Name: _____

Salt Water vs. Fresh Water

We know that fresh water, unlike salt water, is drinkable. But are there other differences between salt water and fresh water? Perform the following experiments to find out.

> Section A) Experiments: Weight and Buoyancy

1. *Do you think fresh water and salt water have different weights? And if so, how might this affect ships and species that live in a lake versus an ocean?*

_____

_____

_____

_____

_____

_____

_____

Test your answer!

- *Fill two identical buckets with equal amounts of water (approximately 5L).*
- *Add 250 ml of coarse salt to one of the buckets, and stir it until the salt dissolves.*
- *Place each bucket on a scale and record its weight.*

i) Salt water: _____

ii) Fresh water: _____

iii) In conclusion, which weighs more: salt water or fresh water?

_____

Name: _____

2. Float a plastic "boat" (a plastic bowl will do) in each bucket. Be sure to use the same size of boat in each bucket. Gently add pennies or marbles to each boat. Count the number it takes to sink each boat.

   i) Salt water boat: _____

   ii) Fresh water boat: _____

3. Add another 250 ml of coarse salt to the salt water, and stir it until the salt dissolves.

   i) How many more marbles can you add to the boat before it sinks?

_____

4. The tendency of an object to float or rise when submerged in water is called buoyancy. Which is more buoyant – fresh water or salt water? Explain your answer.

_____

_____

_____

_____

5. The **density** of the water affects the amount of upward force that it exerts on a floating object (the buoyancy). Denser water exerts more upward force. Based on what you've learned from the experiments, which is more dense: salt water or fresh water?

_____

Name: _____

6. Have you ever tried to float in a lake or an ocean? Was it harder or easier to float in the ocean? Think about some of the large mammals that live in the ocean, like dolphins, whales and seals. How might buoyancy be important to their survival?

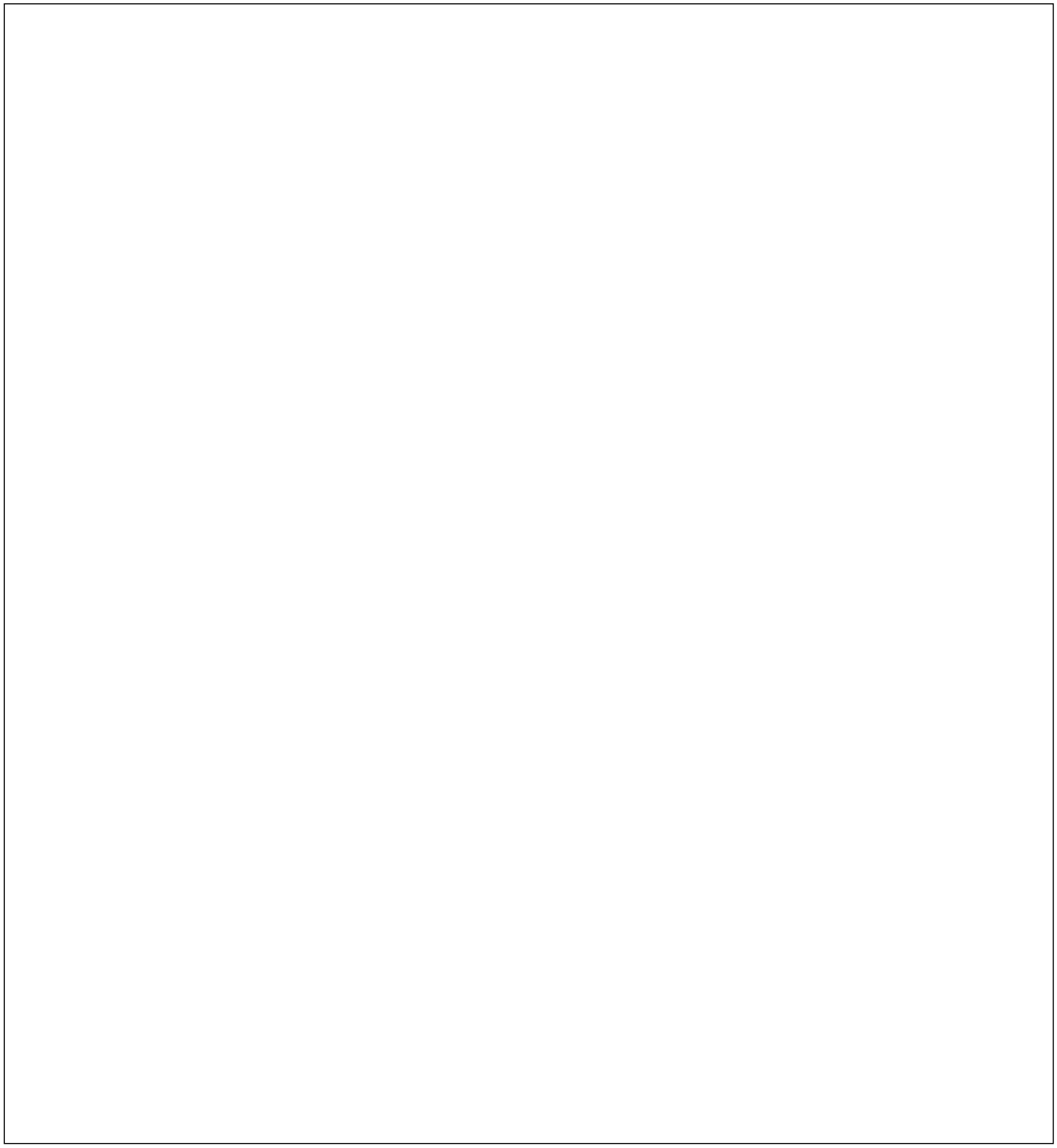
7. What would happen to a very heavily loaded ship as it travels from an open ocean to a fresh water river?

8. Ships that overload cargo in seaports can run into trouble when they try to dock in freshwater ports. Overloaded ships can run aground, spill cargo, sink or puncture the ships hull and leak fuel or oil into the surrounding water.

   Samuel Plimsoll (1824-1898) was a member of the British Parliament who was concerned about the number of ships that sank because of overloading. He established the Plimsoll Mark to help fix the problem.

   i) Using an encyclopedia, research the Plimsoll Mark. Draw a ship with the Plimsoll Mark in the box on the following page. Include diagrams that explain what each initial on the Plimsoll Mark tells us about the buoyancy and safety of the ship.

Name: _____



Canon

Name: _____

Section B) Experiments: Freezing and Boiling Points

1. Have you ever wondered why we spread salt on our winter roads and sidewalks? Try this experiment to find out:

   - Fill two beakers with 250 ml of ordinary tap water.
   - Dissolve 15 ml of salt in one of the beakers.
   - Put both beakers in the freezer.
   - Check both beakers after 15 minutes, 30 minutes, 45 minutes and one hour. Record your observations at each interval.

Time	Fresh Water	Salt Water
15 mins		
30 mins		
45 mins		
60 mins		

   i) Which one starts to freeze first? How long did it take? Did the other one begin to freeze after an hour?

_____

2. When it snows in the winter, do people in your town pour salt on icy sidewalks? Do you know why? Try this experiment to find out:

   - Put two ice cubes on two separate plates.
   - Sprinkle salt on one of the ice cubes.

   i) Which ice cube melts faster?

_____

   ii) Based on the experiments above, which has a lower freezing point: fresh or salt water?

_____

Name: _____

iii) When you add an impurity like salt to water, it prevents the water from changing phases – in this case, from a liquid to a solid. The more salt you add, the more you will _____ _____ the freezing point.

3. What do you think will happen if we add salt to water as it's changing states from a liquid to a gas? Do you think that adding salt to water will raise or lower the boiling point?

_____

_____

_____

4. Test your theory:
   - Fill two beakers with 250 ml of ordinary tap water.
   - Add 50 ml of salt to one of the beakers.
   - Heat both beakers over a Bunsen burner following the safety procedures outlined by your teacher.
   - Use a stopwatch to record how long it takes each beaker of water to boil.

   i) How long did it take the salt water to boil?

   _____

   ii) How long did it take the fresh water to boil?

   _____

   iii) In conclusion, salt water has a _____ boiling point than fresh water.

Name: _____

Section C) Experiments: pH Levels

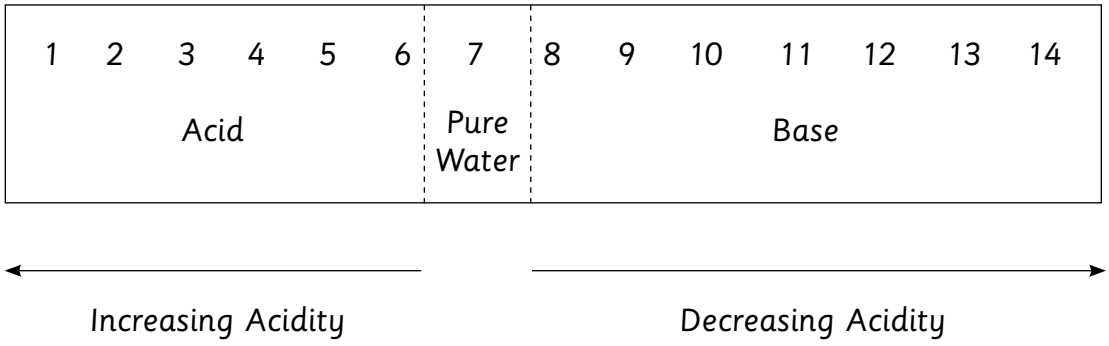
1. *Every liquid can be classified as either an* ***acid*** *or a* ***base****, except pure, distilled water, which is neutral. The ions in a liquid determine if it's an acid or a base.*

   Acid: *A solution that has an excess of hydrogen ions. One common weak acid is vinegar.*

   Base: *A solution that has an excess of hydroxide ions. One common weak base is water with baking soda in it.*

   Ion: *An atom or group of atoms that carries a positive or negative electric charge.*

2. *pH stands for "Potential of Hydrogen". pH measures the concentration of hydrogen ions in a solution to determine the acidity of a substance (in this case, water). The pH scale goes from 1 to 14, with acids and bases on opposite ends. A pH of 1 is extremely acidic while a pH of 14 is extremely basic. Always be really careful when handling very strong acids and bases because they are corrosive, which means that they can burn through substances like skin or even iron. For this reason, most household liquids have a pH level somewhere near 7.*



Did You Know?

Mixing acids and bases together can create an explosion! In fact, the very first rocket fuels were produced by mixing acids and bases.

Try mixing white vinegar and baking soda to see what happens when you mix a weak acid with a weak base. Be careful – it can get messy!

Canon

Name: _____

You can measure the pH of water by using litmus paper – a special kind of paper coated with a chemical that changes to many different shades, depending on the pH reading.

Litmus test

- Very acidic - Red
- Acidic - Orange/Yellow
- Neutral - Green
- Basic/base/alkali - Blue
- Very basic/base/alkali - Purple

Start with two beakers filled with 250 ml of ordinary tap water, and one beaker filled with 250 ml of distilled water.

Dissolve 30 ml of salt in one of the beakers filled with tap water.

i) Dip a strip of litmus paper in the distilled water, then carefully, set it aside to dry. Don't touch the wet part of the strip, or the dirt and oil on your skin could change the reading. What is the pH level of the distilled water?

_____

ii) Use a second strip of litmus paper to determine the pH level of the fresh tap water.

_____

iii) Use a third strip of litmus paper to determine the pH level of the salt water.

_____

Name: _____

3. Use the results from question 2 to help you interpret the colour of the strips.

   i) Is the tap water an acid, base, or is it neutral?

   _____

   ii) Does the tap water have a higher or lower pH than the distilled water? Why do you think they might have different readings?

   _____

   _____

   iii) Does the salt water have a higher or lower pH than the distilled water?

   _____

   iv) Given the litmus tests above, is the salt water an acid or a base?

   _____

4. What effect do you think salt water might have on the hull of a ship?

   _____

   _____

5. Try this experiment to test your theory:

   - Fill two beakers with 250 ml of ordinary tap water.
   - Dissolve 50 ml of salt in one of the beakers.
   - Prepare two identical strips of aluminum foil.
   - Submerge one strip of aluminum foil in the beaker with fresh water.
   - Submerge the other strip in the beaker with salt water.
   - Remove both pieces of foil after 24 hours.

Name: _____

i) Draw the piece of foil in the appropriate box, noting any changes that have occurred:

Foil from beaker with fresh water	Foil from beaker with salt water

ii) Based on your observations, how do you think seawater affects ships and oil tankers? How might this contribute to water pollution and impact the species living in the area?

_____

_____

_____

_____

Name: _____

iii) What can people working on ships traveling the ocean do to prevent this kind of water pollution?

_____

_____

_____

_____

6. You've probably heard of acid rain but do you know what it is? When certain chemicals mix with rainwater, they lower its pH level, changing neutral water into an acid. Do some independent research to answer the following questions:

   i) What chemicals cause acid rain?

   ii) How do these chemicals end up in the rain?

   iii) What human activities cause acid rain?

   iv) What are the environmental effects of acid rain?

   v) What are some solutions that industries and the Canadian government have implemented to try to fix the acid rain problem?

   vi) Name three things that you can do to help reduce acid rain.

Answers: Salt Water vs. Fresh Water

Section A) Experiments: Weight and Buoyancy

1. i) Open - Student hypothesis.

   iii) Salt water weighs more than fresh water.

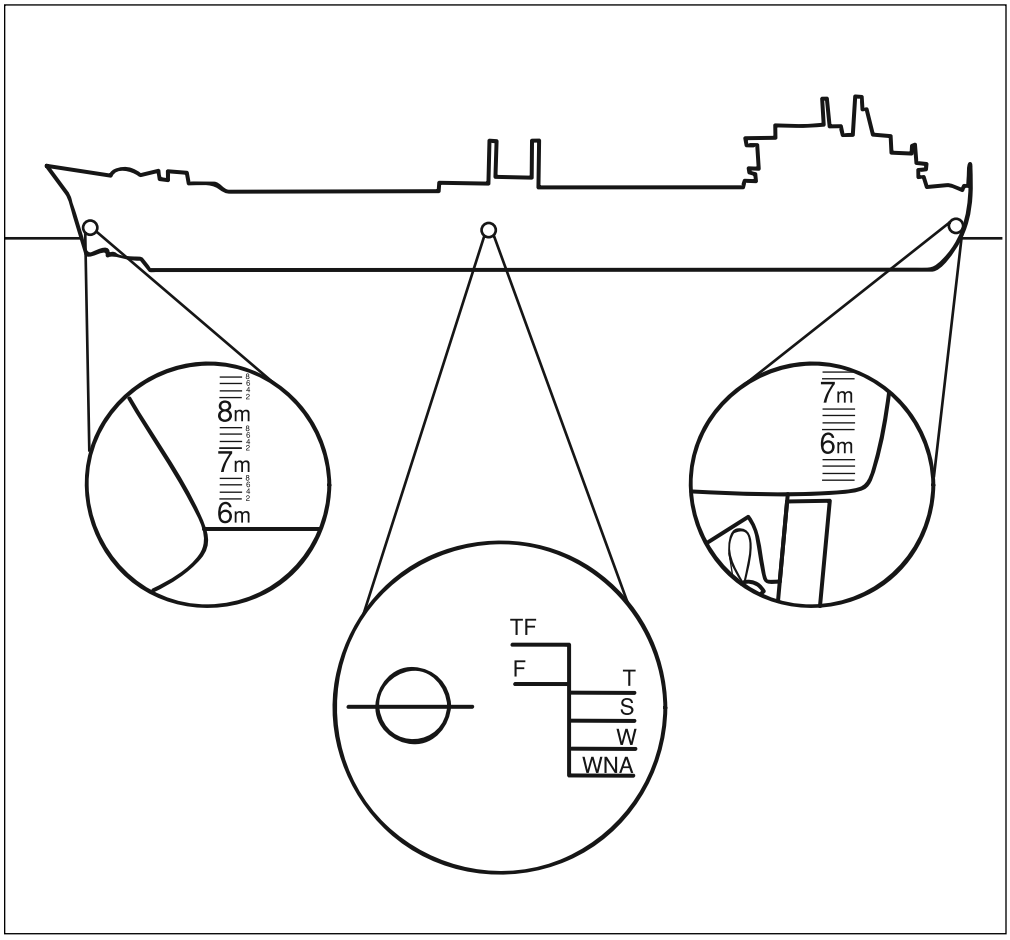
4. Salt water is more buoyant than fresh water.

5. Salt water is more dense than fresh water.

6. Easier to float in an ocean. Open – Mammals, whales, dolphins and seals cannot breathe underwater. Therefore, these large mammals rely on salt water's buoyancy to help them float to the surface to collect air.

7. Open – The ship would sink lower into the water as it moves from the buoyant seawater to the less-dense fresh water.

8.



- The Plimsoll Mark is a reference mark located on the ship's hull that indicates the depth to which the ship can be safely loaded.
- As cargo is added, the boat sinks deeper into the water until it reaches the Plimsoll Mark, also called the international load line.
- Thanks to Plimsoll, all ships on the ocean must have an international load line.
- Each ship can be loaded to different load lines depending on the season and the zone in which they're traveling.
- The load line is higher in tropical fresh water (TF), therefore less cargo can be loaded and the ship will be lighter.
- It drops for seawater (S), therefore more cargo can be loaded and the ship will be heavier.
- It drops even lower for winter seawater (W) or winter North Atlantic waters (WNA), where more weight on the ship will make it more stable and therefore safer during the rougher sea conditions and among the bigger waves.

Section B) Experiments: Freezing and Boiling Points

1. i) The fresh water freezes faster.

2. i) The ice cube with salt on it melts faster.

   ii) Salt water has a lower freezing point.

   iii) The more salt you add, the more you will lower the freezing point.

3. Student hypothesis. But adding salt in the water will raise the boiling point.

4. iii) In conclusion, salt water has a higher boiling point than fresh water.

Section C) Experiments: pH Levels

2. Open – Depends on region (see 3.i).

3. i) pH of the tap water will vary from town to town depending on how soft or hard the water is. Water hardness can be most simply described as the mineral levels in the water. Hard water has a high dissolved mineral content. Soft water has very little. The most common mineral in water is calcium, however, other minerals may also be present. Most people's tap water is either slightly hard or soft depending on where it comes from. Well water from areas with a lot of limestone (calcium) is often hard. Water that comes from lakes and rainwater is often devoid of minerals, making it soft.

ii) Hard water (high mineral content) is usually high in pH (basic or alkaline). Soft water (low mineral) is usually low in pH (acidic). The minerals in hard water act as a buffer which reduce the amount of acid in the water. The resulting water will be more alkaline and higher in pH.

iii) Higher

iv) Base

4. Student hypothesis.

5. i) The foil in the fresh water won't have changed much. The foil in the salt water will be corroded with holes and tarnished.

   ii) Salt water can be corrosive to hulls. Corrosion and rust leads to multiple problems. First, the break down of metal leaching into the water can affect pH in some environments, though in tiny amounts. Second, and more importantly, leaks or structural damage to hulls can result in leakage of contents of ship. This includes dirty or oily bilge water and contents of container ships. WWF-Canada reports that in Eastern Canada alone, over 300,000 seabirds die from oil discharges from ships, including both accidental and intentional dumping.

   Note: Corrosion level is not determined exclusively by salt or pH levels.

   iii) Inspect the hull regularly for signs of corrosion and ensure the hull is painted or protected by special covering materials such as gelcoat, laminates, etc.

6. i) Nitrogen oxides, sulfur dioxide , nitric and sulphuric acids.

   ii) They are in the air as emissions from burning fossil fuels, and bond with water molecules in the air, forming a weak acid.

   iii) Anything that burns fossil fuels: driving cars, heating houses with coal, gas or oil, etc.

   iv) It lowers the pH level of lakes, rivers, streams, and soil, which can harm and even kill many species of plants and animals. Acid rain can also slow tree growth and affect an entire forest. It also corrodes building materials, resulting in damage to historical buildings and works of art.

Answers: Salt Water vs. Fresh Water (continued)

v) Open:

- Burning less coal, or low-sulphur coal
- Use cleaner forms of energy like wind, hydro, etc.
- Clean up smokestacks and exhaust pipes. Add “scrubbers” that chemically remove sulphur from coal.
- Creating a government treaty to reduce acid rain. The Acid Rain Program committed Canada to cap emissions in seven provinces by 40 percent between 1980 and 1994. They continue to decline (63 percent in Canada between 1980 and 2001).

vi) Open:

- Take public transit, walk, ride your bike, skateboard, rollerblade, etc. to school instead of driving. Driving less means burning less fossil fuels.
- Choose cleaner forms of energy like hydro, wind power, etc.
- Use less energy. Turn off lights, computers and other appliances when you’re not using them. Use energy efficient appliances.
- Turn down the heat in the winter and the air conditioning in the summer.
- Maintain your family’s vehicle properly to reduce its emissions.