Calculations for Solutions Worksheet and Key

1)	23.5g of NaCl is dissolved in enough water to make .683 L of solution. a) What is the molarity (M) of the solution?
	b) How many moles of NaCl are contained in 0.0100 L of the above NaCl solution?
	c) What volume (L) of this NaCl solution would contain 0.200 moles of NaCl?
2)	12.5g of glucose ($C_6H_{12}O_6$) is dissolved in enough water to make 750.0 mL of solution. a) What is the molarity (M) of the solution?
	b) How many moles of glucose are contained in 237 mL of the above glucose solution?
	c) What volume (L) of this glucose solution would contain 0.079 moles of glucose?

3) 45.7 g of magnesium chloride ($MgCl_2$) is dissolved in 2.40 kg of water.				
a) What is the molality (m) of the solution?				
b) How many moles of $MgCl_2$ are contained in 1.76 kg of solvent?				
c) How many kg of solvent would contain 0.0150 moles of $MgCl_2$?				
4) 114.5 g of KCl is dissolved in enough water to make 3.6 L of solution.				
a) How many osmoles are in one mole of KCl when it dissolves?				
b) What is the osmolarity of the solution?				
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c) How many osmoles are contained in 1.00 L of the above potassium chloride solution?				
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d) How many liters (I) of this notaceium chloride colution would contain 0.250 osmolos?				
d) How many liters (L) of this potassium chloride solution would contain 0.350 osmoles?				

5) 7.58 g of 2-propanol (C_3H_8O) is added to enough water to make 1.50 L of solution.
a) How many osmoles are in one mole of 2-propanol when it dissolves?
b) What is the osmolarity of the solution?
c) How many osmoles are contained in 25.00 mL of the above 2-propanol solution?
d) How many liters (L) of this 2-propanol solution would contain 0.00575 osmoles?
6) 46.0 g of barium nitrate is dissolved in 2.60 kg of water.
a) How many osmoles are in one mole of barium nitrate when it dissolves?
b) What is the osmolality of the solution?
7) A glucose ($C_6H_{12}O_6$) solution is prepared by adding 5.00 grams of glucose to enough water to make 200.0 ml of solution.
a) What is the %(w/v) of the solution?
b) What volume (mL) of this solution would contain 0.0735 grams of glucose?
c) How many grams of glucose would be present in 185 mL of this solution?

8)	234.5 g of KCl is dissolved in enough water to make 3.6 L of solution.
	a) How many equivalents of potassium (K^+) are in one mole of KCl when it dissolves? (note: you are concerned with the Eq from K^+ <i>only</i> , do not include Eq from Cl')
	b) What is the concentration of potassium in (Eq/L) ?
	c) How many equivalents (Eq) of K ⁺ are contained in 0.700 L of the above potassium chloride solution?
	d) How many liters (L) of this potassium chloride solution would contain 0.050 equivalents Eq of K ⁺ ?
9)	0.250 g of aluminum sulfate is dissolved in enough water to make 150 mL of solution. a) How many equivalents of sulfate ion (SO_4^{2-}) are in one mole of aluminum sulfate when it dissolves?
	(note: you are concerned with the Eq from SO_4^{2-} only, do not include Eq from Al^+)
	b) What is the concentration of sulfate in (Eq/L) ?
	c) How many equivalents (Eq) of SO_4^{2-} are contained in 0.0280 L of the above aluminum sulfate solution?
	d) How many liters (L) of this aluminum sulfate solution would contain 0.0025 equivalents Eq of SO_4^{2-}?

Molarity calculations (fill-in all the boxes)

solute	moles of	grams of	volume of	Concentration
	solute	solute	solution	(Molarity, M=mole/L)
NaCl	3.00 moles		0.500 L	
NaCl		13.5 g	0.150 L	
NaCl	0.375 moles			1.00 M
NaCl		0.059 g		0.30 M
KNO ₃	1.57 moles			0.770 M
KNO ₃		1.98 g		2.00 M
KNO ₃			0.288 L	0.197 M

Osmolarity calculations

solute	moles of solute	osmoles of solute	grams of solute	volume of solution	Concentration (Osmolar = osmole/L)
KCl	2.40 moles			0.600 L	
KCl			1.5 g	0.750 L	
KCl	0.050 moles				1.00 osmolar
KCl			0.892 g		0.150 osmolar
glucose C ₆ H ₁₂ O ₆	1.50 moles				1.22 osmolar
glucose C ₆ H ₁₂ O ₆			1.17 g		0.0100 osmolar
glucose C ₆ H ₁₂ O ₆				0.375 L	0.0750 osmolar

Key

- 1) 23.5g of NaCl is dissolved in enough water to make .683 L of solution.
 - a) What is the molarity (M) of the solution?

Molar mass of NaCl = 58.44 g/mole

Moles of NaCl:

Molarity =
$$\left(\frac{\text{moles}}{\text{liter solution}}\right) = \left(\frac{0.402 \text{ moles NaCl}}{0.683 \text{ L of solution}}\right) = 0.589 \text{ moles NaCl/L} = 0.589 M NaCl$$

b) How many **moles** of NaCl are contained in 0.0100 L of the above NaCl solution?

- Note: The concentration gives us the relationship between the **amount of solute** and **the amount of solute** and **the amount of solution**....we use the **concentration** as a **conversion factor**!!!!
 - c) What volume (L) of this NaCl solution would contain 0.200 moles of NaCl?

- 2) 12.5g of glucose ($C_6H_{12}O_6$) is dissolved in enough water to make 750.0 mL of solution.
 - a) What is the molarity (M) of the solution?

Molar mass of glucose = 180.18 g/mole

Moles of glucose:

Molarity =
$$\left(\frac{\text{moles}}{\text{liter solution}}\right) = \left(\frac{0.0694 \text{ moles glucose}}{0.7500 \text{ L of solution}}\right) = 0.0925 \text{ mole glucose/L} = 0.0925 M glucose$$

b) How many moles of glucose are contained in 237 mL of the above glucose solution?

c) What volume (L) of this glucose solution would contain 0.079 moles of glucose?

0.079 m oles glucos e	L of solution	= 0.85 L of solution
	0.0925 moles glucose	

- 3) 45.7 g of magnesium chloride (MgCl₂) is dissolved in 2.40 kg of water.
 - a) What is the molality (m) of the solution?

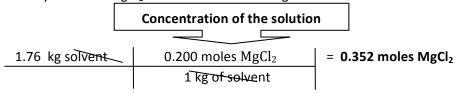
Molar mass of $MgCl_2 = 95.21 \text{ g/mole}$

Moles of MgCl₂:

$$\frac{45.7 \text{ g MgCl}_2}{95.21 \text{ g MgCl}_2} = 0.480 \text{ moles MgCl}_2$$

Molality =
$$\left(\frac{\text{moles}}{\text{kg of solvent}}\right) = \left(\frac{0.480 \text{ moles MgCl}_2}{2.40 \text{ kg of solvent}}\right) = 0.200 \text{ moles MgCl}_2 / \text{kg} = 0.200 \text{ m MgCl}_2$$

b) How many moles of MgCl₂ are contained in 1.76 kg of solvent?



c) How many kg of **solvent** would contain 0.0150 moles of MgCl₂?

- 4) 114.5 g of KCl is dissolved in enough water to make 3.6 L of solution.
 - a) How many **osmoles** are in **one mole** of KCl when it dissolves? **one mole** of KCl = 2 **osmoles**
 - This relationship can be used as a **conversion factor** to *convert* between **moles** and **osmoles**:

$$\left(\begin{array}{c} \textbf{2 osmoles} \\ \hline \textbf{1 mole KCI} \end{array}\right) \quad \text{or} \quad \left(\begin{array}{c} \textbf{1 mole KCI} \\ \hline \textbf{2 osmoles} \end{array}\right)$$

- b) What is the osmolarity of the solution?
- First get the moles of KCl then convert to osmoles:

Molar mass of KCl = 74.55 g/mole

Osmoles in solution:

Osmolarity =
$$\left(\frac{\text{osmoles}}{\text{L of solution}}\right) = \left(\frac{3.072 \text{ osmoles}}{3.6 \text{ L of solution}}\right) = 0.85 \text{ osmoles /L solution} = 0.85 \text{ osmoles}$$

c) How many osmoles are contained in 1.00 L of the above potassium chloride solution?

Concentration of the solution				
1.00 L solution		0.85 osmoles	= 0.85 osmoles	
		<u>Cofsolution</u>		

- As in the case of molarity (M) and molality (m), the concentration (osmolarity this time) gives us the relationship between the amount of solute and the amount of solution....we use the concentration as a conversion factor!!!!
- d) How many liters (L) of this potassium chloride solution would contain 0.350 osmoles?

- 5) 7.58 g of 2-propanol (C₃H₈O) is added to enough water to make 1.50 L of solution.
 - a) How many **osmoles** are in **one mole** of 2-propanol when it dissolves? **one mole** of 2-propanol = **one osmole** (2-propanol does not dissociate into ions)
 - b) What is the **osmolarity** of the solution?

Molar mass of 2-propanol = 60.11 g/mole

Osmoles in solution:

Osmolarity =
$$\left(\frac{\text{osmoles}}{\text{L of solution}}\right) = \left(\frac{0.126 \text{ osmoles}}{1.50 \text{ L of solution}}\right) = 0.0840 \text{ osmoles /L solution}$$

= 0.0840 osmolar

c) How many osmoles are contained in 25.00 mL of the above 2-propanol solution?

d) How many liters (L) of this 2-propanol solution would contain 0.00575 osmoles?

- 6) 46.0 g of barium nitrate is dissolved in 2.60 kg of water.
 - a) How many osmoles are in one mole of barium nitrate when it dissolves?

one mole of $Ba(NO_3)_2 = 3$ osmoles

- Ba(NO₃)₂ dissociates into 3 particles, one Ba²⁺ ion and 2 nitrate ions
- This relationship can be used as a **conversion factor** to *convert* between **moles** and **osmoles**:

$$\left(\begin{array}{c} \textbf{3 osmoles} \\ \hline \textbf{1 mole Ba(NO_3)_2} \end{array}\right) \quad \text{or} \quad \left(\begin{array}{c} \textbf{1 mole Ba(NO_3)_2} \\ \hline \textbf{3 osmoles} \end{array}\right)$$

b) What is the **osmolality** of the solution?

Molar mass of $Ba(NO_3)_2 = 261.35 \text{ g/mole}$

Osmoles in solution :

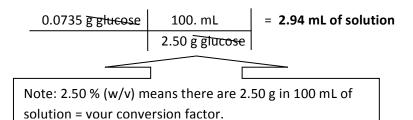
$$\frac{46.0 \text{ g Ba}(NO_3)_2}{261.35 \text{ g Ba}(NO_3)_2} \frac{\text{3 osmoles}}{\text{1 mole Ba}(NO_3)_2} = 0.528 \text{ osmoles Ba}(NO_3)_2$$

$$\frac{\text{261.35 g Ba}(NO_3)_2}{\text{260 smoles}} = \frac{0.528 \text{ osmoles}}{2.60 \text{ kg of solvent}} = 0.203 \text{ osmoles/kg}$$

- 7) A glucose ($C_6H_{12}O_6$) solution is prepared by adding 5.00 grams of glucose to enough water to make 200.0 ml of solution.
 - a) What is the %(w/v) of the solution?

$$\%(w/v) = \left(\frac{g \text{ solute}}{mL \text{ of solution}}\right) \times 100 = \left(\frac{5.00 \text{ g glucose}}{200.0 \text{ mL}}\right) \times 100\% = 2.50 \% (w/v)$$

- b) What volume (mL) of this solution would contain 0.0735 grams of glucose?
- Use the concentration as a conversion factor!



- c) How many grams of glucose would be present in 185 mL of this solution?
- Use the concentration as a conversion factor!

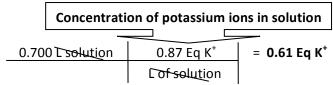
- 8) 234.5 g of KCl is dissolved in enough water to make 3.6 L of solution.
 - a) How many equivalents of potassium (K^+) are in one mole of KCl when it dissolves? one mole of KCl = 1 Eq K^+ (recall that an equivalent is a mole of charge)
 - This relationship can be used as a **conversion factor** to *convert* between **moles** and **equivalents**:

$$\left(\begin{array}{c} \mathbf{1} \ \mathsf{Eq} \ \mathsf{K}^{\mathsf{+}} \\ \hline \mathbf{1} \ \mathsf{mole} \ \mathsf{KCl} \end{array}\right) \qquad \mathsf{or} \qquad \left(\begin{array}{c} \mathbf{1} \ \mathsf{mole} \ \mathsf{KCl} \\ \hline \mathbf{1} \ \mathsf{Eq} \ \mathsf{K}^{\mathsf{+}} \end{array}\right)$$

- b) What is the concentration from **potassium** in $(Eq K^{+}/L)$?
- First get the moles of KCl then convert **equivalents (Eq)**: Molar mass of KCl = 74.55 g/mole
- Equivalents (Eq) in solution

(Eq/L) =
$$\left(\frac{\text{\# Eq K}^+}{\text{L of solution}}\right) = \left(\frac{3.146 \text{ Eq K}^+}{3.6 \text{ L of solution}}\right) = 0.87 \text{ Eq K}^+/\text{L solution}$$

- c) How many **equivalents Eq of K**⁺ are contained in 0.700 L of the above potassium chloride solution?
- As in the case of molarity (M), the concentration (Eq/L this time) gives us the relationship between the amount of solute and the amount of solution....we use the concentration as a conversion factor!!!!



d) How many liters (L) of this potassium chloride solution would contain **0.050 equivalents Eq of K**⁺?

$$\begin{array}{c|cc}
0.050 \text{ Eq. K}^{+} & 1 \text{ L of solution} \\
\hline
0.87 \text{ Eq. K}^{+} & \\
\end{array} = \textbf{0.057 L of solution}$$

- 9) 0.250 g of aluminum sulfate is dissolved in enough water to make 150 mL of solution.
 - a) How many equivalents of sulfate ion (SO_4^{2-}) are in one mole of aluminum sulfate when it dissolves? one mole of $Al_2(SO_4)_3 = 6$ Eq SO_4^{2-} (recall that an equivalent is a mole of charge/mole of compound)
 - o 3 moles sulfate ions x (2 moles of charge/1 mole sulfate ions) = 6 Eq
 - This relationship can be used as a **conversion factor** to *convert* between **moles** and **equivalents**:

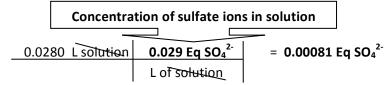
$$\left(\frac{6 \text{ Eq SO}_4^2}{1 \text{ mole Al}_2(SO_4)_3}\right) \qquad \text{or} \qquad \left(\frac{1 \text{ mole Al}_2(SO_4)_3}{6 \text{ Eq SO}_4^2}\right)$$

- b) What is the concentration of sulfate in (Eq/L)?
- First get the moles of $Al_2(SO_4)_3$ then convert **equivalents (Eq)**: Molar mass of $Al_2(SO_4)_3$ = 342.17 g/mole
- Equivalents (Eq) in solution

O Note: we must convert from **mL** of solution to **L** of solution

$$(Eq/L) = \left(\frac{\# Eq SO_4^{2-}}{L \text{ of solution}}\right) = \left(\frac{0.00438 Eq SO_4^{2-}}{0.15 L \text{ of solution}}\right) = 0.029 Eq SO_4^{2-}/L \text{ solution}$$

- c) How many **equivalents (Eq) of SO₄**²⁻ are contained in **0.0280 L** of the above aluminum sulfate solution?
- As in the case of molarity (M), the concentration (Eq/L in this case) gives us the relationship between the amount of solute and the amount of solution....we use the concentration as a conversion factor!!!!



d) How many liters (L) of this aluminum sulfate solution would contain **0.0025 equivalents Eq of SO₄²⁻?**

0.0025 Eq \$0 ²	1 L of solution	= 0.086 L of solution
	0.029 Eq SO ₄ ²⁻	

Molarity calculations (fill-in all the boxes)

solute	moles of	grams of	volume of	Concentration
	solute	solute	solution	(Molarity, M=mole/L)
NaCl	3.00 moles	175 g	0.500 L	6.00 M
NaCl	.231 moles	13.5 g	.150 L	1.54 M
NaCl	.375 moles	21.9 g	.375 L	1.00 M
NaCl	.0010 moles	.059 g	.0033 L	0.30 M
KNO ₃	1.57 moles	159 g	2.04 L	.770 M
KNO ₃	.0196 moles	1.98 g	.00980 L	2.00 M
KNO ₃	.0567 moles	5.73 g	.288 L	.197 M

Osmolarity calculations

solute	moles of	osmoles of	grams of	volume of	Concentration
	solute	solute	solute	solution	(Osmolar = Osmole/L)
KCl	2.40 moles	4.80 osmoles	179 g	0.600 L	8.00 osmolar
KCl	0.020 moles	0.040 osmoles	1.5 g	0.750 L	0.053 osmolar
KCl	.050 moles	0.10 osmoles	3.7 g	0.10 L	1.00 osmolar
KCl	0.0120 moles	0.0240 osmoles	0.892 g	0.160 L	0.150 osmolar
glucose C ₆ H ₁₂ O ₆	1.50 moles	1.50 osmoles	270. g	1.23 L	1.22 osmolar
glucose C ₆ H ₁₂ O ₆	0.00649 moles	0.00649 osmoles	1.17 g	.649 L	0.0100 osmolar
glucose C ₆ H ₁₂ O ₆	0.0281 moles	0.0281 osmoles	5.06 g	0.375 L	0.0750 osmolar