Lab: Kool-Aid

Summary
In this lab, students calculate grams of Kool-Aid powder required to make 3 different solutions of Kool-Aid (C₁₂H₂₂O₁₁) with the following concentrations: 0.2 M, 0.5 M, and 1.0M. Determine the concentration (molarity) of properly prepared Kool-Aid through a taste test.

Resource Type Lab

Grade Level High school

Objectives
By the end of this lesson, students should be able to
• explain the concept of molarity.
• calculate the number of grams of solute required to produce a given molarity of solution.

Chemistry Topics
This lesson supports students’ understanding of
• Solutions
• Molarity

Time
Teacher Preparation: 1 hour
Lesson: 1 hour

Materials
For each group:
• Kool-Aid powder
• Water
• Plastic cups
• Balance

Safety
• Food in the lab should be considered a chemical, not for consumption.
• Always wear safety goggles when handling chemicals in the lab.
• If you allow students to consume the Kool-Aid, conduct this experiment outside of a lab setting and do not measure any ingredients with glassware from the lab.

Teacher Notes
• Keep plenty of paper towels on hand in case of spills.

FOR THE STUDENT

Student Activity Sheet: Kool-Aid Lab
Lesson

Background
This activity reviews stoichiometry and solutions by making different concentrations of a 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 (formula: molarity = moles/volume).

Prelab Questions
1. Calculate the molar mass of Kool-Aid. Assume the solute is pure table sugar, called sucrose. Its chemical formula is C\textsubscript{12}H\textsubscript{22}O\textsubscript{11}.
2. What mass of Kool-Aid is needed to make a 0.2-M solution from 100 mL? (Hint: two step problem–molarity, mole conversion)
3. What mass of Kool-Aid is needed to make a 0.5-M solution from 100 mL?
4. What mass of Kool-Aid is needed to make a 1.0-M solution from 100 mL?
5. A chemist makes two Kool-Aid solutions with varying concentrations. The chemist makes solution A by dissolving 50.0 g of sugar in 400.0 mL of water. She then makes solution B by dissolving 50.0 g of sugar in 200.0 mL of distilled water. What can be said about the solution’s concentrations? (use at least three of the following terms in your explanation: saturated, dilute, supersaturated, homogeneous, unsaturated, solvent, solute, solution)

Purpose
Apply your knowledge to calculate grams of Kool-Aid powder required to make three different solutions of Kool-Aid (C\textsubscript{12}H\textsubscript{22}O\textsubscript{11}) with the following concentrations: 0.2 M, 0.5 M and 1.0 M. Determine the concentration (molarity) of properly prepared Kool-Aid through a taste test.

Hypothesis
Make an educated guess: Which of the three solutions will provide the best tasting drink?

Procedure
Part I:
1. Select your taster(s). Taste the Kool-Aid and rank on a scale of 1-5 (1 = gross and 5 = amazing taste). Create a data table to record the amount of Kool-Aid used (in grams), color, and taste ranking.
2. Mix the Kool-Aid ($C_{12}H_{22}O_{11}$) exactly following the directions for one serving size. Label cup “Control.”
   a. Measure 1 cup of water. Convert cups into liters.
   b. Find the mass of 1 tablespoon of Kool-Aid powder in grams.

Part II:
1. Mark the 100-mL mark on a plastic cup by measuring 2.5 cm from the bottom of the cup and drawing a line. (Usually you would use more accurate measuring techniques, but you can’t drink out of lab equipment.) Repeat on all three cups.
   a. Measure the mass of the plastic cup = __________ g
2. Create a data table to record the mass of solute (Kool-Aid) used in grams, color, taste ranking (1-5), and smell description for each solution concentration (0.2 M, 0.5 M, and 1.0 M).
3. Use each cup to mass out the correct amount of solid Kool-Aid for each solution sample. Use the mass values from the prelab.
4. Add water to the cup until you have 0.1 L of solution (fill it up to the line you drew). Stir. Repeat for all three solution concentrations.
5. Observe and taste the solutions you have made.
6. Record your observations: (ex. looked like? Taste? Which seems more concentrated, saturated, supersaturated, unsaturated?)

Analysis
(Reminder: 1 gram H$_2$O = 1 mL; 1 L = 1,000 mL)
1. Was your hypothesis supported by your lab findings/evidence? Explain.
2. If you were working for the Kool-Aid company, which concentration would you recommend to customers? Explain why, using evidence and reasoning to support your claim.
3. If 104 grams of Kool-Aid was dissolved in enough water to make 3.60 L of solution, what would be the:
   a. Molarity?
   b. g/L?
   c. % mass composition?
   d. ppm?
4. Bryan loves Kool-Aid. He makes a super-concentrated solution of Kool-Aid by heating water to boiling and then dissolving Kool-Aid until no more would dissolve. After cooling, he notices that there is a bunch of Kool-Aid powder on the bottom of his solution. What happened? Explain your answer.
5. Assume you added citric acid (H$_3$C$_6$H$_5$O$_7$) and baking soda (NaHCO$_3$) to the Kool-Aid solution to create a fizzy drink. The following is the reaction that would take place:
   citric acid + baking soda $\rightarrow$ sodium citrate (Na$_3$C$_6$H$_5$O$_7$) + water + carbon dioxide
   a. Write out the balance equation for the chemical reaction.
   b. What is the molar mass of citric acid?
c. If you used 10.0 grams of citric acid how many moles of citric acid would you have?
d. How many moles of carbon dioxide would be produced from 10 grams of citric acid?

**MULTIPLE CHOICE** Explain your answer.

6. If you tried to dissolve Kool-Aid in an ice cube you would have a difficult time. But ice is composed of the same molecule as water, so why is it so difficult to dissolve Kool-Aid in an ice cube?
   a. In ice, the temperature is too low and so the Kool-Aid becomes a solid.
   b. In ice, there is very little random molecular motion so the action of dissolving isn’t as noticeable.
   c. Water is wet and things only dissolve when wet.
   d. Water molecules have a stronger attraction to Kool-Aid particles than ice molecules.

7. Which of the following increases the rate at which a solute is dissolved by a solvent?
   a. Keeping the solution completely still.
   b. Placing the solution in an ice bath as it forms.
   c. Heating the solvent to its boiling point before adding the solute.
   d. Leaving the solute in chunks rather than breaking it up before dissolving it.

**Conclusion**
Write one paragraph that describes what happened in the experiment, what your data tells you about the experiment (restate your results), and what you learned from completing the experiment.