

to Analysis Question 5 was an inference, and what they directly observed to be true as a result of the evaporation was evidence.

6. Discuss how the food coloring is analogous to a toxic substance.



Ask, *Imagine that the food coloring is a toxic substance. Do you think that diluting the substance with a lot of*

water will make it safe? Students' answers will vary. Some should suggest that if it is much more dilute, it may not be harmful. However, it will not be completely gone, and may still cause problems. Remind students of Activity 34, "Water Pollution," where they read that some substances, such as bacterial contaminants, are harmful in very small amounts.

■ EXTENSION 1

Although the concept of parts per ____ is very difficult, it is necessary for expressing concentration. As a demonstration or an additional student activity, you could mix one scoop of cinnamon with nine scoops of salt. Stir the mixture, and record the shade of the color. Take one scoop from Cup 1 and add it to Cup 2. Then add nine scoops of salt to dilute the mixture of cinnamon in salt to one part per 100. Continue the procedure through Cup 9, and observe the progression in the color's shade.

This activity is a concrete example of a serial dilution and an important reinforcement of the concept of particles, as represented by the granules of cinnamon and sugar (although, of course, actual molecules of cinnamon and sugar, or of food coloring dye and water, are far smaller). The concept of particles is used many times throughout the course.

■ EXTENSION 2

Show Transparency 40.1, "Dilution of Red Food Coloring," to help students calculate the percent, fraction, and ratio of cinnamon to salt in the mixture in each cup. You may want to work through one or two examples with the class first and then allow students to work independently to calculate the rest either in class or as homework. This is an excellent way to reinforce the math concepts students are learning in math class.

■ EXTENSION 3

You may wish to have students pick one of the comparisons from Transparency 40.3, "Some Interesting Comparisons," and make a drawing or diagram of the comparison. This can be a very helpful way for students to think about the concept in a more visual way.

SUGGESTED ANSWERS TO QUESTIONS

1. *Which is more dilute, Cup 1 or Cup 2? How do you know this?*


Cup 2, for two reasons. First, the color in Cup 2 is lighter. Second, we know that in Cup 2 we mixed nine drops (parts) of water with one drop (part) of the same red food coloring solution as is present in Cup 1.

2. *If Cup 1 has a concentration of one part in 10, and Cup 2 has 1/10 the concentration of Cup 1, what is the concentration in Cup 2?*

One part per 100.


3. *Which cup has a concentration of one part of food coloring per one million parts of solution?*

Cup 6.

4.  *What is the number of the cup in which the solution first appeared colorless? What is the concentration of the solution in this cup? Hint: Express the answer for concentration as one part per ____.*

Usually it is Cup 5, 6, or 7. This varies depending on students' techniques and abilities to see color.

The concentration in Cup 5 is one part dye per 100,000 parts solution. In Cup 6, the concentration is one part per million or 1 ppm.

5.  *Do you think there is any of the food coloring in Cup 8, even though it appears colorless? Explain.*

Students' answers may vary depending on the inference they make. Some may infer that there must be some food coloring present since it was in the original solution that became colorless with dilution.