Lessons 3, 4 and 5

Stage 1 – Desired Results

Established Goals:
8-4-02 **Demonstrate that water, as compared to other substances, has a high heat capacity** and is able to dissolve a wide variety of solutes. GLO: C1, C2, C5, D3
8-4-03 **Compare and contrast characteristics and properties of fresh and salt water. Examples: freezing point,** density, dissolved materials, global distribution, relative amounts, biologically diverse components of each… GLO: D3, D5, E1
8-4-05 **Describe how the heat capacity of large bodies of water** and the movement of ocean currents influence regional climates. Examples: Gulf Stream effects, El Niño, **lake effect**… GLO: D3, D5, E2

Understandings:
Students will understand that…
Life on Earth is possible because of water's unique properties.
Water is the only natural substance that is found in all three states - liquid, solid (ice), and gas (steam) at the temperatures normally found on Earth.
Water can absorb a tremendous amount of heat acting like a heat buffer for the Earth.

Essential Questions:
What are the unique characteristics of fresh and salt water and how do they affect the Earth's climate?
How do we teach about water from a sustainability focus?

Students will know…
-and describe all three states of matter - solid, liquid, and gas - within the normal temperature range at Earth's surface for fresh water and for saline water.
-how the high heat capacity & abundance of liquid water makes life on Earth possible.

Students will be able to…
Participate in three labs in a safe manner
-demonstrate through experimentation, that water containing salts and minerals has different properties than fresh water.
-graph data to analyze and articulate results/conclusions.

Stage 2- Assessment Evidence

Performance Tasks:
Lab reports (with graphs) handed in to be marked

Other Evidence:
Peer assessment of lab behaviour

Materials Required

Station 1	Station 2	Station 3
distilled water	distilled water	hot plate
Seawater(saltwater)	seawater	4 flasks (same size)
stopwatch	isopropyl alcohol	4 thermometers
hot plate	3 thermometers that can measure from -10°C to 110°C	bucket of ice water
2 flasks with rubber stoppers that hold a thermometer	3 large test tubes with a one hole fitted stoppers	stop watch
2 thermometers that can measure from -10°C to 110°C	3 Pyrex beakers	sand
graph paper	dry ice chunks*	soil
stopwatch	gloves	
	graph paper	

***you can purchase dry ice from Praxair (in Winnipeg) for about $3.00 a kg – you need to bring a small cooler to hold it. Praxair: 663-4393, 650 Nairn. An alternative to dry ice is a salt-ice mixture but with less dramatic results.**

Safety Considerations

<u>Safety Guidelines for Using Electric Hot Plates</u>
Use a hot plate with a smooth, clean surface.
Hot plates appear exactly the same whether hot or at room temperature. Always assume they are hot and act accordingly.
Keep the electrical cord of a hot plate away from water and the heating surface.
The cord of the hot plate should be checked periodically for frays and faults. Any hot plate with faulty wiring should

not be used. Repair or replaced immediately.
Safety Rules for All Heating Processes
When heating glassware, make sure to use only glassware made of borosilicate glass (Pyrex® brand or Kimax® brand). Common glass can break, explode or shatter very easily when subjected to heat shock.
Never set hot glassware on cold surfaces or in any way change its temperature suddenly. Even a Pyrex® or Kimax® beaker will break if cold water is poured into a hot beaker.
Use care when working with hot glass. Hot glass looks exactly the same as room temperature glass.
Do not leave hot glassware unattended, and allow ample time for the glass to cool before touching.
Check the temperature of the glassware by placing your hand near, but not touching, the potentially hot glass.
Have hot pads, thick gloves, or beaker tongs available for grasping hot glassware.
Never heat a closed container.
Any set-up should be designed to allow for fast removal of the heat source.

Background Information

Water has unique properties. About 97 percent of all water is in the oceans. Salt water or seawater has characteristics similar to fresh water with some noticeable differences because of the salts that are dissolved in water.

Prior Knowledge

The salt in seawater comes from the weathering of earth's land surface.
Water can be a liquid or a solid and can go back and forth from one form to the other.
When liquid water disappears, it turns into a gas (vapor) in the air and can reappear as a liquid when cooled, or as a solid if cooled below the freezing point.

Common Preconceptions

Students generally do not regard freezing as taking place at a specific temperature.
Students consider heat and temperature to be the same thing, often arguing that if you increase the amount of heat you will increase the temperature.
Boiling is the maximum temperature a substance can reach.

Additional Information

Liquid water (H2O) is often perceived to be pretty ordinary as it is transparent, odourless, tasteless and ubiquitous. Water is unique in that it is the only natural substance that is found in all three states -- liquid, solid (ice), and gas (steam) - at the temperatures normally found on Earth. Earth's water is constantly interacting, changing, and in movement. 0° on the Celsius scale is water's freezing point, and 100° is water's boiling point. Water is unusual in that the solid form, ice, is less dense than the liquid form, which is why ice floats. Water has a high specific heat index or capacity. This means that water can absorb a lot of heat before it begins to get hot. This is why water is valuable to industries and in your car's radiator as a coolant. The high specific heat index of water also helps regulate the rate at which air changes temperature, which is why the temperature change between seasons is gradual rather than sudden, especially near the oceans.

Stage 3 – Learning Plan

(adapted from AQUARIUS http://www.bigelow.org/aquarius/prop_fresh_sea.html) Used by permission.

Station 1 Boiling Point

Fill one flask with distilled water and one flask with seawater. Insert the thermometers through the stoppers and cap the flasks. Make sure the thermometers are suspended in the liquids. Set both samples aside for half an hour so that they are all at room temperature

Activity – Station 1 (Boiling Point)

In this procedure, students will explore the boiling point of water, including the differences between salt water and fresh water. Ask students to hypothesize: “Which will boil first: salt water or fresh water? Why?”
Record the temperature of the distilled water and seawater in the flasks. Turn on the hot plate.
Begin with the distilled water. Check and record the temperature every 30 seconds. When the water begins bubbling and the temperature levels off, the water is boiling. Keep recording the temperature for 3 minutes after you see bubbles. Plot and graph your data. What is the boiling point of distilled water? How long did it take the distilled water to reach the boiling point?
Repeat the experiment with seawater. Record the thermometer reading every 30 seconds. Plot and graph your data. What is the boiling point of seawater? How long did it take the sea water to reach the boiling point?
Compare the results of the two experiments. Use your graphs. Are there any differences in the boiling points? How do you explain these differences?

Station 2 Freezing Point

Isopropyl alcohol works nicely because it contains water. When the water in the alcohol freezes, it should sink. There are numerous stores that sell dry ice as either chunks or cubes. Always use sturdy

gloves and / or tongs to handle dry ice. If you do not wish to use dry ice, use a salt-ice mixture instead. In this procedure, students will explore the freezing point of water, including the differences between salt water and fresh water. Ask the students the following questions: "For pure water, the freezing point is defined as 0°C, but have you ever measured it? How can we measure it? Can we put the thermometer in a solid chunk of ice or in chopped ice? What is the temperature of ice? Which will freeze more slowly, salt or fresh water? Why?"
Fill one test tube with distilled water, the second with seawater, and the third with alcohol. Insert the thermometer through each rubber stopper and cap the test tubes. Make sure that the thermometer is suspended in the water. Record the temperature of each test tube.
Using tongs or heavy gloves, fill the bottom of three Pyrex beakers with chunks of dry ice.**STOP Review Safety Procedures** WARN STUDENTS: "DO NOT TOUCH THE DRY ICE WITH YOUR BARE HANDS!" Place each test tube in a beaker of dry ice.
Record the temperatures every 30 seconds until they level off. Observe the test tube of alcohol. What happens to the water that is in the alcohol? Compare it to the freezing point of the salt water and of the fresh water. Does the ice float or sink?
Plot and graph your data. Compare the information on the three graphs. What is the freezing point of fresh water? Seawater? Alcohol?

Station 3 Heat Capacity

In this procedure, students will examine water's ability to store heat. Water has a higher heat capacity than almost any other liquid. This means that it takes a lot of heat to change water's temperature significantly. We can measure and compare the heat capacities of water, air and "earth". Ask the students: "Based on your experience, which will heat and cool more slowly: water, air, soil or sand? Why?" If your students require more guidance, please use BLM #4.
Fill one flask with water, one with soil, one with sand, and leave one flask empty. This flask is filled with air. Insert thermometers through rubber stoppers and cap the flasks.
Record the temperature in each flask at room temperature. **STOP Review Safety Procedures** Place all four flasks on top of the hot plate and start the stopwatch. Record the time it takes for the water to reach 33°C. Also record the temperature of the empty flask and the soil and sand flask at that instant. Ask the students: "Is the temperature in the flask of air higher or lower than the temperature of the flask of water, sand and soil?"
Remove all flasks from the heat and place them in ice water. Record the time it takes for each flask to reach its original room temperature. Ask the students: "Which flask took longer to reach its original room temperature?"

Class Discussion Questions

1. What are the implications of water having a higher heat capacity than that of land when people live near a large water source like Lake Winnipeg related to climate? *Water covers about 71% of Earth's surface. Thus its ability to store heat strongly affects our climate. The water may absorb the heat during the day and give off the heat in evenings to make for milder nights/seasons than areas further from large water sources.*
2. Why do you think that the boiling points of fresh and salt water have an effect on our local climate? How? *The boiling point of a liquid is the temperature at which it turns to gas. Water, when heated, evaporates and boils slowly compared to other liquids. This means that the heat of vaporization is high—the highest of all common liquids. Because of the high heat of vaporization, water evaporates slowly and absorbs a lot of heat. Water's high heat of vaporization gives it a high boiling point (100°C). This is why much of Earth's water is in liquid form.*
3. How can you relate the results of these experiments to the three aspects of sustainable development? *Prompt students to think about how this experiment may impact on economics (climate in coastal areas) as well as environment (differences in grow seasons between Vancouver and Winnipeg) and heath.*

Homework Learning Activities

Remind students to continue to work on water use chart

Extension Activities

Each group can be assigned or choose an example of how ocean currents influence regional climates and share with the class (jigsaw). For example, the groups could research

1. Gulf Stream effects
2. El Niño
3. Lake effects

Station 1

1. Predict and record in your science notebook: "Which will boil first: salt water or fresh water? Why?"
2. Record the temperature of the distilled water and seawater in the flasks. Turn on the hot plate.
   ****STOP Review Safety Procedures****
3. Begin with the distilled water. Check and record the temperature every 30 seconds. When the water begins bubbling and the temperature levels off, the water is boiling. Keep recording the temperature for 3 minutes after you see bubbles. Plot and graph your data. What is the boiling point of distilled water? How long did it take the distilled water to reach the boiling point?
4. Repeat the experiment with seawater. Record the thermometer reading every 30 seconds. Plot and graph your data. What is the boiling point of seawater? How long did it take the sea water to reach the boiling point?

Compare the results of the two experiments. Use your graphs. Are there any differences in the boiling points? How do you explain these differences?

Station 2

1. Discuss and record answers to the following questions:
    a. For pure water, the freezing point is defined as 0°C, but have you ever measured it?
    b. How can we measure it?
    c. Can we put the thermometer in a solid chunk of ice or in chopped ice?
    d. What is the temperature of ice?
    e. Which will freeze more slowly, salt or fresh water? Why?
2. Fill one test tube with distilled water, the second with seawater, and the third with alcohol. Insert the thermometer through each rubber stopper and cap the test tubes. Make sure that the thermometer is suspended in the water. Record the temperature of each test tube.

Using tongs or heavy gloves, fill the bottom of three Pyrex beakers with chunks of dry ice.**STOP Review Safety Procedures** "DO NOT TOUCH THE DRY ICE WITH YOUR BARE HANDS!" Place each test tube in a beaker of dry ice.

Record the temperatures every 30 seconds until they level off. Observe the test tube of alcohol. What happens to the water that is in the alcohol?

Compare it to the freezing point of the salt water and of the fresh water. Does the ice float or sink?

Plot and graph your data. Compare the information on the three graphs. What is the freezing point of fresh water? Seawater?

Station 3

1. Discuss and record in your science notebook the following question: based on your experience, which will heat and cool more slowly: water, air, soil or sand? Why?
2. Fill one flask with water, one with soil, one with sand and leave one flask empty. This flask is filled with air. Insert thermometers through rubber stoppers and cap the flasks.
3. Record the temperature in each flask at room temperature. **STOP Review Safety Procedures** Place all four flasks on top of the hot plate and start the stopwatch. Use sheet to record information. Record the time it takes for the water to reach 33°C. Also record the temperature of the empty, soil and sand flasks at that instant.
4. Record whether the temperature in the flask of air is higher or lower than the temperature of the flask of water, soil and of sand?
5. Remove all four flasks from the heat and place them in ice water. Record the time it takes for each flask to reach its original room temperature.
6. Record which flask took the longest to reach its original room temperature.

Première station

1. Prédisez et enregistrez dans votre cahier de sciences: «Laquelle bouillira la première, l'eau salée ou l'eau fraîche? Pourquoi?»
2. Enregistrez la température de l'eau distillée et de l'eau de mer dans les flacons. Allumez l'élément.

Stop! Revoyez procédés sécuritaires!

3. Commencez avec l'eau distillée. Vérifiez et enregistrez la température toutes les 30 secondes. Quand l'eau commence à bouillonner et que la température plafonne, l'eau bout. Continuez à enregistrer la température pendant 3 minutes après avoir vu les bulles. Inscrivez vos données et faites un graphique. Quel est le point d'ébullition de l'eau distillée? Combien de temps a-t-il fallu pour que l'eau distillée atteigne le point d'ébullition?
4. Répétez l'expérience avec l'eau de mer. Inscrivez la lecture du thermomètre à toutes les 30 secondes. Inscrivez vos données et faites un graphique. Quel est le point d'ébullition de l'eau de mer? Combien de temps a-t-il fallu pour que l'eau de mer atteigne le point d'ébullition?
5. Comparez les résultats des deux expériences. Servez-vous de vos graphiques. Y a-t-il des différences dans les points d'ébullition? Comment expliquez-vous ces différences?

Deuxième station

1. Discutez et inscrivez vos réponses aux questions suivantes:

    a. Pour l'eau pure, on marque le point de congélation à 0oC. Mais l'avez-vous jamais mesuré?
    b. Comment peut-on le mesurer?
    c. Peut-on mettre le thermomètre dans un bloc de glace solide ou dans des éclats de glace?
    d. Quelle est la température de la glace?
    e. Laquelle gèlera plus lentement, l'eau salée ou l'eau fraîche? Pourquoi?

2. Remplissez une éprouvette d'eau distillée, une deuxième avec de l'eau salée et une troisième avec de l'alcool. Insérez un thermomètre à travers chaque bouchon en caoutchouc et refermez bien les éprouvettes. Assurez-vous que le thermomètre est suspendu dans le liquide. Inscrivez la température de chaque éprouvette.

Avec des pinces ou des gants épais, remplissez le fond de trois béchers Pyrex avec des morceaux de glace carbonique. Stop Revoyez procédés sécuritaires! Ne touchez pas la glace carbonique de vos mains nues. Placez chaque éprouvette dans un bécher de glace carbonique. Inscrivez la température à toutes les 30 secondes jusqu'à ce qu'elle s'arrête de descendre. Observez l'éprouvette d'alcool. Qu'arrive-t-il à l'eau qui est dans l'alcool?

Comparez le point de congélation de l'eau salée et de l'eau fraîche. Est-ce que la glace flotte ou sombre?

Inscrivez vos données et faites un graphique. Comparez les renseignements des trois graphiques. Quel est le point de congélation de l'eau fraîche? De l'eau de mer?

Troisième station

1. Discutez et inscrivez dans votre cahier de sciences la question suivante : D'après votre expérience, quel élément se réchauffera et se refroidira le plus lentement : l'eau, l'air, le sol ou le sable? Pourquoi?
2. Remplissez un flacon d'eau, un de sol, un de sable et laissez un flacon vide. Ce flacon est rempli d'air. Insérez des thermomètres à travers des bouchons en caoutchouc et fermez bien les flacons.
3. Inscrivez la température de chaque flacon à la température de la chambre. **STOP Revoyez procédés sécuritaires** Placez les trois flacons par-dessus l'élément chauffant et commencez le chronomètre. Inscrivez le temps qu'il faut pour que l'eau atteigne 33°C. Au même moment, inscrivez aussi la température des flacons vide, de sol et de sable.
4. Enregistrez si la température du flacon d'air est plus élevée ou plus basse que la température des flacons d'eau, de sol et de sable.
5. Enlevez les quatre flacons de l'élément chauffant et placez-les dans de l'eau glacée. Enregistrez le temps qu'il faut pour que chaque flacon retourne à la température de la chambre originale.
6. Enregistrez quel flacon a mis le plus de temps à atteindre la température de chambre originale.

BLM #4

Name ________________

Lab 3

Heating and Cooling Times

	Air	Soil	Sand	H20
Room Temperature				
Temperature (when H20 is 33 degrees)	*	*	*	Time it took for H20 o reach 33 degrees _______
		Is this temp ↑ or ↓ than air?	Is this temp ↑ or ↓ than air?	Is this temp ↑ or ↓ than air?
	Remove all from heat Put into ice			
Time it takes to get to room temperature				

Nom _______________

LABO 3

Temps de réchauffement et de refroidissement

	Air	Terre	Sable	H20
Température de la chambre				
Température (quand H20 est 33 degrés)	*	*	*	Temps nécessaire pour que H20 atteigne 33 degrés ________
		Cette température est-elle ↑ ou ↓ plus que l'air?	Cette température est-elle ↑ ou ↓ plus que l'air?	Cette température est-elle ↑ ou ↓ plus que l'air?
	Enlevez tout de la chaleur Mettez dans la glace			
Temps nécessaire pour atteindre la température de la chambre				