

Candidate Index Number: \_\_\_\_\_

## Chemistry, Case 1

Topic: The Ice Experiment

Marks: 60

### Credits

Our appreciation to **Li-hsuan Yang**, Department of Education, University of Michigan – Flint, who authored this case study. For purposes of improved readability and summary writing, some modifications **may** have been made to the original text.

### Abstract

Does an ice cube melt more quickly in salt water or in freshwater? The answer surprises a group of science student teachers. To explain the phenomenon they must figure out the interactions between two clusters of concepts: (1) density and its relationship to floating or sinking, and (2) three modes of heat or energy transfer due to a temperature difference (particularly conduction and convection, with an optional discussion of radiation).

### Objectives

- Give the definition of density as mass per unit volume.
- Describe how density affects the floating or sinking behaviour of an object or a fluid.
- Understand that heat transfer resulting from temperature difference can take place in more than one way (conduction, convection, or radiation).
- Describe the mechanisms of conduction and convection.

### The Case

Four students finished some experiments using salt and ice.

In the first experiment, they dropped salt on a block of ice, and they observed that salt made the ice melt at temperatures below its normal melting point. Indeed, salt helps ice to melt.

They now intend to teach this new knowledge they just acquired to their classmates. In their classroom demonstration, they challenged the students to guess which ice cube would melt first, the one in salt water or the one in freshwater. While they did believe that an ice cube in salt water would melt first, to their surprise and ultimate embarrassment, the ice cube in fresh water melted much more quickly than the one in salt water.

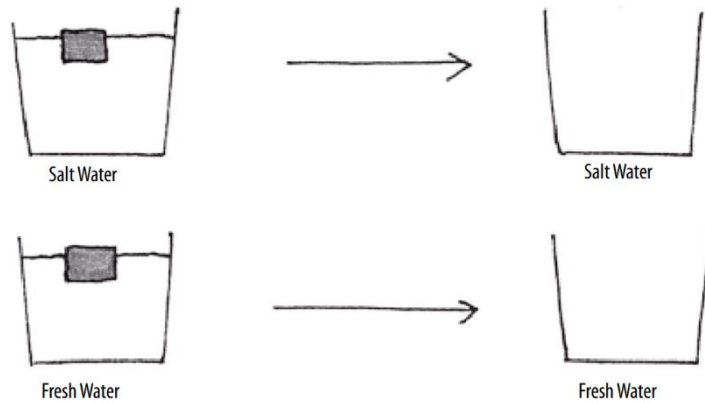
After the school day, the four students returned home in complete disbelief, asking themselves, "How come?". On reaching home,

1. The first student wanted to bake some cookies for her family. As she poured some water and oil into the measuring cup, she noticed that the oil was sitting on top of the water. She thought about that for a moment. Then suddenly she exclaimed, "I know what happened with the ice cubes!"
2. The second went to a hot air balloon show that evening. As he was watching the hot air balloons rising, John said to himself, "I guess I might have an idea to solve the problem involved in our experiment."
3. The third went on a vacation that weekend. As she went swimming in the ocean, she noticed that her body seemed to float higher in ocean water than in fresh water. She thought, "I bet I know why that ice cube in the salt water took so long to melt."
4. The fourth accidentally knocked over a glass of iced tea on the counter of her bathroom. She noticed that the brown iced tea seemed to go to the bottom of the bath tub filled with warm water. She wondered if that has anything to do with their experiment.

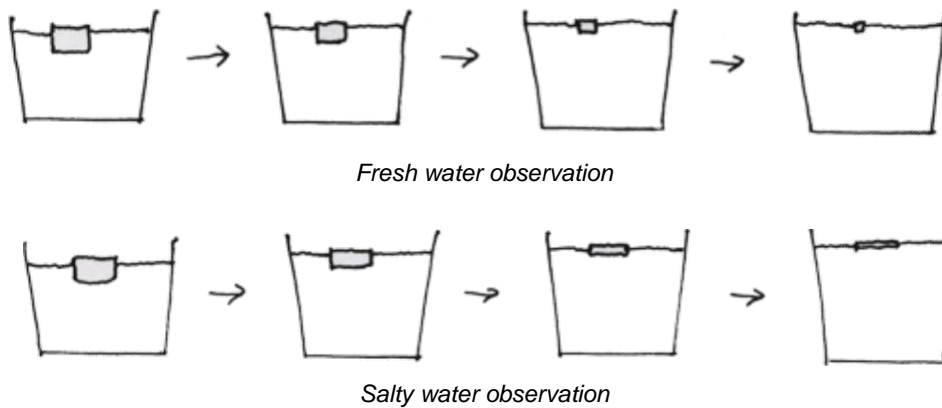
The four students saw each other on Monday. After exchanging ideas, they thought they now had a perfect explanation for the mystery. They wanted to test their idea. They made colored ice cubes by putting several drops of food coloring in the water before freezing it into ice. Then they repeated the original experiment with the colored ice cubes. They couldn't wait to see if the test would confirm their idea or not

### Questions

1. What do you think might be the explanation they are trying to test with the colored ice cubes?
2. If their explanation were correct, draw what you would expect to see in the experiment with colored ice cubes.



As the four students were doing the experiment, they noticed that the two ice cubes not only melted at different rates, they also melted in different ways. The one in fresh water was becoming smaller and smaller all around, but the one in salt water seemed to be staying the same size when looked at from above. The one in salt water was also melting more slowly. It looked like it was not melting from the sides. They wondered whether it was melting from the top down or from the bottom up?



### Questions

1. Do you think the ice cube in salt water is melting from the top down or from the bottom up? Why do you think so?
2. What test would you do to verify your idea?
3. How would you explain what you see in the test?
4. How does the density of an object or a fluid affect its floating or sinking behavior in another fluid? Can you think of examples of this principle at work in everyday experience?
5. What are the two ways that heat is transferred from a region of higher temperature to a region of lower temperature in this example of an ice cube in a glass of water? Is there yet another way that heat could be transferred between two objects?
6. Can you think of examples of heat transfer in everyday experiences? Which way(s) of heat transfer is (are) involved in each example?

