating at high pressures deep below the surface and breathing compressed air causes more gas, especially nitrogen, to be dissolved in the blood than would otherwise be dissolved at surface pressure. As the diver surfaces the pressure decreases and makes the gases less soluble. If the diver surfaces quickly, bubbles of nitrogen gas form in the blood with excruciating pain and may result in death.

   What affect does pressure have on the solubility of a gas?

   Why does pressure have this effect on gases?

4. Why does a soda fizz when you open it? Explain in terms of pressure and solubility.

5. What conditions would give soda the most amount of dissolved $CO_{2\,(g)}$?

Directions: Please fill out the following table. For each solute listed determine whether the **NATURE** of the compound is **NONPOLAR COVALENT, POLAR COVALENT, or IONIC**. Then determine if the solute will be soluble or insoluble in the solvent.

	SOLVENT			
	Water	**Octane (nonpolar)**	**Hexane (nonpolar)**	**Ethanol (polar)**
NaCl Nature (polar or nonpolar or ionic):	Soluble Insoluble	Soluble Insoluble	Soluble Insoluble	Soluble Insoluble
HCl Nature:	Soluble Insoluble	Soluble Insoluble	Soluble Insoluble	Soluble Insoluble
O_2 Nature:	Soluble Insoluble	Soluble Insoluble	Soluble Insoluble	Soluble Insoluble
KCl Nature:	Soluble Insoluble	Soluble Insoluble	Soluble Insoluble	Soluble Insoluble
CO_2 Nature:	Soluble Insoluble	Soluble Insoluble	Soluble Insoluble	Soluble Insoluble

1. Check the conditions under which each of the following solutes will be most soluble.

Solute Name	Solute Formula	Temperature		Pressure			Best Solvent	
		Low	High	Low	High	No Effect	H_2O	CCl_4
potassium nitrate	$KNO_3(s)$							
hydrogen chloride	$HCl(g)$							
nitrogen trihydride	$NH_3(g)$							
ammonium chloride	$NH_4Cl(s)$							
carbon dioxide	$CO_2(g)$							
potassium iodide	$KI(s)$							
potassium chlorate	$KClO_3(s)$							

2. Naphthalene, a nonpolar substance that sublimes at room temperature, can be used to protect wool clothing from being eaten by moths.

a. Explain, in terms of *intermolecular forces,* why naphthalene sublimes.

b. Explain why naphthalene is *not* expected to dissolve in water.

c. The empirical formula for naphthalene is C_5H_4 and the molecular mass of naphthalene is 128 grams/mole. What is the molecular formula for naphthalene?

REGENTS QUESTIONS:

1. The attraction between water molecules and an Na^+ ion or a Cl^- ion occurs because water molecules are

   A) linear B) symmetrical
   C) polar D) nonpolar

2. The solubility of KCl(s) in water depends on the

   A) pressure on the solution
   B) rate of stirring
   C) size of the KCl sample
   D) temperature of the water

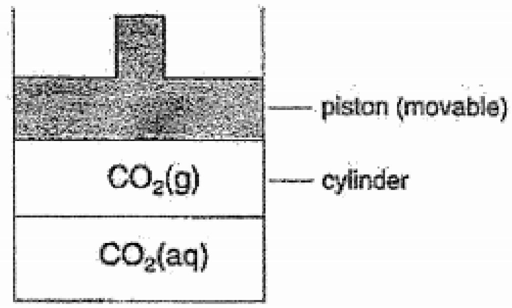
3. Under which conditions of temperature and pressure is a gas most soluble in water?

   A) high temperature and low pressure
   B) high temperature and high pressure
   C) low temperature and low pressure
   D) low temperature and high pressure

4. At room temperature, the solubility of which solute in water would be most affected by a change in pressure?

   A) methanol B) sugar
   C) carbon dioxide D) sodium nitrate

5. 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) increase pressure and decrease temperature
   B) increase pressure and increase temperature
   C) decrease pressure and decrease temperature
   D) decrease pressure and increase temperature

LESSON 3: TYPES OF SOLUTIONS AND SOLUBILITY CURVES

Objective:

- ***Use solubility curves (Table G) to determine if a solutions is saturated, unsaturated or supersaturated.***
- ***Determine how much of a solute can dissolve or will precipitate using Table G***

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

(a) 80 g $NaNO_3$ in 100 g H_2O at 10ºC ______________________________

(b) 75 g $NaNO_3$ in 100 g H_2O at 10ºC ______________________________

(c) 90 g $NaNO_3$ in 100 g H_2O at 10ºC ______________________________

(d) 90 g KNO_3 in 100 g H_2O at 50ºC ______________________________

(e) 40 g KCl in 50 g H_2O at 60ºC ______________________________

(f) 35 g $NaNO_3$ in 50 g H_2O at 10ºC ______________________________

(g) 5 g $KClO_3$ in 200 g H_2O at 5ºC ______________________________

(h) 30 g NH_4Cl in 200 g H_2O at 10ºC ______________________________

2. Tell how many MORE grams of each solute must be added to 100 g of water to form a saturated solution at that temperature.

Grams Solute per 100 g H_2O	**Solute Added to make Saturated**		**Grams Solute per 200 g H_2O**	**Solute Added to make Saturated**		**Grams Solute per 200 g H_2O**	**Solute Added to make Saturated**
a. 35 g KNO_3 at 40ºC			e. 70 g NaCl at 90ºC			i. 25 g NH_3 at 5ºC	
b. 50 g NH_3 at 10ºC			f. 10 g NH_3 at 90ºC			j. 30 g $NaNO_3$ at 50ºC	
c. 15 g KCl at 75ºC			g. 20 g $KClO_3$ at 40ºC			k. 15 g $KClO_3$ at 75ºC	
d. 95 g KI at 15ºC			h. 35 g KCl at 60ºC			l. 5 g KCl at 75ºC	

3. Tell how many grams of each solute will crystallize/precipitate/settle. Assume all solutions are saturated and in 100 grams of H_2O.

Amount cooled	**Amount Precipitated**		**Amount cooled**	**Amount Precipitated**
a. KNO_3 (aq) is cooled from 70ºC to 40ºC			e. NaCl (aq) is cooled from 100ºC to 40ºC	
b. NH_4Cl (aq) is cooled from 90ºC to 20ºC			f. KNO_3 (aq) is cooled from 65ºC to 25ºC	
c. KCl (aq) is cooled from 55ºC to 30ºC			g. $KClO_3$ (aq) is cooled from 100ºC to 40ºC	
d. KI (aq) is cooled from 20ºC to 5ºC			h. $NaNO_3$ (aq) is cooled from 45ºC to 10ºC	

4. Rank the following solids in order from least to most soluble in 100 g H_2O at 50ºC :
   NH_4Cl, $NaNO_3$, $KClO_3$, KNO_3

5. Rank the following gases in order from least to most soluble in 100 g H_2O at 50ºC :
   NH_3, SO_2, HCl

LESSON 4: CONCENTRATION OF SOLUTIONS

Objective:

- ***Calculate the concentration of various solutions***

1. Calculate the molarity of each of the following solutions:

(a) 2.5 mol of NaOH in 0.500 L of solution

(b) 1.8L of solution containing 3.3 mol KNO_3

(c) 30. g of NaOH in 0.500 L of solution

(d) 522 g of K_2SO_4 in 1.5 L of solution

(e) 12 g of HCl in 250 mL of solution

2. Calculate the total moles of solute in each of the following solutions:

(a) 1.7 L of 0.35M NaOH

(b) 50 mL of 3.3-molar KNO_3

(c) 5.0 L of 1.25 M NaOH

(d) 116 mL of 1.5 M K_2SO_4

3. Calculate the total grams of solute in each of the following solutions:

(a) 1.0 L of 0.5 M $CaCl_2$

(b) 500 mL of 3.3-molar KNO_3

(c) 0.25 L of 1.0 M NaOH

(d) 42 mL of 1.7 M K_2SO_4

Percent by mass

1. Calculate the percent by mass of the following solutions:

   a. 50.0 grams of solute in 200.0 grams of solution

   b. 25.0 grams of solute in 150.0 grams of solution

   c. 15.0 grams of NaCl in 250.0 grams of solution

   d. 10.0 grams of KI in 1000.0 grams of solution

Parts Per Million

1. Calculate the concentration of chlorine in ppm in a swimming pool if there is 0.02 g of chlorine in 10,000 g of pool water.

2. Exposure to lead has been linked to delays in physical and mental development and attention deficit disorders in children as well as kidney problems in adults. One source of this toxic heavy metal is drinking water in older homes whose plumbing contains lead. Water with a lead concentration of below 0.015ppm is considered safe to drink. A 100 g water sample taken from a home contains 1.2×10^{-6} grams of lead. Is this water considered safe to drink?

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
• 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

c.) Explain, in terms of molecular polarity, why oxygen gas has low solubility in water. Your response must include *both* oxygen and water.

d.) Under what kind of conditions of temperature and pressure would oxygen gas be most soluble in water?

e.) An aqueous solution has a concentration of 7 ppm of oxygen dissolved in 1000. grams of solution. Calculate the amount of oxygen in the solution in grams. Your response must include *both* a correct numerical setup and the calculated result.

LESSON 5: COLLIGATIVE PROPERTIES

Objective:

- ***Differentiate between boiling point elevation and freezing point depression and the factors that influence them***

1. Which solution has the highest boiling point?
   (1) 0.5 M NaCl
   (2) 0.5 M $CaCl_2$
   (3) 1.0 M $(NH_4)_3PO_4$
   (4) 2.0 M CH_3OH

2. Compared to pure water, an aqueous solution of calcium chloride has a
   (1) higher boiling point and higher freezing point
   (2) higher boiling point and lower freezing point
   (3) lower boiling point and higher freezing point
   (4) lower boiling point and lower freezing point

3. Which solution has the highest boiling point?
   (1) 1.0 M KNO_3 (3) 1.0 M $Ca(NO_3)_2$
   (2) 2.0 M KNO_3 (4) 2.0 M $Ca(NO_3)_2$

4. Which solution has the *lowest* freezing point?
   (1) 10. g of KI dissolved in 100. g of water
   (2) 30. g of KI dissolved in 100. g of water
   (3) 20. g of KI dissolved in 200. g of water
   (4) 40. g of KI dissolved in 200. g of water

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

6. Which aqueous solution of KI freezes at the lowest temperature?
   (1) 1 mol of KI in 500. g of water (3) 1 mol of KI in 1000. g of water
   (2) 2 mol of KI in 500. g of water (4) 2 mol of KI in 1000. g of water

7. 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
   (1) lower boiling point and a higher freezing point
   (2) lower boiling point and a lower freezing point
   (3) higher boiling point and a higher freezing point
   (4) higher boiling point and a lower freezing point

Complete the following chart:

Compound Ionic Or Molecular?	Electrolyte or Nonelectrolyte?	How many particles the compound breaks up into	Rank in order of which one affects the boiling and freezing points the least to most 1 = affects them least 4 = affects them most
$BaBr_2$			
LiF			
C_2H_6O			
$Fe(NO_3)_3$			

Directions: Read the following passage and then answer the corresponding questions.

How Does Rock Salt Work, Anyway?

"How come adding rock salt to your ice cream maker makes the ice cream freeze and putting it on the road makes ice melt?"

That's a good question, and here's the answer: in both of these scenarios, humans take advantage of the same scientific properties to achieve two different objectives.

Adding sodium chloride (otherwise known as table salt) to water acts to depress the freezing point of the salt-water solution. In other words, salt water freezes at a lower temperature than fresh water. The exact temperature depends on the concentration of salt and the type of salt used.

When rock salt is added to an ice cream maker, the resulting salt water solution can bathe the metal canister at a temperature less than 32°F (or 0ºC). As the human adds ice, the temperature drops below 0ºC, but the salt water solution doesn't freeze. The result? Harder ice cream!

When rock salt is added to the street, it depresses the freezing point of any water which dissolves it. This salt water solution can exist as a liquid at lower temperatures than fresh water. The result? Salty water, instead of clean ice, if the solution is strong enough to withstand the surface temperature.

Speaking of Melting Ice ...

Pouring table salt on snowy (or pre-snowy) roads isn't the only way to melt ice. Sodium chloride is used because it is cheap and easy to obtain in large quantities. But, as any New Yorker with a car can tell you, salt can be quite corrosive. And as hard as it is on cars, it's just as hard on roadways and bridge decks. This is costly in the long run.

So, alternative methods to road salting are desirable. One type of alternative is using a different kind of salt. Some salts are more effective than others at lowering freezing points, and some salts are more environmentally friendly (and road-, car-, and bridge-friendly). However, these salts are typically much more expensive than ordinary sodium chloride.

written by Derek Arndt
Meteorologist with the Oklahoma MesoNet

1. Why do we put salt on snow covered roads?

2. How does adding rock salt to an ice cream maker make the ice cream harder?

3. Why is it better to use salt on roads instead of sugar ($C_6H_{12}O_6$)?

4. Name two advantages to using NaCl on snowy roads instead of another type of salt.

5. What the scientific term used to describe the fact that adding salt to water decreases its freezing point?

6. Explain why some people add salt to water. Does it make the water boiling faster? What exactly does the salt do to the water that would be a benefit for cooking?

7. Explain why adding a molecular solid to water will not elevate boiling point as much as adding salt to water.

8. If you add 2.0-g of MgO to water what will happen to the freezing and boiling points of water?

9. Rank 1 mole of the substances $C_{12}H_{22}O_{11}$, NaCl, and $CaBr_2$ from least to most effective on snowy roads. Be sure t explain your answer—and you may need your reference tables for this one.