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?

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

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^+ ***only***, 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 solute	grams of solute	volume of solution	Concentration (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 $C_6H_{12}O_6$	1.50 moles				1.22 osmolar
glucose $C_6H_{12}O_6$			1.17 g		0.0100 osmolar
glucose $C_6H_{12}O_6$				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:

$$\frac{23.5\text{ g } \cancel{\text{NaCl}}}{} \left| \frac{1\text{ mole NaCl}}{58.44\text{ g}\cancel{\text{NaCl}}} \right| = .402\text{ moles NaCl}$$

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

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

Concentration of the solution

$$\frac{0.0100\text{ L } \cancel{\text{solution}}}{} \left| \frac{0.589\text{ moles NaCl}}{\cancel{\text{L of solution}}} \right| = \mathbf{0.00589\ mole\ NaCl}$$

- Note: The concentration gives us the relationship between 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?

Concentration of the solution

$$\frac{0.200\text{ moles of NaCl}}{} \left| \frac{\text{L of solution}}{0.589\ \cancel{\text{moles NaCl}}} \right| = \mathbf{.340\ L\ of\ solution}$$

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:

$$\frac{12.5\text{ g } \cancel{\text{glucose}}}{} \left| \frac{1\text{ mole glucose}}{180.18\text{ g }\cancel{\text{glucose}}} \right| = 0\ .0694\text{ moles glucose}$$

$$\text{Molarity} = \left(\frac{\text{moles}}{\text{liter solution}}\right) = \left(\frac{0\ .0694\text{ moles glucose}}{0.7500\text{ L of solution}}\right) = 0.0925\text{ mole glucose/L} = \mathbf{0.0925\ M\ glucose}$$

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

$$\frac{0.237\text{ L } \cancel{\text{solution}}}{} \left| \frac{0.0925\text{ moles glucose}}{\cancel{\text{L of solution}}} \right| = \mathbf{0.0219\ mole\ glucose}$$

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

$$\frac{0.079\ \cancel{\text{moles glucose}}}{} \left|\ \frac{\text{L of solution}}{0.0925\ \cancel{\text{moles glucose}}}\right| = \mathbf{0.85\ L\ of\ solution}$$

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?

Molar mass of $MgCl_2$ = 95.21 g/mole

Moles of $MgCl_2$:

$$\frac{45.7\ \text{g}\ \cancel{MgCl_2}}{} \left|\ \frac{1\ \text{mole}\ MgCl_2}{95.21\ \text{g}\ \cancel{MgCl_2}}\right| = 0.480\ \text{moles}\ MgCl_2$$

$$\text{Molality} = \left(\frac{\text{moles}}{\text{kg of solvent}}\right) = \left(\frac{0.480\ \text{moles}\ MgCl_2}{2.40\ \text{kg of solvent}}\right) = 0.200\ \text{moles}\ MgCl_2\ /\text{kg} = \mathbf{0.200}\ \boldsymbol{m}\ \mathbf{MgCl_2}$$

b) How many **moles** of $MgCl_2$ are contained in 1.76 kg of solvent?

Concentration of the solution

$$\frac{1.76\ \text{kg}\ \cancel{\text{solvent}}}{} \left|\ \frac{0.200\ \text{moles}\ MgCl_2}{1\ \cancel{\text{kg of solvent}}}\right| = \mathbf{0.352\ moles\ MgCl_2}$$

c) How many kg of **solvent** would contain 0.0150 moles of $MgCl_2$?

Concentration of the solution

$$\frac{0.0150\ \cancel{\text{moles}\ MgCl_2}}{} \left|\ \frac{1\ \text{kg of solvent}}{0.200\ \cancel{\text{moles}\ MgCl_2}}\right| = \mathbf{0.0750\ kg\ of\ solvent}$$

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**:

$$\left(\frac{\mathbf{2\ osmoles}}{\mathbf{1\ mole}\ \text{KCl}}\right) \quad \text{or} \quad \left(\frac{\mathbf{1\ mole}\ \text{KCl}}{\mathbf{2\ osmoles}}\right)$$

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:

114.5 g KCl	1 mole KCl	**2 osmoles**	= 3.072 osmoles
	74.55 g KCL	**1 mole KCl**	

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

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**
	L of solution	

- As in the case of molarity (M) and molality (*m*) , the concentration (os*molarity* 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?

0.350 osmoles	L of solution	= **0.41 L of solution**
	0.85 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?

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:

7.58 g 2-propanol	1 mole 2-propanol	**1 osmole**	= 0.126 osmoles
	60.11 g 2-propanol	**1 mole 2-propanol**	

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

= 0.0840 osmolar

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

$$\frac{0.02500 \text{ L solution}}{} \left| \frac{0.0840 \text{ osmoles}}{\text{L of solution}} \right| = \mathbf{0.00210 \text{ osmoles}}$$

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

$$\frac{0.00575 \text{ osmoles}}{} \left| \frac{\text{L of solution}}{0.0840 \text{ osmoles}} \right| = \mathbf{0.0685 \text{ L of solution}}$$

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**

- $Ba(NO_3)_2$ dissociates into 3 particles, one Ba^{2+} ion and 2 nitrate ions

- This relationship can be used as a **conversion factor** to *convert* between **moles** and **osmoles**:

$$\left(\frac{\mathbf{3 \text{ osmoles}}}{\mathbf{1 \text{ mole}}\ Ba(NO_3)_2}\right) \quad \text{or} \quad \left(\frac{\mathbf{1 \text{ mole}}\ Ba(NO_3)_2}{\mathbf{3 \text{ osmoles}}}\right)$$

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

Molar mass of $Ba(NO_3)_2$ = 261.35 g/mole

- Osmoles in solution :

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

$$\text{Osmolality} = \left(\frac{\mathbf{osmoles}}{\mathbf{kg\ of\ solvent}}\right) = \left(\frac{0.528 \text{ osmoles}}{2.60 \text{ kg of solvent}}\right) = 0.203 \text{ osmoles/kg}$$

= **0.203 osmolal**

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?

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

b) What volume (mL) of this solution would contain 0.0735 grams of glucose?

- Use the concentration as a conversion factor!

0.0735 ~~g glucose~~	100. mL	= **2.94 mL of solution**
	2.50 ~~g glucose~~	

Note: 2.50 % (w/v) means there are 2.50 g in 100 mL of solution = your conversion factor.

c) How many grams of glucose would be present in 185 mL of this solution?

- Use the concentration as a conversion factor!

185 ~~mL solution~~	2.50 g glucose	= **4.63 g glucose**
	100. ~~mL 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?

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**:

$$\left(\frac{\textbf{1 Eq } K^+}{\textbf{1 mole} \text{ KCl}}\right) \quad \text{or} \quad \left(\frac{\textbf{1 mole} \text{ KCl}}{\textbf{1 Eq } K^+}\right)$$

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 :

234.5 ~~g KCl~~	1 ~~mole KCl~~	**1 Eq K^+**	= **3.146 Eq K^+**
	74.55 ~~g KCL~~	**1 ~~mole~~** ~~KCl~~	

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

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**!!!!

Concentration of potassium ions in solution

$$\frac{0.700\ \cancel{\text{L solution}}}{} \left| \frac{0.87\ \text{Eq } K^+}{\cancel{\text{L of solution}}} \right| = \mathbf{0.61\ Eq\ K^+}$$

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

$$\frac{0.050\ \cancel{\text{Eq } K^+}}{} \left| \frac{1\ \text{L of solution}}{0.87\ \cancel{\text{Eq } K^+}} \right| = \mathbf{0.057\ L\ of\ solution}$$

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)**

- **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**:

$$\left(\frac{\mathbf{6\ Eq\ SO_4^{2-}}}{\mathbf{1\ mole}\ Al_2(SO_4)_3}\right) \quad \text{or} \quad \left(\frac{\mathbf{1\ mole}\ Al_2(SO_4)_3}{\mathbf{6\ Eq\ SO_4^{2-}}}\right)$$

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 :

$$\frac{0.250\ \cancel{\text{g } Al_2(SO_4)}}{} \left| \frac{1\ \cancel{\text{mole } Al_2(SO_4)_3}}{342.17\ \cancel{\text{g } Al_2(SO_4)_3}} \right| \frac{\mathbf{6\ Eq\ SO_4^{2-}}}{\mathbf{1\ \cancel{mole\ Al_2(SO_4)_3}}} \right| = \mathbf{0.00438\ \ Eq\ \ SO_4^{2-}}$$

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

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

c) How many **equivalents (Eq) of SO_4^{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**!!!!

Concentration of sulfate ions in solution

$$0.0280\ \cancel{\text{L solution}} \times \frac{\mathbf{0.029\ Eq\ SO_4^{2-}}}{\text{L } \cancel{\text{of solution}}} = \mathbf{0.00081\ Eq\ SO_4^{2-}}$$

d) How many liters (L) of this aluminum sulfate solution would contain **0.0025 equivalents Eq of SO_4^{2-}**?

$$0.0025\ \cancel{\text{Eq } SO_4^{2-}} \times \frac{\text{1 L of solution}}{\mathbf{0.029}\ \cancel{\mathbf{Eq\ SO_4^{2-}}}} = \mathbf{0.086\ L\ of\ solution}$$

Molarity calculations (fill-in all the boxes)

solute	moles of solute	grams of solute	volume of solution	Concentration (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 solute	osmoles of solute	grams of solute	volume of solution	Concentration (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 $C_6H_{12}O_6$	1.50 moles	**1.50 osmoles**	**270. g**	**1.23 L**	1.22 osmolar
glucose $C_6H_{12}O_6$	**0.00649 moles**	**0.00649 osmoles**	1.17 g	**.649 L**	0.0100 osmolar
glucose $C_6H_{12}O_6$	**0.0281 moles**	**0.0281 osmoles**	**5.06 g**	0.375 L	0.0750 osmolar