Solutions Worksheet #1: Molarity

Molarity = \frac{\text{moles}}{\text{Liters}}

1) Compute the mass of solute needed to make 500.0 mL of solution at the indicated molarity.

   a: 0.5M sulfuric acid
   \[
   0.5M = \frac{\text{mol}}{0.5L} \quad \implies \quad \text{mol} = 0.25 \text{mol} \times \frac{98.08 g}{1 \text{mol H}_2\text{SO}_4} = 24.52 g
   \]

   b: 0.1M iron (III) chloride
   \[
   0.1M = \frac{\text{mol}}{0.5L} \quad \implies \quad \text{mol} = 0.05 \text{mol} \times \frac{93.55 g}{1 \text{mol FeCl}_3} = 4.68 g
   \]

   c: 0.01M HNO₃
   \[
   0.01M = \frac{\text{mol}}{0.5L} \quad \implies \quad \text{mol} = 0.005 \text{mol} \times \frac{63.02 g}{1 \text{mol HNO}_3} = 0.315 g
   \]

   d: 3M NH₃
   \[
   3M = \frac{\text{mol}}{0.5L} \quad \implies \quad \text{mol} = 1.5 \text{mol} \times \frac{17.03 g}{1 \text{mol NH}_3} = 25.5 g
   \]

   e: 6.0M HCl
   \[
   6.0M = \frac{\text{mol}}{0.5L} \quad \implies \quad \text{mol} = 3 \text{mol} \times \frac{36.46 g}{1 \text{mol HCl}} = 109.4 g
   \]

   f: 5.0M KOH
   \[
   5.0M = \frac{\text{mol}}{0.5L} \quad \implies \quad \text{mol} = 2.5 \text{mol} \times \frac{56.11 g}{1 \text{mol KOH}} = 140.3 g
   \]

   g: 0.50M sodium hydroxide
   \[
   0.50M = \frac{\text{mol}}{0.5L} \quad \implies \quad \text{mol} = 0.25 \text{mol} \times \frac{40.03 g}{1 \text{mol NaOH}} = 10 g
   \]

2) Complete the table:

<table>
<thead>
<tr>
<th>Solute Formula</th>
<th>Name of Solute</th>
<th>Molar Mass (Solute)</th>
<th>Mass of Solute (grams)</th>
<th>Moles of Solute (moles)</th>
<th>Molarity of Solution (M)</th>
<th>Volume of Solution (L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NaCl</td>
<td>Sodium chloride</td>
<td>58.44 g/mol</td>
<td>58.44</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>NaOH</td>
<td>Sodium hydroxide</td>
<td>40.00 g/mol</td>
<td>117.0</td>
<td>2.9</td>
<td>0.7</td>
<td>4.0</td>
</tr>
<tr>
<td>MgCl₂</td>
<td>Magnesium chloride</td>
<td>95.21 g/mol</td>
<td>190.3</td>
<td>2.0</td>
<td>1.0</td>
<td>2.0</td>
</tr>
<tr>
<td>NaCl</td>
<td>Sodium chloride</td>
<td>40.00 g/mol</td>
<td>292.5</td>
<td>7.3</td>
<td>0.5</td>
<td>141.6</td>
</tr>
<tr>
<td>KBr</td>
<td>Potassium bromide</td>
<td>119.00 g/mol</td>
<td>238.0</td>
<td>2.0</td>
<td>2.0</td>
<td>1.0</td>
</tr>
<tr>
<td>FeCl₃</td>
<td>Iron (III) chloride</td>
<td>91.30 g/mol</td>
<td>182.6</td>
<td>2.0</td>
<td>0.1</td>
<td>5.0</td>
</tr>
<tr>
<td>HCl</td>
<td>Hydrochloric acid</td>
<td>36.46 g/mol</td>
<td>438.0</td>
<td>12.0</td>
<td>6.0</td>
<td>2.0</td>
</tr>
</tbody>
</table>

Show your work here:
3) Calculate the number of moles and the number of grams of solute in each solution:

<table>
<thead>
<tr>
<th>Volume and Molarity of solution</th>
<th>Moles of solute (mol)</th>
<th>Molar Mass of solute (g/mol)</th>
<th>Mass of solute (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0 liter of .5 M NaCl</td>
<td>0.5 mol</td>
<td>58.44</td>
<td>29.22</td>
</tr>
<tr>
<td>500.0 mL of 2.0 M KNO₃</td>
<td>1.0 mol</td>
<td>101.11</td>
<td>101.11</td>
</tr>
<tr>
<td>250.0 mL of 1.0 M CaCl₂</td>
<td>1.075 mol</td>
<td>110.98</td>
<td>2.77</td>
</tr>
<tr>
<td>2.0 liters of .30 M Na₂SO₄</td>
<td>0.60 mol</td>
<td>142.05</td>
<td>85.23</td>
</tr>
</tbody>
</table>

Show your work here:

4) How many moles of H₂SO₄ are in 1.00 liter of a 1.55M H₂SO₄ solution? How many grams?

\[ 1.55 \text{ M} = \frac{\text{mol}}{1.00 \text{ L}} \quad \text{mol} = 1.55 \text{ mol} \times \frac{98.079 \text{ g} \text{H}_2\text{SO}_4}{1 \text{ mol} \text{H}_2\text{SO}_4} = 151.9 \text{ g} \text{H}_2\text{SO}_4 \]

5) How many grams of sodium sulfate are contained in 1.50L of 0.25M solution?

\[ 0.25 \text{ M} = \frac{\text{mol}}{1.50 \text{ L}} \quad \text{mol} = 0.1375 \text{ mol} \times \frac{142.08 \text{ g} \text{Na}_2\text{SO}_4}{1 \text{ mol} \text{Na}_2\text{SO}_4} = 53.2 \text{ g} \text{Na}_2\text{SO}_4 \]

6) How many grams of ammonium sulfate are required to prepare 3.50L of a 1.55M solution?

\[ 1.55 \text{ M} = \frac{\text{mol}}{3.50 \text{ L}} \quad \text{mol} = 5.425 \text{ mol} \times \frac{132.139 \text{ g} (\text{NH}_4)\text{}_{2}\text{SO}_4}{1 \text{ mol} (\text{NH}_4)\text{}_{2}\text{SO}_4} = 868.7 \text{ g} (\text{NH}_4)\text{}_{2}\text{SO}_4 \]

7) How many moles of sodium chromate are contained in 1.75 L of a 2.00M solution?

\[ 2.00 \text{ M} = \frac{\text{mol}}{1.75 \text{ L}} \quad \text{mol} = 3.5 \text{ mol} \]

8) A sample of glucose (C₆H₁₂O₆) is dissolved in water. How many moles of glucose are dissolved in 200.0 mL of solution if its concentration is 0.150M?

\[ 0.150 \text{ M} = \frac{\text{mol}}{0.2 \text{ L}} \quad \text{mol} = 6.03 \text{ mol} \times \frac{180.16 \text{ g} \text{C}_6\text{H}_{12}\text{O}_6}{1 \text{ mol} \text{C}_6\text{H}_{12}\text{O}_6} = 5.413 \]

9) A mass of 98g of sulfuric acid are dissolved in water to prepare a .50M solution. What is the volume of the solution, in liters?

\[ 0.50 \text{ M} = \frac{1 \text{ mol}}{x} \quad 98 \text{ g} \times \frac{1 \text{ mol} \text{H}_2\text{SO}_4}{98.079 \text{ g} \text{H}_2\text{SO}_4} = 1 \text{ mol} \]

\[ x = 2 \text{ L} \]

10) What is the molarity of a solution of HNO₃ that contains 12.6g of solute in 500ml of solution?

\[ \frac{12.6 \text{ g} \text{HNO}_3 \times \frac{1 \text{ mol}}{63.02 \text{ g} \text{HNO}_3}}{0.2 \text{ mol} \times \frac{0.5 \text{ L}}{0.4} = 0.4 \text{ M} } \]
Solutions Worksheet #2: Molarity and Dilution Problems

Molarity = \frac{\text{moles}}{\text{Liters}}

1) Describe how you would prepare 5.00 liters of a 6.00M solution of potassium hydroxide.

\[ 6.00M = \frac{x}{5.00L} \quad x = 30.0\text{mol KOH} \times \frac{56.11\text{g KOH}}{1\text{mol KOH}} = 1,683\text{g KOH} \]

Add 1,683g KOH in 5.00 L of water

2) How would you prepare 100.0mL of 0.4M MgSO₄ from a stock solution of 2.0M MgSO₄?

\[ 100.0\text{mL} \times 0.4\text{M} = V_2 \times 2.0\text{M} \quad V_2 = 20\text{mL} \]

Put 20mL of 2.0M MgSO₄ in a flask and add water until the volume reaches 100mL

3) If 1.00L of water is added to 3.00 L of a 0.60M solution of HCl, what is the new molarity of the acid solution?

\[ 6.00M \times 3.00L = M_2 \times 4.00L \]

\[ M_2 = \frac{4.5M}{1} \]

4) What is the concentration when 50.0mL of 1.0M Na₂SO₄ is diluted to 500mL?

\[ 1.0M \times 50.0\text{mL} = M_2 \times 500\text{mL} \]

\[ M_2 = 0.1M \]

5) How would you prepare 4.0L of 0.5M sodium carbonate from a 10.0M solution?

\[ 10.0M \times V_1 = 0.5M \times 4.0L \quad V_1 = 0.2L \]

0.2L of 10.0M sodium carbonate solution in a volumetric flask and add water to the 4.0L mark

6) You need 267mL of 0.25M NaCl, but the only supply of NaCl you have is 1.75M NaCl. How do you prepare the required solution?

\[ 1.75M \times V_1 = 0.25M \times 267\text{mL} \quad V_1 = 38.1\text{mL} \]

Add 38.1mL of 1.75M NaCl solution in a volumetric flask and dilute with water to the 267mL mark
7) Describe how you would prepare 1.50L of a 0.25M solution of sodium sulfate.

\[
0.25\text{M} = \frac{x}{1.50\text{L}} \Rightarrow x = 0.375\text{mol} \cdot \frac{141.99\text{g}}{1\text{mol}} = 53.25\text{g}
\]

add 53.25g Na₂SO₄ to 1.50L of water

8) Calculate the molarity of a solution containing 10.0 grams of sulfuric acid in 500 ml of solution.

\[
10.0\text{g H}_2\text{SO}_4 \times \frac{1\text{mol H}_2\text{SO}_4}{98.08\text{g H}_2\text{SO}_4} = 0.10\text{mol H}_2\text{SO}_4
\]

\[
M = \frac{0.10\text{mol}}{0.500\text{L}} = 0.20\text{M}
\]

9) Hydrogen peroxide solution for hair bleaching is usually prepared by mixing 5.0 g of hydrogen peroxide, H₂O₂, per 100.0 ml of solution. What is the molarity of this solution?

\[
5.0\text{g H}_2\text{O}_2 \times \frac{1\text{mol}}{34.02\text{g}} = 0.147\text{mol} \Rightarrow M = \frac{0.147\text{mol}}{0.10\text{L}} = 1.47\text{M}
\]

10) A chemist wants to dilute 50.0 ml of 3.50 M Sulfuric acid to 2.00 M Sulfuric acid. To what volume must it be diluted?

\[
3.50\text{M} \cdot 50.0\text{mL} = 2.00\text{M} \cdot V_2
\]

\[
V_2 = 87.5\text{mL}
\]