UNIT 7: SOLUTIONS STUDY GUIDE
REGENTS CHEMISTRY

Name KEY
Unit 7 Exam will be on Thursday 2/16

Vocabulary- Match the terms to the correct definitions.

1. B colligative properties
2. E concentration
3. S electrolyte
4. T nonelectrolyte
5. G molarity
6. H parts per million
7. J saturated solution
8. K unsaturated solution
9. L supersaturated solution
10. M solubility
11. N soluble
12. F insoluble
13. P solute
14. Q solvent
15. O solution
16. R "like dissolves like"
17. I precipitate
18. D dilute
19. C concentrated
20. A aqueous

a) a homogeneous mixture in which water is the solvent

b) the boiling point of a solution is higher than that of a pure solvent; the freezing point of a solution is lower than that of a pure solvent

c) having a lot of solute dissolved

d) not a lot of solute is dissolved

e) a measure of the amount of solute present in a unit amount of solution

f) refers to a substance that does not dissolve in a solvent

g) a measure of concentration; units are M

h) a measure of concentration; units are ppm

i) an insoluble substance that settles out of solution as a solid

j) the maximum amount of solute is dissolved in a given amount of solvent at a certain temperature

k) less than the maximum amount of solute is dissolved in a given amount of solvent at a certain temperature

l) a special case when more than the maximum amount of solute is dissolved in a given amount of solvent at a certain temperature

m) a measure of how much of substance can dissolve in a given amount of solute; these curves are given on Table G

n) capable of being dissolved

o) a homogeneous mixture

p) the substance that is dissolved

q) the substance doing the dissolving

r) the saying to help us remember that polar substances dissolve polar substances; nonpolar dissolves nonpolar

s) an ionic compound that dissociates into mobile ions to make a solution that can conduct electricity

t) a covalent compound that doesn't dissociate; can't conduct electricity

Learning Target Checklist – How prepared are you for the Unit 7 test? Check yourself against this unit's learning targets.

I can apply the saying "like dissolves like" to ionic, polar, and nonpolar substances to explain solubility/insolubility.

1. Base your answer to the following question on An unknown solid was tested and showed the properties listed below:

   Properties
   low melting point
   nearly insoluble in water
   non-conductor of electricity
   relatively soft solid

   a) State the type of bonding you would expect of this substance. Covalent

   b) Explain why this substance is insoluble in water. It must be nonpolar

2. Base your answer to the following question on he information below.

   Two alcohols that are used in our everyday lives are rubbing alcohol and ethylene glycol. Rubbing alcohol is used as an antiseptic. Ethylene glycol is the main ingredient in antifreeze, which is used in automobile cooling systems.

   Explain, in terms of molecular polarity, why rubbing alcohol, 2-propanol, is soluble in water. Rubbing alcohol is polar, as is water.

3. Base your answer to the following question on the information below.

   The compound 1,2-ethanediol can be mixed with water. This mixture is added to automobile radiators as an engine coolant. The cooling system of a small van contains 6690 grams of 1,2-ethanediol. Some properties of water and 1,2-ethanediol are given in the table below.

   Properties of Water and 1,2-ethanediol

Property	Water (H_2O)	1,2-ethanediol (CH_2OHCH_2OH)
gram-formula mass (g/mol)	18.0	62.0
boiling point at standard pressure (°C)	100.0	197.2

   State, in terms of molecular polarity, why 1,2-ethanediol is soluble in water. 1,2-ethanediol is polar, as is water.

4. Base your answer to the following question on the information below.

   Some Properties of Three Compounds at Standard Pressure

Compound	Boiling Point (°C)	Solubility in 100. Grams of H_2O at 20.°C (g)
ammonia	−33.2	56
methane	−161.5	0.002
hydrogen chloride	−84.9	72

   Explain, in terms of molecular polarity, why hydrogen chloride is more soluble than methane in water at 20.°C and standard pressure.

   Hydrogen chloride is polar, methane is nonpolar. Since water is polar and "like dissolves like", hydrogen chloride is more soluble.

I can identify and define properties of electrolytes.

1.) Which laboratory test result can be used to determine if KCl(s) is an electrolyte?
(1) pH of KCl(aq) (2) pH of KCl(s)
(3) electrical conductivity of KCl(aq) (4) electrical conductivity of KCl(s)

2.) Which species can conduct an electric current?
(1) NaOH(s) (2) CH_3OH(aq) (3) H_2O(s) (4) HCl(aq)
ionic

3.) Which compound is an electrolyte?
(1) $C_6H_{12}O_6$ (2) CH_3OH (3) $CaCl_2$ (4) CCl_4
ionic

4.) Based on Reference Table *F*, which of these salts is the best electrolyte?
(1) sodium nitrate (2) magnesium carbonate (3) silver chloride (4) barium sulfate
$NaNO_3$ ✓ $MgCO_3$ insoluble $AgCl$ insoluble $BaSO_4$ insoluble

5.) Given the equation for the dissolving of sodium chloride in water:

$$NaCl(s) \xrightarrow{H_2O} Na^+(aq) + Cl^-(aq)$$

Explain, in terms of *particles,* why NaCl(s) does *not* conduct electricity.

NaCl as a solid does not have mobile/free moving charged particles.

I can explain how dissolving solutes in solvent affects the freezing and boiling points.

1. Which sample, when dissolved in 1.0 liter of water, produces a solution with the highest boiling point?

   A) 0.1 mole ~~M~~ B) 0.2 mole ~~M~~
   C) 0.1 mole $MgCl_2$ D) 0.2 mole $MgCl_2$

2. A solution consists of 0.50 mole of $CaCl_2$ dissolved in 100. grams of H_2O at 25°C. Compared to the boiling point and freezing point of 100. grams of H_2O at standard pressure, the solution at standard pressure has

   A) a lower boiling point and a lower freezing point
   B) a lower boiling point and a higher freezing point
   C) a higher boiling point and a lower freezing point
   D) a higher boiling point and a higher freezing point

3. Which solution has the highest boiling point at standard pressure?

   A) 0.10 M KCl(aq) B) 0.10 M K_2SO_4(aq)
   C) 0.10 M K_3PO_4(aq) D) 0.10 M KNO_3(aq)

4. 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?

   A) Both the freezing point and boiling point of the solution are higher.
   B) Both the freezing point and boiling point of the solution are lower.
   C) The freezing point of the solution is higher and the boiling point of the solution is lower.
   D) The freezing point of the solution is lower and the boiling point of the solution is higher.

5. Compared to the freezing point and boiling point of water at 1 atmosphere, a solution of a salt and water at 1 atmosphere has a

   A) lower freezing point and a lower boiling point
   B) lower freezing point and a higher boiling point
   C) higher freezing point and a lower boiling point
   D) higher freezing point and a higher boiling point

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 → more particles

   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. Compared to the freezing point of 1.0 M KCl(aq) at standard pressure, the freezing point of 1.0 M $CaCl_2$ (aq) at standard pressure is → more ions / particles

   A) lower B) higher
   C) the same

8. At standard pressure when NaCl is added to water, the solution will have a

   A) higher freezing point and a lower boiling point than water
   B) higher freezing point and a higher boiling point than water
   C) lower freezing point and a higher boiling point than water
   D) lower freezing point and a lower boiling point than water

9. Base your answer to the following question on the information below.

   In a laboratory, a student makes a solution by completely dissolving 80.0 grams of KNO_3(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.

   Compare the boiling point of the solution at standard pressure to the boiling point of water at standard pressure. BP of solution is higher.

10. Base your answer to the following question on the information below and on your knowledge of chemistry.

    A 2.50-liter aqueous solution contains 1.25 moles of dissolved sodium chloride. The dissolving of NaCl(s) in water is represented by the equation below.

    $$NaCl(s) \xrightarrow{H_2O(l)} Na^+(aq) + Cl^-(aq)$$

    Compare the freezing point of this solution to the freezing point of a solution containing 0.75 mole NaCl per 2.50 liters of solution.

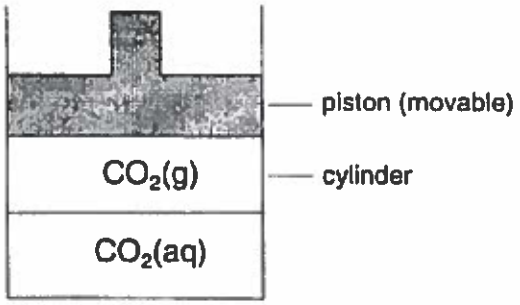
    FP of solution w/ 1.25 moles is lower.

I can explain how temperature and pressure (for gases) affect solubility.

1. 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

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

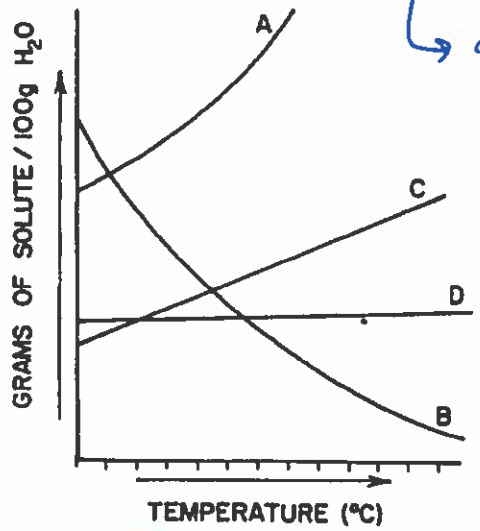


   Which changes *must* increase the solubility of the carbon dioxide? gas

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

3. The graph below represents four solubility curves. Which curve best represents the solubility of a gas in water?

   decreases as T ↑



   A) *A* B) *B* C) *C* D) *D*

4. What change will cause the solubility of $KNO_3(s)$ to increase?

   A) decreasing the pressure
   B) increasing the pressure
   C) decreasing the temperature
   D) increasing the temperature

I can use solubility guidelines (Table F) to identify whether or not a compound is soluble in water.

1.) Which compound is insoluble in water?
(1) KOH (2) NH_4Cl (3) Na_3PO_4 (4) $PbSO_4$

2.) According to Table *F*, which compound is soluble in water?
(1) barium phosphate (2) calcium sulfate
(3) silver iodide (4) sodium perchlorate

3.) According to Table *F*, which of these salts is *least* soluble in water?
(1) LiCl (2) RbCl (3) $FeCl_2$ (4) $PbCl_2$

4.) According to Reference Table *F*, which of these compounds is the *least* soluble in water?
(1) K_2CO_3 (2) $KC_2H_3O_2$ (3) $Ca_3(PO_4)_2$ (4) $Ca(NO_3)_2$

5.) Which ion combines with Ba^{2+} to form a compound that is most soluble in water?
(1) S^{2-} (2) OH^- (3) CO_3^{2-} (4) SO_4^{2-}

I can calculate molarity, mass of solute or volume of solution using the molarity formula.

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

2.) 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

$\frac{4 mol}{2 L}$

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

Na: 1 (23)
O: 1 (16)
H: 1 (1)
40

$\# mols = \frac{20}{40} = 0.5 mols$

$Molarity = \frac{0.5 mols}{0.5 L} = \boxed{1 M}$

4.) Calculate the molarity of a solution made from dissolving 2.43 moles of HCl in 758 mL of water.

$M = \frac{2.43}{0.758} = \boxed{3.21 M}$

5.) How many moles of NaOH are required to give 3.0L of a 6.4 M solution?

$6.4 M = \frac{x}{3.0 L}$ $\boxed{x = 19.2 mols}$

6.) Miss Virga is making a solution of $K_3(PO_4)$ and water. She mixes 1.2 grams $K_3(PO_4)$ with enough water to make a 3.7 L solution. What is the molar concentration of her solution?

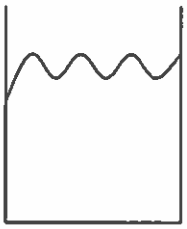
K: 3 (39.1) = 117.3
P: 1 (31) = 31 +
O: 4 (16) = 64
: 212.3 g/mol

$\# mols = \frac{1.2}{212.3} = 0.0057 mols$

$M = \frac{0.0057}{3.7} = \boxed{0.0015 M}$

7.) Miss Virga makes 2 aqueous solutions as follows:

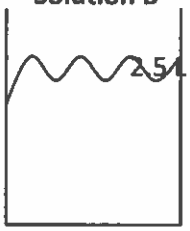
Solution A



2.5 L of solution

0.5 moles of $CuSO_4$

Solution B



2.5 L of solution

1.4 moles of $CuSO_4$

a. What is the solute in both solution A and solution B? $CuSO_4$

b. What is the solvent in both solution A and solution B? Water

c. Calculate the molarity (concentration) of both solutions.

Solution A

$M = \frac{0.5}{2.5} = 0.2 M$

Solution B

$M = \frac{1.4}{2.5} = 0.56 M$

d. Which solution is more concentrated? B

I can calculate parts per million, mass of solute or mass of solution using ppm formula.

1. What is the concentration expressed in parts per million of a solution containing 20.0 grams of $C_6H_{12}O_6$ in 80.0 grams of H_2O?

   $ppm = \frac{20}{80+20} \times 1{,}000{,}000$

   A) 2.50×10^5 ppm B) 2.00×10^5 ppm
   C) 4.00×10^6 ppm D) 5.00×10^6 ppm

2. What is the concentration expressed in parts per million of a solution containing 15.0 grams of KNO_3 in 65.0 grams of H_2O?

   $ppm = \frac{15}{15+65} \times 1{,}000{,}000$

   A) 1.88×10^5 ppm B) 2.00×10^5 ppm
   C) 2.31×10^5 ppm D) 5.33×10^6 ppm

3. Base your answer to the following question on the information below.

   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 grams of fluoride ions.

   How many parts per million of fluoride ions are present in the analyzed sample? Is the town's drinking water safe to drink? Support your decision using information in the passage and your calculated fluoride level.

   $ppm = \frac{0.000250}{175} \times 1{,}000{,}000 = 1.43 ppm$

   Yes the town's drinking water is safe b/c it is below 4 ppm.

4. An aqueous solution contains 300. parts per million of KOH. Determine the number of grams of KOH present in 1000. grams of this solution.

   $300 = \frac{x}{1000} \times 1{,}000{,}000$

   $x = 0.300$ grams KOH

5. What is the total mass of solute in 1000. grams of a solution having a concentration of 5 parts per million?

   A) 0.005 g B) 0.05g
   C) 0.5 g D) 5g

   $5 = \frac{x}{1000} \times 1{,}000{,}000$

6. A 2400.-gram sample of an aqueous solution contains 0.012 gram of NH_3. What is the concentration of NH_3 in the solution, expressed as parts per million?

   A) 5.0 ppm B) 15 ppm
   C) 20. ppm D) 50. ppm

   $ppm = \frac{0.012}{2400} \times 1{,}000{,}000$

I can identify a solution as saturated, unsaturated or supersaturated when given temperature and mass of solute (using Table G).

1. At standard pressure, which substance becomes *less* soluble in water as temperature increases from 10.°C to 80.°C?

   A) HCl B) KCl C) NaCl D) NH_4Cl

2. Which compound is *least* soluble in water at 60. °C?

   A) $KClO_3$ B) KNO_3 C) NaCl D) NH_4Cl

3. An unsaturated aqueous solution of NH_3 is at 90°C in 100. grams of water. According to Reference Table *G*, how many grams of NH_3 could this unsaturated solution contain?

   A) 5 g B) 10. g C) 15 g D) 20. g

4. According to your Reference Tables, which substance forms an unsaturated solution when 80 grams of the substance is dissolved in 100 grams of H_2O at 10°C?

   A) KI B) KNO_3
   C) $NaNO_3$ D) NaCl

5. According to Reference Table *G*, which of these substances is most soluble at 60ºC?

   A) NaCl B) KCl C) $KClO_3$ D) NH_4Cl

6. According to Reference Table *G*, how many grams of KNO_3 would be needed to saturate 200 grams of water at 70°C?

   100g H_2O → 134 g
   x2 200g H_2O → 268g x2

7. Based on Reference Table *G*, 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?

   100g H_2O → 42g
   200g H_2O → 84g

8. According to Reference Table *G*, how many grams of KNO_3 would be needed to saturate 200 grams of water at 70°C?

   A) 43 g B) 86 g C) 134 g D) 268 g

9. Which compound is *least* soluble in 100 grams of water at 40°C?

   A) SO_2 B) NaCl C) $KClO_3$ D) NH_4Cl

10. According to Reference Table G, what is the approximate difference between the amounts of $KClO_3$ and KNO_3 soluble in 100 grams of water at 40ºC?

    A) 17 g B) 22 g C) 47 g D) 64 g

$KClO_3$ – 16g
KNO_3 – 64g

64 – 16 = 48