Lab Activity- Kool-Aid Concentration

Introduction: This activity introduces you to solutions and allows you to experience making different concentrations of Kool-Aid solution. There are many ways to calculate the concentration of a substance including: molarity (M), parts per million (ppm), percent composition (% comp), and grams per liter (g/L). In chemistry, concentration is usually measured by the number of moles of substance dissolved in a liter of liquid. This is called molarity and is expressed as mol/L or M (The formula is: M = moles/Liter).

Purpose:
- Practice molarity calculations in order to make 3 different solutions of Kool-Aid with the following concentrations: 0.1 M, 0.4 M, & 0.7 M.
- Determine the concentration (molarity) of properly made Kool-Aid through a taste test.

Materials:
Kool-Aid Powder, Popsicle sticks (to stir solutions), Water, Balance, Plastic cups

Pre-Lab Calculations: For full credit you must show the formula, all your work, and box/highlight your answer!

1. If 0.35 moles of NaCl was dissolved in enough water to make 200 ml of solution, what is the molarity? (NOTE: 1000 ml = 1 L)
   
   Step 1: \[
   \frac{200 \text{ mL}}{1000 \text{ mL}} = 0.2 \text{ L}
   \]

   Step 2: \[
   \frac{0.35 \text{ mol NaCl}}{0.2 \text{ L}} = 1.75 \text{ M NaCl} \rightarrow 2 \text{ M NaCl}
   \]

2. You are asked to make 500 mL of a 0.250 M sodium chloride (NaCl) solution.
   a. How many moles of NaCl would you need?
   
   \[
   0.250 \text{ M} = \frac{x \text{ mol NaCl}}{0.5 \text{ L}}
   \]
   
   \[
   x = 0.125 \text{ mol NaCl}
   \]

   b. How many grams of NaCl would you need?
   
   \[
   \frac{0.125 \text{ mol NaCl}}{1 \text{ mol NaCl}} = 58 \text{ g NaCl}
   \]

   \[
   \Rightarrow 7 \text{ g NaCl}
   \]

3. You need to prepare 100 mL of a 0.050 M solution of calcium chloride (CaCl₂).
   a. How many moles of CaCl₂ are needed?
   
   \[
   0.050 \text{ M} = \frac{x \text{ mol CaCl₂}}{0.1 \text{ L}}
   \]
   
   \[
   x = 0.005 \text{ mol CaCl₂}
   \]

   b. How many grams of CaCl₂ are needed?
   
   \[
   \frac{0.005 \text{ mol CaCl₂}}{1 \text{ mol CaCl₂}} = 110 \text{ g CaCl₂}
   \]

   \[
   \Rightarrow 0.55 \text{ g CaCl₂}
   \]

4. YOUR KOOl-AID CALCULATIONS: SHOW WORK!

**The “molar mass” of Kool-Aid powder: 342 g/mol**

Kool-Aid is mostly sucrose sugar (C₁₂H₂₂O₁₁)**

<table>
<thead>
<tr>
<th>Cup #1</th>
<th>100 mL of a 0.1 M solution:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calculate # of moles of Kool-Aid powder needed:</td>
<td>0.1 M = \frac{x \text{ mol C₁₂H₂₂O₁₁}}{0.1 \text{ L}}</td>
</tr>
</tbody>
</table>
| \*
| x = 0.01 mol C₁₂H₂₂O₁₁ |

<table>
<thead>
<tr>
<th></th>
<th>342 g</th>
<th>C₁₂H₂₂O₁₁</th>
<th>0.01 mol</th>
</tr>
</thead>
<tbody>
<tr>
<td>*</td>
<td>1 mol</td>
<td>C₁₂H₂₂O₁₁</td>
<td>*</td>
</tr>
<tr>
<td>*</td>
<td>3.42 g</td>
<td>C₁₂H₂₂O₁₁</td>
<td>*</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cup #2</th>
<th>100 mL of a 0.4 M solution:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calculate # of moles of Kool-Aid powder needed:</td>
<td>0.4 M = \frac{x \text{ mol C₁₂H₂₂O₁₁}}{0.1 \text{ L}}</td>
</tr>
</tbody>
</table>
| \*
| x = 0.04 mol C₁₂H₂₂O₁₁ |

<table>
<thead>
<tr>
<th></th>
<th>342 g</th>
<th>C₁₂H₂₂O₁₁</th>
<th>0.04 mol</th>
</tr>
</thead>
<tbody>
<tr>
<td>*</td>
<td>1 mol</td>
<td>C₁₂H₂₂O₁₁</td>
<td>*</td>
</tr>
<tr>
<td>*</td>
<td>13.68 g</td>
<td>C₁₂H₂₂O₁₁</td>
<td>*</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cup #3</th>
<th>100 mL of a 0.7 M solution:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calculate # of moles of Kool-Aid powder needed:</td>
<td>0.7 M = \frac{x \text{ mol C₁₂H₂₂O₁₁}}{0.1 \text{ L}}</td>
</tr>
</tbody>
</table>
| \*
| x = 0.07 mol C₁₂H₂₂O₁₁ |

<table>
<thead>
<tr>
<th></th>
<th>342 g</th>
<th>C₁₂H₂₂O₁₁</th>
<th>0.07 mol</th>
</tr>
</thead>
<tbody>
<tr>
<td>*</td>
<td>1 mol</td>
<td>C₁₂H₂₂O₁₁</td>
<td>*</td>
</tr>
<tr>
<td>*</td>
<td>23.94 g</td>
<td>C₁₂H₂₂O₁₁</td>
<td>*</td>
</tr>
</tbody>
</table>
Procedure to making Kool-Aid (for every lab group of 3-4 people):
1. Using your calculations from question #4 above, measure out the correct amount of solid Kool-Aid powder (grams) into the assigned cup to make a 0.1 M solution. Be careful not to include the mass of the cup in your measurement!
2. Transfer the powder into the assigned “mixing cup”.
3. Add water into the “mixing cup” until you have 100 mL of solution. Stir with a spoon or stick.
4. Observe and taste the solutions you have made. You can have one “designated taster” or you can pour a little into separate little cups for each group member to taste. Record in data table.
5. Repeat steps 1-5 in order to make the 0.4 M and 0.7 M solutions.
6. Clean-Up…Throw away cups that you drank out of, but save the mixing & measuring cups.

<table>
<thead>
<tr>
<th>Data / Observations:</th>
<th>0.1 M solution:</th>
<th>0.4 M solution:</th>
<th>0.7 M solution:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Observations</strong></td>
<td>Answers will vary</td>
<td>Answers will vary</td>
<td>Answers will vary</td>
</tr>
<tr>
<td>- looks (colors), smells, tastes</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

Calculations / Analysis:
1. Which concentration that you tested was closest to the ideal concentration of Kool-Aid? What was wrong with each of the other solutions that you made?
   Answers will vary. Some solutions will not have enough Kool-Aid for your taste, while others will have too much.

2. What was the **solute** used in this lab? What was the **solvent**?
   Solute = Kool-Aid powder  Solvent = water

3. What is molarity?
   Molarity is a measure of the number of moles of solute per liter of solution.

Questions for discussion: You must show the formula, all your work, and box/highlight your answers!
1. Write the formulas for the 4 different ways to calculate concentrations:
   a. Molarity
   \[ M = \frac{\text{Moles}}{\text{Liters}} \]
   b. grams/ Liter
   \[ M = \frac{\text{Grams of Solute}}{\text{Liters of Solution}} \]
   c. % composition
   \[ M = \frac{\text{Grams of Solute}}{\text{Grams of Solution}} \times 100 \]
   d. Parts per million
   \[ M = \frac{\text{Grams of Solute}}{\text{Liters of Solution}} \times 10^6 \]

Determine the following concentrations using the 4 different methods:
   **(Reminder: 1 gram H$_2$O = 1 mL & 1 L = 1000 mL)**
2. If 1.80 moles of NaCl was dissolved in enough water to make 3.60 L of solution:
   a. Molarity?
   \[ M = \frac{1.80 \text{ mol}}{3.60 \text{ L}} = 0.500 \text{ M NaCl} \]
   b. Grams/ Liter?
   \[ \frac{104 \text{ g NaCl}}{3.60 \text{ L}} = 28.9 \text{ g/L} \]
   c. % composition?
   \[ \frac{104 \text{ g NaCl}}{3600 \text{ g}} \times 100 = 2.89\% \text{ NaCl} \]
   d. Parts per million?
   \[ \frac{104 \text{ g NaCl}}{3600 \text{ g}} \times 10^6 = 289,900 \text{ ppm} \]
3. If 20 grams of NaOH was dissolved in enough water to make a 250 mL NaOH solution:
   a. Molarity?
   \[ M = \frac{0.5 \text{ mol}}{0.25 \text{ L}} = 2.0 \text{ M NaOH} \]
   b. Grams/ Liter?
   \[ \frac{20 \text{ g NaOH}}{0.25 \text{ L}} = 80 \text{ g/L} \]
   c. % composition?
   \[ \frac{20 \text{ g NaOH}}{250 \text{ g}} \times 100 = 8\% \text{ NaOH} \]
   d. Parts per million?
   \[ \frac{20 \text{ g NaOH}}{250 \text{ g}} \times 10^6 = 80,000 \text{ ppm} \]