Biological Principles
Lab: The Water Molecule

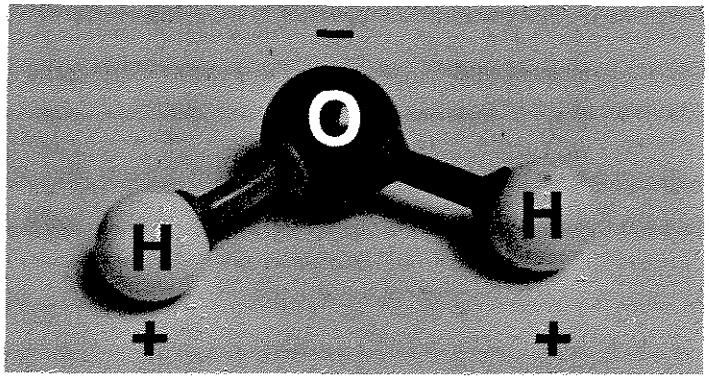
Name: _____

PURPOSE
- ❑ To investigate how the bonding of the atoms in the water molecule affects its behavior.
- ❑ To relate how water's behavior is important to life.

MODULE 1: Water as a charged molecule

INTRODUCTION

To fully understand the behavior of the water molecule, you must first understand its structure. The water molecule has two hydrogen atoms covalently bonded to one oxygen atom. The attraction of the oxygen nucleus for the shared electrons is stronger than hydrogen's nuclear attraction for the shared electrons. As a result of this unequal pull on the electrons, the oxygen end of the molecule has a slight negative charge while the hydrogen end of the molecule has a slight positive charge. A molecule with unequal electron sharing is called a **polar molecule**.



MATERIALS

- ❑ buret
- ❑ buret stand
- ❑ clamp
- ❑ funnel
- ❑ tap water
- ❑ piece of wool fabric
- ❑ glass rod
- ❑ 250-ml beaker

PROCEDURE

1. Clamp the buret to the stand.
2. Place the funnel in the opening on top of the buret and place the beaker below it. Close the stopcock.
3. Fill your buret half full with tap water.
4. Take the glass rod and rub it vigorously with the wool until the glass is warm to the touch. (The glass rod will develop a positive charge because the wool will strip some of the electrons from the glass.)
5. Open the stopcock and allow the water to slowly stream into the beaker.
6. Hold the side of the glass rod about 5 mm away from the side of the water stream. **Do not let the glass rod touch the water stream.**
7. Observe the stream and answer Question 1 on your lab report.

MODULE 2: Cohesion and adhesion

INTRODUCTION

Water molecules are attracted to each other and to other molecules that are polar. **Cohesion** refers to the bonding of water molecules to each other. The slightly positive pole of a water molecule is attracted to the slightly negative pole of another water molecule. **Adhesion** refers to the bonding of water to other polar molecules. The weak attractions between polar molecules are **non-covalent** (hydrogen) **bonds**. These bonds give water many unique properties. Cohesion between water molecules results in a high **surface tension**, a measure of how much energy is required to break the surface of a liquid. Surface tension is responsible for the ability of small insects to "walk" on water.

The following three "mini-experiments" will help you visualize water's cohesive properties.

MATERIALS

- ❑ clean microscope slide
- ❑ alcohol in a dropper bottle
- ❑ water in a dropper bottle
- ❑ Petri dish
- ❑ tap water
- ❑ lens paper
- ❑ straight pin
- ❑ 2 toothpicks
- ❑ detergent in a dropper bottle
- ❑ small diameter capillary tube
- ❑ large diameter capillary tube
- ❑ colored water

PROCEDURE – Experiment #1

1. Place one drop of water on one end of the microscope slide.
2. Place one drop of alcohol on the other end of the slide.
3. Answer Question 2 on your lab report.

PROCEDURE – Experiment #2

1. Fill the Petri dish half full with tap water.
2. Place a piece of lens paper on the surface of the water.
3. Carefully place a straight pin on the lens paper.
4. Using the toothpicks, push down the corners of the lens paper allowing the pin to rest on the surface of the water.
5. Record your observations and answer Questions 3a and 3b on your lab report.
6. Add a drop of detergent to the dish.
7. Record your observations in Question 3c on your lab report.
8. Empty and rinse the Petri dish.

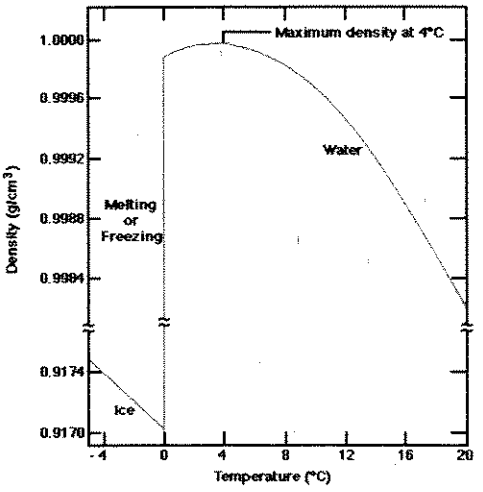
PROCEDURE – Experiment #3

1. Fill the Petri dish half full with colored water.
2. Stand both the large and small diameter capillary tubes in the water and hold them there for 5 secs.
3. Remove the tubes.
4. Observe the heights of the water in each and answer Question 4 on your lab report.

MODULE 3: The density of water

INTRODUCTION

One of water's more unique properties is how its density will change in response to changes in temperature. With most substances, density will increase as the temperature decreases. Water, however, reaches its maximum density at 4 °C. Below this temperature, the hydrogen bonds between water molecules become longer, causing the water molecules to move farther apart. As a result, water molecules in ice form are less closely packed (and therefore are less dense) than water molecules in liquid form.



MATERIALS

- ❑ 1000-ml beaker
- ❑ hot tap water
- ❑ piece of white paper
- ❑ cold red water
- ❑ 10-ml pipette
- ❑ green pipette pump
- ❑ blue ice cubes

PROCEDURE

1. Put approximately 800 ml hot tap water into the 1000-ml beaker.
2. Place the beaker on the white paper. This will allow the effects of the two colors to be seen better.
3. Take up 10 ml of cold red water into the pipette.
4. With the pipette held 2 cm from the bottom of the beaker, dispense the red water slowly. This should form a red layer on the bottom of the beaker.
5. Gently place a blue ice cube on top of the water.
6. Observe the movement of the water and answer Question 5 on your lab report.

CLEAN-UP

- ❑ Empty all glassware in the sink.
- ❑ Wash all used glassware (except the burets) in hot soapy water and leave them by the side of the sink.
- ❑ Discard the toothpicks in the trash.
- ❑ Discard the capillary tubes in the glass disposal box at the front of the lab.
- ❑ Return all remaining lab materials to the instructor's bench.
- ❑ Wipe down the lab bench with cleanser and paper towels.
- ❑ Push in your chair when you leave.

Biological Principles
Lab Report: The Water Molecule

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1. **Draw** and **describe** what happened when you hold the positively charged rod next to the water stream.

Question 2

a. Draw the elevation of each drop, as viewed from the side:

water | alcohol

b. What is the diameter of each drop?

water: _____
alcohol: _____

c. Why are the size and shape of the two drops so different?

Question 3

a. Describe how the surface of the water around the pin appears.

b. Why does the pin rest on the surface of the water when it is denser than the water?

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c. Describe what happened to the pin when the detergent was added.

Question 4

a. How high did the water rise in each capillary tube?

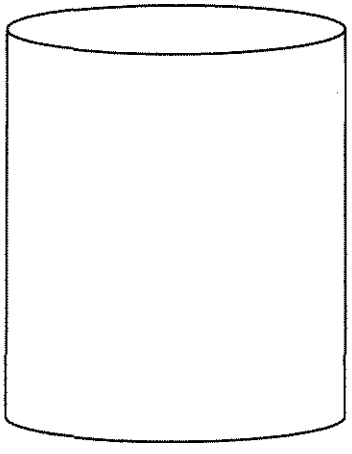
b. What conclusion can you draw about the relationship between the inner diameter of the tube and the height to which the water will rise?

Question 5

a. What happens to the cold red water when you add it to the beaker?

b. Explain why the ice cube floats.

c. Draw what you observed when you added the blue ice cube to the beaker of water.



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d. Using your observations above regarding the way the ice melted and the water moved, describe what happens in a pond during a spring thaw. How is this an advantage to the organisms living in the pond?

_____

_____

_____

_____

_____

e. Draw four water molecules in both liquid form and frozen form:

Liquid	Frozen