



Is Dilution the Solution to Pollution?

Subject: Science (Earth Science, Aquatic Science, Environmental Science)

Grade level: 6-8

Rationale or Purpose: This lab demonstrates the meaning of dilution and shows the possible disconnect between appearance and actual water quality.

Materials:

- two glass beakers for each team
- eyedropper for each team
- white egg carton for each team
- dye
- tap water

Lesson Duration: one 50-minute period

Objectives:

- Science 112.22 (1A), demonstrate safe practices during field and lab investigations
- Science 112.22 (2B), collect data by observing and measuring
- Science 112.22 (2C), analyze and interpret information to construct reasonable explanations
- Science 112.22 (2D), communicate valid conclusions
- Science 112.22 (4A), collect, analyze, and record information using tools
- Science 112.22 (7B), classify substances by their physical and chemical properties

- Science 112.23 (1A), demonstrate safe practices during field and lab investigations
- Science 112.23 (2B), collect data by observing and measuring
- Science 112.23 (2C), analyze and interpret information to construct reasonable explanations
- Science 112.23 (2D), communicate valid conclusions
- Science 112.23 (4A), collect, analyze, and record information using tools
- Science 112.23 (7C), recognize that compounds are composed of elements
- Science 112.23 (14C), draw conclusions about effects of human activities on the environment

- Science 112.24 (1A), demonstrate safe practices during field and lab investigations
- Science 112.24 (2B), collect data by observing and measuring
- Science 112.24 (2C), analyze and interpret information to construct reasonable explanations
- Science 112.24 (2D), communicate valid conclusions
- Science 112.24 (4A), collect, analyze, and record information using tools
- Science 112.24 (12C), predict the results of modifying the Earth's water cycle
- Science 112.24 (14C), draw conclusions about effects of human activities on the environment

Activity:

Step 1: Gather all materials before class

Step 2: Introduce the topic of pollution to the class and explore the different types of pollution in water. Show the class a clear glass of tap water and ask it is safe to drink. Ask why they said yes or no.

Step 3: Instruct students to immediately clean up any spilled water.

Step 4: Describe the lesson steps:

4a: Teacher will put 10 drops of dye into cup #1 for each team.

4b: Record the color of the liquid in cup #1 in the data table.

4c: Using the eyedropper, students will take one drop from cup #1 and place it in cup #2

4d: Rinse eyedropper thoroughly in the rinse beaker.

4e: Add 9 drops of water from the clean water beaker to cup #2. Carefully swirl the egg carton to mix the contents.

4f: Record the color of the liquid in cup #2.

4g: Repeat steps 4c to 4f for each of the remaining cups. Each cup receives one drop from the preceding cup and 9 drops of clean water.

Step 4: Have each team of students get tap water for each of their beakers; also ask them to get one eyedropper per team and to number the cups of the egg carton.

Step 5: Students should complete the exercise and record all their data.

Step 6: Direct students to clean up all materials.

Step 7: Have students calculate the concentration for each cup by multiplying the original drop concentration (the concentration of the last cup from which you just took that drop) by the dilution factor.

Step 8: Instruct students to complete the question sheet.

Modification: none

Student Product: Students will produce a data table and a completed question sheet on the exercise.

Closure: Collect data tables and question sheets. Discuss several questions with the class:

Is dilution the solution for pollution?

At what dilution level would you feel safe drinking water with gasoline?

How would you determine the dilution level that would be considered safe?

Are the safe levels the same for all people? (i.e., children vs. adults)

How can you safely dispose of water contaminated with gasoline?

Assessment or evaluation: Complete the attached grading rubric to evaluate students on correct lab practices, properly completed data table, and correctness of questions.

Extension:

1. Construct graphs (scatter plots with points connected) of the concentration of the dye in each of the cups. Have students describe the shape of the data line and whether it ever hits zero. Discuss how these lower amounts are detected.

2. Have students do research on how maximum contaminant levels are determined; this could include a discussion on the ethics of using animals to test contaminated water.

3. Have students check with the local water company to find out the level of certain contaminants in your local drinking water. Compare these to the federal standards. How do these levels compare to the concentration of the dye in this experiment?

4. Complete this exercise again, but with diesel fuel. In this case, it is odor, not color which is the better detector of the pollutant. Or, complete with salt; make all the mixtures, then taste them (starting with the most dilute) until a salty flavor is detected.

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Materials:

- two glass beakers for each team
- eyedropper for each team
- white egg carton for each team
- dye (teacher will bring to each team)
- tap water

Procedures:

1. Get all materials, except for the dye.
2. Label one beaker "Rinse water" and the other "Clean water."
3. Number the cups in the egg carton, 1 to 12.
4. Have the teacher put 10 drops of dye into cup #1.
5. Record the color of the liquid in cup #1 in the data table.
6. Using the eyedropper, take one drop from cup #1 and place it in cup #2.
7. Rinse eyedropper thoroughly in the "Rinse water" beaker.
8. Add 9 drops of water from the "Clean water" beaker to cup #2. Carefully swirl the egg carton to mix the contents.
9. Record the color of the liquid in cup #2.
10. Repeat steps 6 through 9 for each of the remaining cups. Each cup receives one drop from the preceding cup and 9 drops of clean water.
11. Clean up all materials.
12. Calculate the concentration for each cup by multiplying the original drop concentration (the concentration of the last cup from which you just took that drop) by the dilution factor.
13. Complete the question sheet.

Name: _____ Date: _____

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Data Collection

Cup #	Color	Dilution factor	Concentration
1			100%
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			

Follow-up Questions

1. A 10% solution of dye and water contains _____ parts of solution for every part of dye.
2. Cup #2 is _____ times more dilute than cup #1.
3. In cup #2 there is _____ parts dye for every _____ parts solution.

4. In which cup does the solution first appear to be colorless.

5. What is the concentration in that cup?

6. Do you think there is any dye left in this cup even though it is colorless? Explain.

7. On your chart, label the cup that has a concentration of one part per million with "1 ppm" and the cup with a concentration of one part per billion with "1ppb." Which is the greater concentration, 1 ppm or 1 ppb?

8. Is it possible for chemicals to be in drinking water that cannot be detected by the human eye or taste buds?

9. Name one helpful chemical that is put into your drinking water intentionally by the water company. Why is this chemical used?

10. What can you do as an individual to make certain that harmful chemicals do not pollute your local drinking water?

11. Name one benefit to allowing companies to get rid of their chemical waste by diluting it into lakes and streams. What is the disadvantage to this practice?