Density and Buoyancy

by Charles Bertsch

Grade level 5

Time required
12 to 15 forty five minute class periods

Materials/Technology
Plastic _ gallon containers
Plastic vials – 1” x 2.5 “
Plastic eyedroppers
Spot plates
Food coloring
Cardboard trays
Paper towels
Glass eyedroppers
7 Up
Clear drinking straws
Salt
Raisins
Bowls
Beakers
Quart jars
Paper clips
Crayons
Empty tea bags
Small objects such as wood blocks, plastic chips, rocks, washers, wax, tin foil, etc.
Research tools such as books, Internet, etc.

Summary
In this unit, students will use the scientific process to investigate the concepts of density and buoyancy. They will apply their knowledge to describe how some Native Americans built and used boats and nets for fishing and travel.

Objectives
The student will:
1) understand the conceptual meanings and relationships of density and buoyancy.
2) plan and conduct scientific investigations to answer questions about density and buoyancy.
3) record scientific data and develop conclusions based on their data.
4) realize some of the idiosyncrasies, benefits and shortcomings of scientific research.
5) research Kootenai and Pend d’Oreille boats and fishing weirs and apply their knowledge of buoyancy and density to explain how they work.

Montana Science standards addressed
1) Students design, conduct, evaluate, and communicate scientific investigations.
2) Students demonstrate knowledge of properties, forms, changes, and interactions of physical and chemical systems.

Assessment
Suggestions for student assessment include:
1) informal observations of students during the activities.
2) using the learning cycle model.
3) having students complete teacher-generated drill and practice activities on vocabulary, concepts and spelling using the following terms: density, buoyancy, dispersion, semipermeable membrane, and Archimedes’ principle.
4) journal writing, student communication, and written tests.

Background
The Scientific Method
Listed below is an outline of the scientific process and how it can be used to get students to enhance their ability to use scientific investigations to solve problems and learn about science:

The Scientific Method-Process:

1) Identifying a Problem
2) Gathering Pertinent Data
3) Formulating a Hypothesis
4) Performing Experiments
5) Interpreting Results
6) Drawing Conclusions and Conjectures

By using the scientific process we are able to formulate and state hypotheses and to evaluate such hypotheses by experimentation or observation. We can also use the scientific process to reinforce writing and organizational skills, help students to become self-directed learners, foster positive student interaction and cooperation, and develop a positive sense of self. We will use the scientific method to inquire, explore, and examine the world rather than merely to expound upon it.

Using an organizational writing strategy that reinforces the scientific process will help us to manage our approach to science inquiry. It gives us a tool that will help to manage a whole group of students while providing a structured process in which students have the chance to formulate and investigate their own research questions. The following writing strategy can be adapted and changed in a variety of ways. What follows is the basic framework on which this writing strategy for scientific investigation is based.

Scientific Process Writing Strategy

1) <u>Research Question</u> – Students formulate and write out a research that reflects an inquiry that is generated from the teacher or students. In the beginning, the writing of the research question will need to be teacher directed. As students begin to become familiar with this process, they will take over control of formulating and writing their research questions, thus giving them more ownership in this process.
2) <u>Procedure</u> - Students will develop and define a procedure that will enable them to formulate a process where they will be able to seek an answer to their research question. In the beginning, this phase will need to be teacher directed. As students develop organizational skills and problem solving strategies, they will be able to design their own procedures for scientific investigation and experimentation.
3) <u>Prediction</u> - Students will write out a prediction or a conjecture based upon previous knowledge and experiences. They will use their past knowledge to guess what may happen when they do their investigations. Thus students will see how their prior knowledge may be changed because of new learning.
4) <u>Investigations and observations</u> - Students will record their observations while they follow their research procedures. Students will need work on developing observational skills and strategies for organizing their observations.
5) <u>Conclusions</u> - After students have recorded their observations, they will use this information to come up with some conclusions about what they have observed. In this phase, students will be given time to share their results and conclusions. Through discussions, students will begin to connect new knowledge with prior knowledge.
6) <u>Hypothesis</u> - From their observations and conclusions, students will formulate a hypothesis that will explain and define their research. In this stage, through teacher and student discus-

sions, students will apply their knowledge to other situations and applications.

7) Proof or experimentation - Students develop a proof or experiment that will help to establish the reliability of their hypothesis. They can also be given the opportunity to investigate and explore new questions that arise as they are working through their experiments.
8) Communication - Students should be given the opportunity to communicate their results with others. They can communicate their findings and thoughts verbally or in a written form. They can use charts, graphs, illustrations, and diagrams to help them explain their information clearly.

This strategy can be adapted and changed in a variety of ways around this basic pattern of investigation. As students become more comfortable and familiar with this process, instruction can move away from teacher-directed instruction to guided-discovery instruction to individualized instruction.

The Activities

The following unit will utilize materials that are simple, inexpensive, and easy to find. All of the activities can be self-directed or teacher initiated investigations that will lead students to perform experiments associated with the concepts of density and buoyancy. The results of the investigations form a foundation of facts from which students make predictions and formulate conclusions. These lessons are intended to give students knowledge of and skills in using the scientific method. Students will come to understand the following concepts: density, buoyancy, dispersion, semi-permeable membrane, and Archimedes' principle.
This unit will take about 12 to 15 forty-five minute periods to finish.

Activity #1
Time required: 45 minutes
Materials (per group): 2 plastic 1/2-gallon containers
4 plastic vials about 1" x 2.5"
2 plastic eyedroppers
1 spot plate
Food coloring (blue, red, green, and yellow, diluted with 20 parts water)
Cardboard tray (for students to work on)
Paper towels (for clean up)

This activity will involve dropping food coloring into some water and making an observation. Discussions about student observations should lead to some unanswered questions and further investigation. The main purpose of this activity is to familiarize students with the equipment, introduce a simple version of the scientific process, and stimulate an interest in the other activities.
Procedure:
Distribute student materials. The teacher puts two different colors of food coloring in each group's spot plate. Students fill their vials with water and then drop one food coloring and then another into the vial of water.
Have the students use and write out a short version of the scientific process to guide them in their investigation. Listed below is an example:

1) Research question: What will happen when I drop five drops of blue food coloring and then five drops of yellow food coloring into a vial of water?
2) Prediction: The colors will mix to form a new color.
3) Observation: The blue food coloring sinks to the bottom and slowly spreads out, etc.

Activity #2
<u>Time required</u>: 45 minutes
<u>Materials</u>: Same as in Activity #1
<u>Procedure:</u>
Have students repeat Activity #1, but let them choose their colors. This time have them write out a research question, prediction, observation, and conclusion. Ask students to answer questions about the experiment such as:

- Why do you think the food coloring goes down in the water?
- Why do you think the color appears lighter in the dropper than in the tube?
- What do you have to do to make a drop look like a ring in the water?
- Does the height from which you drop the solution make a difference as to what the solution looks like in the water?
- What colors did you make when you dropped in the different colored solutions?

Activity #3
<u>Time required</u>: 45 minutes
<u>Materials</u>: Same as above
<u>Procedure:</u>
Have students do something similar to Activities #1 and #2. Allow them to use up to four colors. Have them write out a research question, prediction, observation, and conclusion.
<u>Extension</u>:
Is there a difference in the way food coloring acts or looks in hot versus cold water? Students can follow the scientific process to answer questions like this one.

Activity #4
<u>Time required</u>: 45 minutes
<u>Materials</u>: Same as above, plus salt
<u>Procedure:</u>
This activity will be very similar to the ones above. The procedures will be the same except the student will add salt to one of the food colorings. Students will write out a research question, procedure, prediction, observation, conjecture, and proof. Students will need some guidance in writing up their procedure and some direction in designing a proof.
Pose these research questions to the students:
- How does using salt change the results of your investigations?
- How can you prove that your observations are correct?

Activity #5
Time required: 45 minutes
Materials: Same as in Activity #4
Procedure:
Have students set up their own investigations, doing something similar to Activity #4. Have students write out their activity as they did above. Introduce the concept of density if it has not already been done.

Activity #6
Time required: 45 minutes
Materials: In this activity you will need to prepare 4 one gallon containers of green, red, blue, and yellow colored solution. With the red solution add 2 cups of salt, add 1 cup of salt to the blue solution, add _ cup to the green solution, and add no salt to the yellow solution. Students should not know that you added salt to the colored solutions. Other materials required will be determined by the students' experimental design, but should be similar to those used above.
Procedure:
Students will start out by adding one color to another. They will write out a research question, procedure, prediction, observation, conclusion, and proof. Eventually they will be asked to develop a procedure to determine the least dense solution to the most dense solution.

Activity #7
Time required: 45 minutes
Materials: Same as in Activity #6, plus clear drinking straws
Procedure:
In this activity, students try to layer all four colored solutions in clear soda straws. Use these straws much like you would use a pipette.

Activity #8
Time required: 45 minutes
Materials (per group): 4 colored solutions from Activity #7
4 glass eyedroppers
1 gallon jar
Procedure:
Put each of the different colored solutions into an eye dropper. Put in the amount needed so that the eyedropper will be suspended at the top of the water. Have students predict which solution will empty from the eyedropper first and last. Ask them why one color will empty from the eyedropper before another.

Activity #9 - Buoyancy and Density
Time required: 45 to 60 minutes
Materials: Small objects to test for density and buoyancy such as peanuts, crayons, wood blocks, plastic chips, pieces of tin foil, small rocks, rubber and steel washers, and wax.

Large container of freshwater
Large container of saltwater
Bowls

Procedure:

Give each group a bowl of fresh and a bowl of salt water. Distribute objects to be tested. Explain the directions for the experiment. Students should predict what they think will happen when each object is placed in fresh water and then in salt water. They should record their predictions and their actual observations.

Ask students to answer questions relevant to the experiment, such as:

- What did you observe?
- What does buoyant mean?
- How does density relate to your observations?
- Which object's result do you think is closest to how a whale floats in the ocean? Expand this to how whales move, rest, breathe, etc.

Activity #10 - Comparing through observation the relative density of water, CO_2, and raisins

Time required: 45 minutes

Materials: Beakers
7 Up
Raisins

Procedure:

Give each group a beaker _ full of 7 Up. Have students add 8-10 raisins and observe.

Ask student questions such as:

- Which is the most and least dense: 7 Up, raisins, or CO_2?
- Why do you think so?

Activity #11 - Salt dispersion

Time required: 45 to 60 minutes

Materials: (per group)

1 quart jar	food color and dispenser	6 half peanuts	empty tea bag
1 paper clip	6 small pieces of crayons	water	salt

In this activity students will learn more about buoyancy and density, as well as the concepts of semipermeable membranes and dispersion.

Procedure:

1) Fill the jar 3/4 full of water and add peanuts and crayons
2) Write out an observation.
3) Fill the tea bag with salt and tie.
4) Hang the tea bag in the water with a paper clip. Do not stir.
5) Observe for five minutes and write out an observation.
6) Carefully add four drops of food coloring and do not stir.
7) Observe for ten minutes and write out observations.

Students should answer the following questions:

- What did you observe?
- List the materials in the jar from the least to the most dense.
- What is buoyant? Can you define buoyancy?
- How does density relate to your observations?
- What is an example of a semi-permeable membrane?
- Can you give an example of dispersion in this system?
- Which object in the activity would have about the same density as the body of a whale?
- How would this explain how a whale moves in water?

Activity #12

Students will do research to find out how the Kootenai and the Pend d'Oreille Indians built and used fish weirs to catch fish. They will also study about how these native people built canoes. Students will use their knowledge of buoyancy and density to explain how the fish weirs worked. They will also explain why the canoes were designed in a certain way and why they were made of a particular kind of wood. (For more information on fish weirs and canoes you may contact: the Kootenai Culture Committee at (406) 849-5541, the Tribal Preservation Office at (406) 675-2700, or the People's Center at (406) 675-0160. The People's Center permanent exhibit has a canoe and fish weir on display.)

Further information

For further information concerning these activities contact Charles Bertsch via electronic mail at bertsch@polson.k12.mt.us

References

Montana Science Advisory Council. (1990). Tool kit for science curriculum development. Helena, MT.