## Calculations Involving Solution Concentration

1. A 0.750 L aqueous solution contains 90.0 g of ethanol, $\mathrm{C}_{2} \mathrm{H}_{5} \mathrm{OH}$. Calculate the molar concentration of the solution in $\mathrm{mol} \cdot \mathrm{L}^{-1}$.
2. What mass of NaCl are dissolved in 152 mL of a solution if the concentration of the solution is 0.364 M ?
3. What mass of dextrose, $\mathrm{C}_{6} \mathrm{H}_{12} \mathrm{O}_{6}$ is dissolved in 325 mL of 0.258 M solution?
4. A mass of 98 g of sulfuric acid, $\mathrm{H}_{2} \mathrm{SO}_{4}$, is dissolved in water to prepare a 0.500 M solution. What is the volume of the solution?
5. A solution of sodium carbonate, $\mathrm{Na}_{2} \mathrm{CO}_{3}$, contains 53.0 g of solute in 215 mL of solution. What is its molarity?
6. What is the molarity of a solution of $\mathrm{HNO}_{3}$ that contains 12.6 g of solute in 5.00 L of solution?
7. What mass of copper(II) nitrate, $\mathrm{Cu}\left(\mathrm{NO}_{3}\right)_{2}$, is present in 50.00 mL of a $4.55 \times 10^{-3} \mathrm{M}$ aqueous solution?
8. A 0.750 L aqueous solution contains 90.0 g of ethanol, $\mathrm{C}_{2} \mathrm{H}_{5} \mathrm{OH}$. Calculate the molar concentration of the solution in $\mathrm{mol} \cdot \mathrm{L}^{-1}$.

## Solution:

1. The question asks for concentration, which means finding molarity, or: $\frac{\text { mole }}{\mathrm{L}}$
2. To convert mass of ethanol to moles, we need to find the molar mass of $\mathrm{C}_{2} \mathrm{H}_{5} \mathrm{OH}$ using the periodic table. Molar mass is $46.1 \mathrm{~g} \cdot \mathrm{~mol}^{-1}$
3. Molarity also requires volume; the question tells us we have 0.750 L .

Put this information together to solve the problem, arranging the information to end up with the desired unit:

$$
\frac{\mathrm{mol}}{\mathrm{~L}}=90.0 \mathrm{~g} \times \frac{1 \mathrm{~mol}}{46.1 \mathrm{~g}} \times \frac{1}{0.750 \mathrm{~L}}=\frac{2.60 \mathrm{~mol}}{\mathrm{~L}} \text { or } 2.60 \mathrm{M}
$$

## Our final answer: $\left[\mathrm{C}_{2} \mathrm{H}_{\mathbf{5}} \mathrm{OH}\right]=\mathbf{2 . 6 0 M}$

2. What mass of NaCl are dissolved in 152 mL of a solution if the concentration of the solution is 0.364 M ?

## Solution:

1. The question asks for mass, so we want to calculate grams
2. We are given the concentration. I suggest you rewrite the concentration as
shown to the right, to better see how the units will cancel out.
3. Because the question involves mass, we will need to know the molar mass of NaCl

Using a periodic table we find the molar mass of NaCl to be $58.5 \mathrm{~g} \cdot \mathrm{~mol}^{-1}$
4. The question gives us the volume in mL . Our unit of concentration uses L , so we will convert 152 mL into 0.152 L .

Put this information together to solve the problem, arranging the information to end up with the desired unit:

$$
\mathrm{g}=\frac{58.5 \mathrm{~g}}{\mathrm{~mol}} \times \frac{0.364 \mathrm{~mol}}{\mathrm{~L}} \times 0.152 \mathrm{~L}=3.24 \mathrm{~g}
$$

## Answer: 3.24 g of NaCl will be required.

3. What mass of dextrose, $\mathrm{C}_{6} \mathrm{H}_{12} \mathrm{O}_{6}$ is dissolved in 325 mL of 0.258 M solution?

## Solution:

1. The question asks for mass, so we want to calculate grams
2. We are given the concentration $(0.258 \mathrm{M})$. I suggest you rewrite the
concentration as shown to the right, to better see how the units will cancel out.
3. Because the question involves mass, we will need to know the molar mass of $\mathrm{C}_{6} \mathrm{H}_{12} \mathrm{O}_{6}$ Using a periodic table we find the molar mass of $\mathrm{C}_{6} \mathrm{H}_{12} \mathrm{O}_{6}$ to be $180.1 \mathrm{~g} \cdot \mathrm{~mol}^{-1}$
4. The question gives us the volume in mL. Our unit of concentration uses $L$, so we will convert 325 mL into 0.325 L .

Put this information together to solve the problem, arranging the information to end up with the desired unit:

$$
\mathrm{g}=\frac{180.1 \mathrm{~g}}{\mathrm{~mol}} \times \frac{0.258 \mathrm{~mol}}{\mathrm{~L}} \times 0.325 \mathrm{~L}=15.1 \mathrm{~g}
$$

## Answer: 15.1 g of dextrose will be required.

4. A mass of 98 g of sulfuric acid, $\mathrm{H}_{2} \mathrm{SO}_{4}$, is dissolved in water to prepare a 0.500 M solution. What is the volume of the solution?

## Solution:

1. The question asks for volume, so we want to calculate litres, L (or mL )
2. The concentration of the solution is: $\frac{0.500 \mathrm{~mol}}{\mathrm{~L}}$
3. Because the question involves mass, we will need to know the molar mass of $\mathrm{H}_{2} \mathrm{SO}_{4}$

Using a periodic table we find the molar mass of $\mathrm{H}_{2} \mathrm{SO}_{4}$ to be $98.1 \mathrm{~g} \cdot \mathrm{~mol}^{-1}$
Put this information together to solve the problem, arranging the information to end up with the desired unit:

$$
\mathrm{L}=\frac{1 \mathrm{~L}}{0.500 \mathrm{~mol}} \times \frac{1 \mathrm{~mol}}{98.1 \mathrm{~g}} \times 98.0 \mathrm{~g}=2.00 \mathrm{~L}
$$

Answer: The volume of the solution will be 2.00 L .
5. A solution of sodium carbonate, $\mathrm{Na}_{2} \mathrm{CO}_{3}$, contains 53.0 g of solute in 215 mL of solution. What is its molarity?

## Solution:

1. The question asks for molarity: $\frac{\text { mole }}{\mathrm{L}}$
2. To convert mass of ethanol to moles, we need to find the molar mass of $\mathrm{Na}_{2} \mathrm{CO}_{3}$ using the periodic table. The molar mass of $\mathrm{Na}_{2} \mathrm{CO}_{3}$ is $106.0 \mathrm{~g} \cdot \mathrm{~mol}^{-1}$
3. Molarity also requires volume; the question tells us we have 215 mL , or 0.215 L .

Put this information together to solve the problem, arranging the information to end up with the desired unit:

$$
\frac{\mathrm{mol}}{\mathrm{~L}}=53.0 \mathrm{~g} \times \frac{1 \mathrm{~mol}}{106.0 \mathrm{~g}} \times \frac{1}{0.215 \mathrm{l}}=\frac{2.33 \mathrm{~mol}}{\mathrm{~L}}
$$

## Our final answer: $\left[\mathrm{Na}_{2} \mathrm{CO}_{3}\right]=2.33 \mathrm{M}$

6. What is the molarity of a solution of $\mathrm{HNO}_{3}$ that contains 12.6 g of solute in 5.00 L of solution?

## Solution:

1. The question asks for molarity: $\frac{\text { mole }}{\mathrm{L}}$
2. To convert mass of ethanol to moles, we need to find the molar mass of $\mathrm{HNO}_{3}$ using the periodic table. Molar mass is $64.0 \mathrm{~g} \cdot \mathrm{~mol}-1$
3. Molarity also requires volume, L ; the question tells us we have 5.00 L .

Put this information together to solve the problem, arranging the information to end up with the desired unit:

$$
\frac{\mathrm{mol}}{\mathrm{~L}}=12.6 \mathrm{~g} \times \frac{1 \mathrm{~mol}}{64.0 \mathrm{~g}} \times \frac{1}{5.00 \mathrm{~L}}=\frac{0.0393 \mathrm{~mol}}{\mathrm{~L}}
$$

Final answer: $\left[\mathrm{HNO}_{3}\right]=3.93 \times 10^{-2} \mathrm{M}$
7. What mass of copper(II) nitrate, $\mathrm{Cu}\left(\mathrm{NO}_{3}\right)_{2}$, is present in 50.00 mL of a $4.55 \times 10^{-3} \mathrm{M}$ aqueous solution?

## Solution:

1. The question asks for mass, so we need to calculate grams
2. We are given the concentration: $\frac{4.55 \times 10^{-3} \mathrm{~mol}}{\mathrm{~L}}$
3. Because the question involves mass, we will need to know the molar mass of $\mathrm{Cu}\left(\mathrm{NO}_{3}\right)_{2}$ Using a periodic table we find the molar mass of $\mathrm{Cu}\left(\mathrm{NO}_{3}\right)_{2}$ to be $187.6 \mathrm{~g} \cdot \mathrm{~mol}^{-1}$
4. The question gives us the volume in mL . Our unit of concentration uses L , so we will convert 50.00 mL into 0.0 .05000 L .

Put this information together to solve the problem, arranging the information to end up with the desired unit:

$$
\mathrm{g}=\frac{187.6 \mathrm{~g}}{\mathrm{~mol}} \times \frac{4.55 \times 10^{-3} \mathrm{~mol}}{\mathrm{~L}} \times 0.500 \mathrm{~L}=4.27 \times 10^{-2} \mathrm{~g}
$$

Final answer: $4.27 \times \mathbf{1 0}^{-\mathbf{2}} \mathrm{g}$ of copper(II) nitrate are present.

