CLASSROOM ACTIVITY
Underwater Plume

How does hot water behave within a body of cold water? How does this discovery apply to the search for deep sea vents on the ocean floor? As you and your team conduct your investigation, focus on the questions below. After you have completed the activity, respond to these questions directly in your journal.

- How does water at high temperatures behave within water at low temperatures?
- What is the relationship of temperature to density? In other words, how will hot water behave when it meets cold water? What is the relationship between density and buoyancy? Which will be less dense and thus more buoyant: the hot water or the cold water?
- How might scientists use their understanding of this relationship between the temperature and density of water to find deep sea vents?

Before you begin your investigation, consider what you already know about temperature and density. Use the questions below to structure your discussion and jot down your answers in your journal.

- Why does hot air rise? Do you think hot water behaves the same way? Why or why not?
- What do you think will happen as the very hot fluids escaping the deep sea vents hit the very cold water at the sea floor?

The captain should appoint group members to collect the required materials while the rest of the group reviews today's procedure. Before beginning, the captain should make sure that the group has all required materials, and that everyone knows the day's procedure.

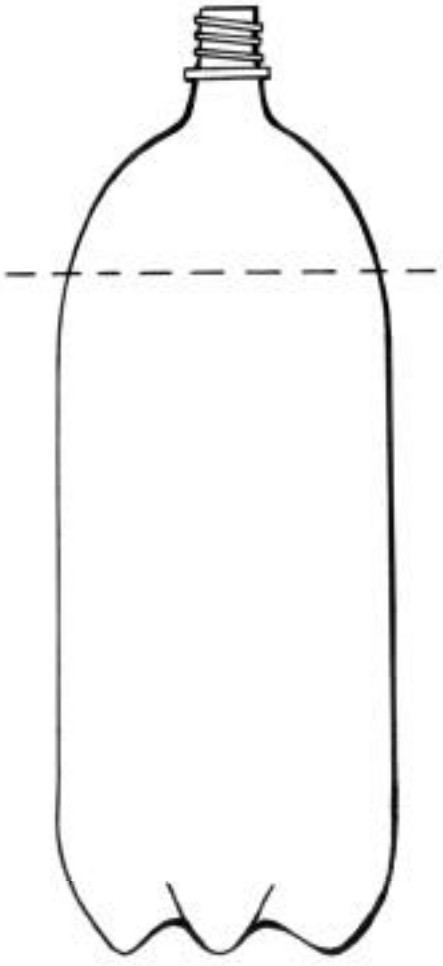
The note taker will take notes on the group's findings for your team, but remember to record your observations and explanations in your journal for your own research notes. Include drawings to illustrate your findings.

CLASSROOM ACTIVITY | Underwater Plume

MATERIALS

- clear, clean two-liter soda bottle
- cold water to fill the soda bottle; hot water to fill small jar
- small piece of aluminum foil to cover small jar
- food coloring (use a dark color, such as blue or purple)
- small baby food jar
- rubber band
- knife/scissors
- paper towels
- white paper

PROCEDURE



1. Prepare the two-liter bottle. Carefully cut the top off the bottle with scissors, right where it begins to bend inward. You should be left with a cylinder bottle; make sure you don't cut off the bottom.

2. Prepare the cover for your small bottle; cut a piece of aluminum foil that will fit snugly over the top of the small bottle with enough overlap to provide a good seal. Secure it with the rubber band. You'll need to take this cover off to fill the bottle with hot water once you're ready to conduct your experiment.

CLASSROOM ACTIVITY | Underwater Plume

3. Use hot and cold water from the tap to fill your bottles. Be sure to let the tap run for a while so you can get the coldest and hottest water available.

4. Now you're almost ready for your experiment. First develop your hypothesis further. Will the hot water escape from the small bottle? Will it mix with the cold water in the large bottle or stay intact? Why or why not If it does mix, how quickly will it do so? Why? Record your prediction on your activity sheet.

5. Fill the large bottle about two-thirds full with cold water. Put about 15 drops of food coloring into the small jar. Then fill it all the way to the top with hot water. Cover the small jar with the aluminum foil cover and allow any excess water to overflow onto a paper towel. Smooth out the aluminum foil and secure it with the rubber band. Quickly clean off any colored water on the outside of the small jar.

6. Place a sheet of white paper behind the large bottle so that you can clearly see what happens in the two-liter bottle.

7. You'll need four team members for this next step: one to hold the large bottle steady, one to lower the small bottle gently to the bottom of the large bottle, one to poke a hole in the aluminum foil cover, and at least one more to watch what happens. Make sure the small bottle person lowers it gently but not too slowly; you want your heat source to be at the bottom when you start observing, before any changes take place. After you lower the small jar into the large bottle, very carefully reach through the water with your scissors and poke a small hole in the aluminum foil. Try to disturb the water as little as possible. Pull your hand out as quickly as you can so you can observe what happens.

CLASSROOM ACTIVITY | Underwater Plume

8. Observe the dark—or hot—water. How does it behave? How does the cold water behave? How can you tell? Describe what happens. Your teacher may request that you repeat the experiment to make sure the pattern is consistent.

9. Discuss what happened, together creating a common explanation for why the hot and cold water behaved this way. How do your observations support your original ideas and hypotheses?

10. How might you apply your discoveries to deep sea exploration? Use the questions on the activity sheet to structure your discussion, and record your ideas on the activity sheet and in your own journal.

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GROUP WORKSHEET 1
DSV TEAM _____

GROUP MEMBERS _____

CAPTAIN _____ NOTE TAKER _____

1. Makes some predictions about what will happen during this experiment. Will the hot water escape from the small bottle? Will it mix with the cold water in the large bottle or remain a separate body? Why or why not? If it does mix, how quickly will it do so? Why?

2. After you lower the small bottle/jar into the large bottle and poke a hole in the aluminum foil cover, describe what you observe. How does the hot water behave? How does the cold water behave? If your teacher asks that you repeat the experiment, describe your second round, too.

HOT WATER
COLD WATER

3. Discuss what happened and why. Record your ideas in the space below.

4. Look back at your predictions Step 1. How do they compare with your outcomes? Which properties of hot/cold water had you taken/not taken into account?

CLASSROOM ACTIVITY | Underwater Plume

GROUP WORKSHEET 3
DSV TEAM _____

5. Consider the "plume" that you created. The ocean is much, much bigger than your soda bottle, and at the sea floor where mid-ocean ridges occur, much, much colder than your cold water. The hot fluid bursting from deep sea vents is also much, much hotter than the water in your smaller bottle. Despite these differences, however, the hot water in your experiment and the hot, mineral-rich water from the vents behave very similarly with respect to cold water. Now that you can visualize the behavior of the hot water based on the results of your experiment, how might you use your knowledge to detect a deep sea vent in the ocean?

6. Begin developing your predictions about life at the deep sea vents. What kinds of organisms might survive in such extremes of temperature? What adaptations would they need?

GROUP DYNAMICS

Comment on how each group member participated in today's discussion.