STEM

SCIENCE • TECHNOLOGY • ENGINEERING • MATH

FRONTIER SCHOOL DIVISION

University of Manitoba
Centre for Earth Observation Science

Dedication

The Expedition Churchill project was envisioned by Lucette Barber. Lucette is incredibly passionate about Arctic Science and has worked tirelessly on outreach and communications. The vision was to provide classroom teachers with hands-on activities that complement the Expedition Churchill e-book at all grade levels. Arctic Scientists and classroom teachers from across Manitoba came together to fulfill this vision. Without Lucette and the many hours of help from the dedicated teachers and scientists this project would not have been possible.

Access Expedition Churchill

Website: https://umanitoba.ca/research/expedition-churchill

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Special thanks to Katrina Froese and the team at Fort Whyte Alive for their continued support and contributions in all stages of this project.

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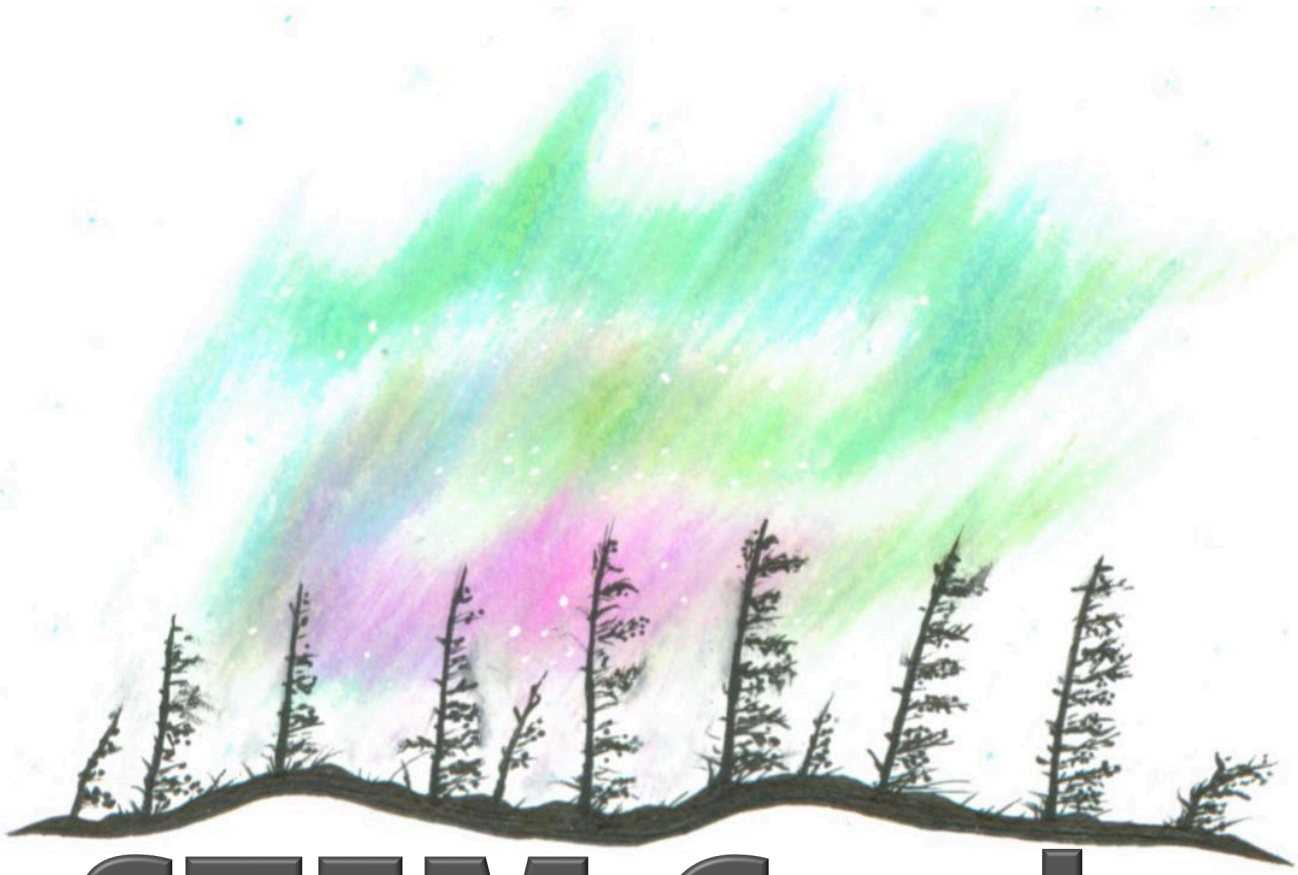

STEM Cards

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CHAPTER 1

A.B.C. AURORA BOREALIS CHROMATOGRAPHY

Materials

- Paper towel or coffee filter cut into strips
- Washable markers
- Cup of water

Method

- Create a circle with any colour of marker about 1cm from the bottom of the paper towel or coffee filter.
- Dip the bottom end of the paper strip into the cup of water, ensuring that the coloured circle is not submerged under water.
- Hold the paper and watch as the water moves up through the coloured circle. The water will separate the colours. Observe what colours you see emerging in the strip.

Extension: Use the strips to make an aurora borealis art piece!

HOW IT WORKS

In chromatography, mixtures are separated using different procedures, and for different purposes. In this activity, the particles in each marker colour are separated as the water climbs up the filter paper. The colours of the aurora borealis are dependent on the altitude and atoms that the ions from the sun strike. Most commonly, green-yellow auroras are produced when ions hit oxygen at low altitude, whereas red is seen at high altitudes. Ions that hit nitrogen produce red-blue aurora, and ions that hit hydrogen or helium produce blue-purple aurora.

EARLY YEARS

Students colour designs (lines, dots, squiggles) ona full, uncut coffee filter. Using spray bottles carefully spray water on the coffee filter. Alternatively, fold and dip the filter into a cup of water. The designs will bleed, run, and mix for students to make their own aurora spectacular!

SENIOR YEARS

Students can conduct a thin-layer chromatography lab, applying close dots of a sample. Once the mobile phase is complete, studentsuse an ultraviolet light to display bands that look similar to aurora borealis.

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CHAPTER 1

HAPPY HYDROPONICS

Materials

- 1L or 2L plastic bottle
- Soil
- Seeds
- String
- Scissors

Method

- Cut the top third off the plastic bottle.
- Create a small hole in the lid of the bottle.
- Secure the string through the hole in the lid. The strip will connect the soil in the bottle top with the water in the bottom of the bottle.
- Place seeds in the soil.
- Fill bottom of the bottle with water and place bottle top so that the string hangs in the water.

EARLY YEARS

Use a Ziploc bag and paper towel to germinate seeds. Place a few seeds inside a damp paper towel. Place the paper towel, with seeds inside, into a sandwich bag. Tape the sealed bag on a sunny window, and watch for growth!

SENIOR YEARS

Senior years are encouraged to experiment with a variety of seeds as well as growing mediums. Students can also experiment with environmental variables such as increased light, darkness, and nutrients.

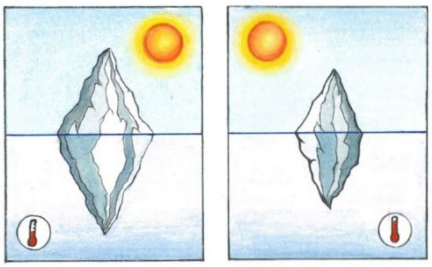
HOW IT WORKS

Seeds are able to germinate in a hydroponic tank because this self-contained environment provides everything that seeds need: nutrients, water and sunlight. The growing season in Churchill is limited due to permafrost, limited natural light, and cold temperatures which reduce the growing season. These factors make it difficult to have access to fresh vegetables and fruits.

RISE UP

Materials

- Two identical clear, plastic food storage containers
- Clay: enough to fill a quarter of each tub with 5cm of clay
- 16-20 ice cubes
- Ruler
- Water
- Food colouring
- Non-permanent marker



Method

- Press equal amounts of clay into one side of each plastic tub to represent land rising out of the ocean. The clay should be pressed at an angle so that when water is added some clay will be above the water. Avoid creating depressions that will block water flow.

Tub 1: Place the same number of ice cubes on the bottom of the tub, next to the clay. This represents sea ice. Pour water into the container until the ice floats. Be sure that no ice is resting on the bottom of the tub. The water shouldn't be higher than the clay land level.

Tub 2: Place as many ice cubes as possible on the flat clay surface. This represents land ice. Pour water into the container on the opposite end of the clay to avoiddisturbing the ice cubes. The water level will be equal to the water level in Tub 1.

- Measure the water level in millimeters in each tub. Record data. Repeat this process at regular timed intervals until all ice has completely melted. Consider accelerating the ice melt by placing both tubs in a warm area.

EARLY YEARS

Place an ice cube into a small container or cup. Place an ice cube with water into a second small container or cup. Time how long it takes for each ice cube to melt. Discuss why this might happen.
How it works: The ice will absorb the warmer energy of the water. Water is denser than air, so its molecules transfer heat at a faster rate than air.

SENIOR YEARS

Explore the effects of thermal expansion by using warm water in both Tub 1 and Tub 2. Record the increase in volume of water. Students could also dissolve salt into the water of both tubs to simulate ocean salinity, and how, it impacts the melting of sea ice and land ice. Stratification of water types can be demonstrated through dyed ice cubes (with food coloring), so when the freshwater (land) ice cubes melt, they will visually interact with the seawater.

HOW IT WORKS

As the global temperature goes up, ice trapped on land in the form of glaciers and ice sheets are melting and adding more water to Earth's oceans. Climate change causes variations in both temperature and snowfall. Warming temperatures cause glaciers to melt faster than they can accumulate new ice. Warming temperatures also mean some areas will get rain rather than snow, further lessening ice accumulation. When glaciers lose more ice in the warmer months than they gain in the colder months, they recede. The rise in sea level has implications for animals and locals that rely on sea ice to hunt and migrate as well puts coastal communities such as Churchill at risk of flooding.

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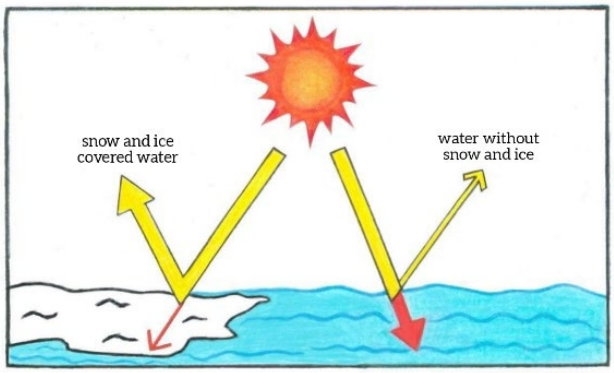
CHAPTER 3

SWEAT OR SHIVER?

Materials

- Black and white material: consider construction paper, t-shirts, or garbage bags
- Water
- 2 Shallow containers
- Two desk lamps *(if conducting experiment indoors)*
- Glass jar or lid to cover water in shallow containers



Method

- Place black and white materials on a flat surface.
- Place the shallow containers onto each surface, and fill with 3-4cm of water.
- Both containers should have the same amount of water.
- Measure both the water level and temperature of each container. Record data.
- After 5 minutes feel each black and white surface with your hand.
- Observe any temperature differences. Measure the water temperature in each container.
- After 10 minutes, measure the water level of each container.
- Repeat this process in 5 and 10 minute intervals for at least 30 minutes.

EARLY YEARS

Conduct this activity without water, using only the black and white materials. Observe and measure temperature of the materials. Discuss which surface absorbed more energy from the light, and how this might impact daily choices.

HOW IT WORKS

The albedo of a surface describes the amount of light that it reflects. If a surface has a high albedo, it reflects the majority of the light energy that hits it. Surfaces with a low albedo absorb the majority of the light energy that hits it.

Dark coloured surfaces have a low albedo, which is why they heat up much faster than light coloured surfaces. Dark coloured surfaces are much warmer than light coloured surfaces. This means that dark coloured water will warm up much quicker than water with a layer of ice and snow on top.

SENIOR YEARS

Repeat this activity with a glass jar covering some of the water in both shallow dishes. Observe any evidence of condensation. Which surface provides enough heat energy for condensation to occur? Discuss implications of both activities as this connects to lost sea ice on the Hudson Bay.

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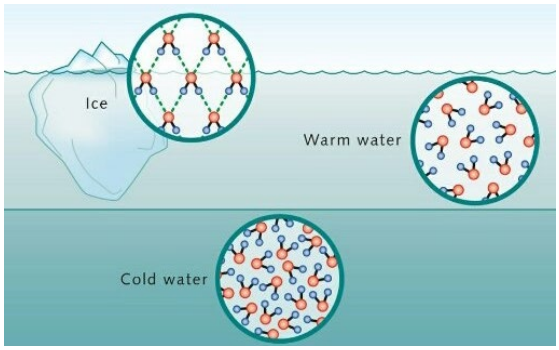
CHAPTER 4

BRINE MAKES THE WORLD GO ROUND

Materials

- Two 2L milk paper cartons
- Salted water
- Food colouring
- Scissors



Method

- Fill one 2L milk carton with tap water and freeze overnight.
- Add 7 teaspoons of salt to 2L of tap water and mix well. Fill the second 2L milk carton with salt water and freeze overnight.
- Remove the cartons from the freezer at least one hour before the demonstration.
- Remove the paper cartons to expose two bricks of ice, called ice cores.
- Add food colouring drops along the top of each core.
- Let the cores melt without disturbing them.
- Observe and discuss the differences between sea ice cores and fresh ice cores melting.

EARLY YEARS

Observe ice floating in cold water, and ice floating in warm water. Why does ice float? Ice is less dense than water because of how water freezes. Frozen water molecules are more organized in its packing whereas liquid water molecules are less organized. Extend this activity by mixing oil and water in a beaker or glass. This illustrates the idea that denser liquids sink (in this example: water or salty water) and less dense liquids (oil or freshwater) float on top.

SENIOR YEARS

Create and conduct some water freezing experiments outside. As ice forms, water organizes itself in its packing. In this process, the ice shoots out the salt and some contaminants. This is called brine. The process leads to atmospheric chemistry interactions. If the freezing process is very fast the brine can form frost flowers. These very salty crystals can form on the surface of the ice.

HOW IT WORKS

When seawater freezes, salt is ejected out of the ice making the surrounding water even saltier. The salts do not fit in the crystal structure of water ice, so the salt is expelled.

This brine rejection by the forming sea ice drains into the surrounding seawater, creating saltier, denser brine. The denser brine sinks, influencing the global ocean circulation pattern.

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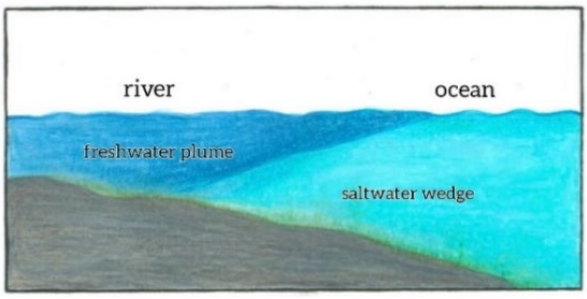
CHAPTER 5

WATER YOU DOING? I'M STRATIFYING!

Materials

- Tap water
- Dark food colouring
- Table salt
- Cooking oil
- Clear glass jar
- Mixing cup
- Straw
- Tablespoon



EARLY YEARS

Conduct a formal experiment to determine which substances can or cannot dissolve in water. Allow students to preform various tests with sugar, salt, oil, pepper, and more. Extend this experiment to see how much salt or sugar can be dissolved into a glass of water before it becomes fully saturated.

Method

- Fill the glass jar 1/3 of the way with tap water.
- In the mixing cup, mix ¼ cup of water with 1 tablespoon of salt. Add 3 drops of the dark food colouring.
- Submerge the straw in the coloured salt water and cover the straw end with your finger. Ensure that the water is being 'held' in the straw.
- Transfer the water in the straw to the tap jar by slowly releasing your finger over the straw. The straw bottom is touching the bottom of the glass jar when it is being released.
- Repeat until a layer of coloured salt water is sitting below the tap water.
- Pour a tablespoon of oil into the glass jar. Observe what happens.
- Move the jar back and forth to create waves. Observe what happens.

SENIOR YEARS

Repeat this activity with water of different temperatures. Mix blue food colouring into a glass with cold tap water and an ice cube. Using a straw, transport this water into a cup with near- boiling water. Slowly release the cold water onto the surface of the hot water. Diagram observations in a science journal. Discuss how this happens in nature, considering areas where the sun warms up the ocean, and areas where cold water flows from glaciers.

HOW IT WORKS

The difference in density between salt water, fresh (tap) water and oil makes these substances stratify. This means they will separate into 3 distinct layers in the cup. The salt water is heavier than the fresh water as it contains a dissolved solid. This makes it sink below the fresh water. When waves are introduced, the salt and fresh water begin to mix. However the oil remains on the top of the water as it is not water soluble. Salt and fresh waters also stratify as the mix in estuaries: places where fresh water rives meet salt water oceans.

CHAPTER 6

SAVE YOUR EGGS, SAVE THE ENVIRONMENT!

Materials

- 2 glasses or transparent cups
- Water
- Vinegar or other acidic liquid such as orange juice or pop
- A small spoon

Method

- Completely submerge one egg in a glass of vinegar.
- Completely submerge the second egg in a glass of water.
- Observe the eggs after 24, 48, and 72 hours. At these times, remove each egg from the liquid and gently feel the shell. Diagram and take notes about the condition of each eggshell.

EARLY YEARS

Repeat this activity using a variety of liquids, including hot water and ice water. Leave the eggs submerged in each liquid for 24 hours. How did each type of liquid affect the egg? Why?

Discover which Arctic organisms have shells. Discuss the impact that this process has on Arctic marine life, and the role that humans play in the acidification of oceans.

HOW IT WORKS

In this activity, the acid slowly dissolves the calcium carbonate in the eggshell. This reaction also releases carbon dioxide bubbles as it weakens the shell. Notice that the eggshell in acid has been weakened, while the one in water has not.
When carbon dioxide from the atmosphere is added to seawater it forms carbonic acid. This increases the acidity of the marine environment. This may have negative consequences for marine organisms, especially those with calcium carbonate shells. Marine organisms with calcium carbonate shells include mollusks, scallops and crabs.

SENIOR YEARS

Repeat this activity with collected shells. Have students create an Arctic aquatic food web. Students will then re-create this Arctic aquatic food web removing organisms that are affected by the acidification of ocean water.

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CHAPTER 7

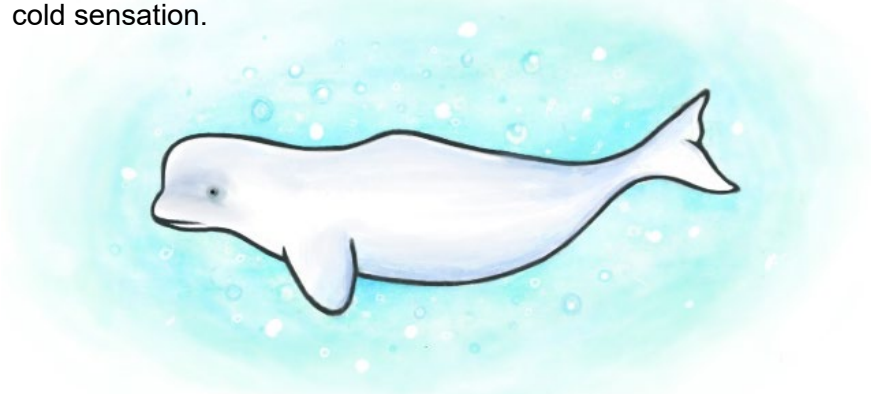
FANTASTIC FATS

Materials

- 2 Plastic bags: re-use any grocery bag, bread bag, or Ziploc bag
- Fat product: butter, margarine, lard, or shortening
- Large bowl
- Ice water

Method

- Fill one bag with a thick layer of butter.
- Place the second bag inside so that the butter is between the two bags.
- Seal the top of the bags together to that the butter does not come out. Be sure to leave the center of the bags open so that your hand can be placed inside.
- With your hand inside, place the blubber glove into the ice water. Time how long it takes for your hand to first feel any cold sensation.



EARLY YEARS

Before the blubber glove is created, explore a variety of insulating materials such as cotton balls, grass, or sawdust. Create a glove for each of these materials and time how long it takes to feel the first sensation of cold. Compare results.

SENIOR YEARS

Research a variety of Arctic animals and how thick their fat layers are. Compare this to human habitats and the need for insulation in cold climates. Create and conduct a formal experiment using a variety of insulating materials. Consider designing an insulator for a hot or cold beverage, or keeping an ice cube from melting.

SAFETY: Do not keep hand in the ice water after the first sensation of cold is noticed.

HOW IT WORKS

Large mammals such as polar bears and belugas have more layers of blubber to help protect them from the harsh Arctic climate. Their size helps to retain heat, and the blubber acts as an insulator. The layer of blubber can be up to 10cm thick! In this activity, the insulated blubber bag showcases how effective the blubber layer is in cold water.

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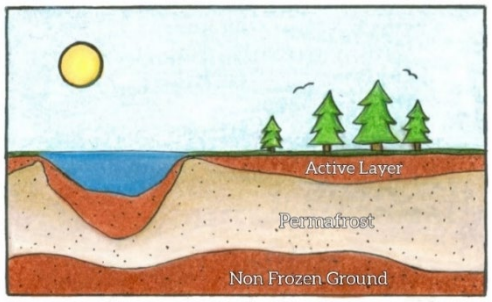
CHAPTER 8

NOT-SO-PERMA-FROST

Materials

- 1 large clear container
- 1 tray of ice cubes
- Soil or sand from the ground, enough to fill a container half-way
- 2 cups of water
- Variety of toothpicks, wood skewers, twigs, popsicle sticks



Method

- **Make Permafrost:** Mix water and soil until soil is moist.
- Pour ⅔ of soil into container.
- Dig out a narrow channel in middle of the soil for the 'river'.
- Place toothpicks, twigs, popsicle sticks, skewers into the moist soil to mimic a forest. Ensure you have trees along the riverbank.
  Freeze for a minimum of 12 hours!
- Place ice cubes on top of soil - these will be ice wedges on land.
- Add last ⅓ of moistened soil on top of the ice cubes.
  Freeze for minimum 3 hours!
- **Melt Permafrost:** Pour water into the river channel of the frozen permafrost.
- Leave permafrost model alone but check back periodically to observe how it is melting. Consider accelerating the ice melt by placing the model near a source of heat.
- What happens as the permafrost thaws? What areas thaw first? Which trees slump first? What happens to the ice wedges?

EARLY YEARS

Freeze soil with toothpicks in it overnight. In another container, freeze soil plus water with toothpicks in it overnight. Compare toothpicks' stability in frozen vs. non-frozen soil, both with water and without. Extend the discussion with how soil and water get messy in the springtime. Connect this by explaining how this process can affect very deep soil and permafrost.

SENIOR YEARS

Have individuals or small groups of students freeze a container of soil plus water. Use the design process to build a house on permafrost to see how it is affected by the melting ground. Include discussion on effects of permafrost degradation on infrastructure (roads, buildings, coastlines/shipping ports) and adaptation techniques being utilized in affected communities.

HOW IT WORKS

Permafrost is mostly found in the polar regions of the world and is defined as a soil mixture (rocks, soil, ice, sand and organic material) that has been frozen for at least 2 consecutive years. As the polar climate warms, permafrost is no longer 'perma' - it is thawing, or melting. This means that what used to be solid land is now changing. It is often sinking or slumping, creating challenges for the flora, fauna and people who live in these areas. Slumps often happen near rivers, lakes and coastlines. The nutrients, soil, plants and trees transform ecosystems when they sink into the waterways.

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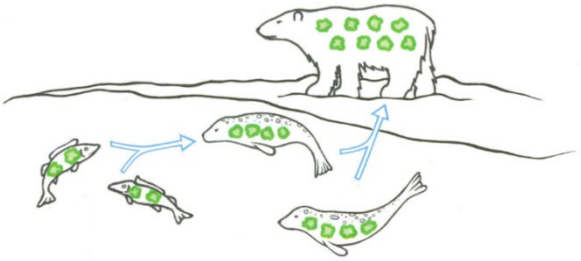
CHAPTER 9

ARCTIC INVADERS



Materials

- Pompoms, paperclips or similar items of different sizes
- Pictures of Arctic animals: walrus, clams, zooplankton, benthic worms, fish, beluga whale, humans, and more.

Activity 1: Grasshopper Effect (Atmospheric Transport)

- Divide the classroom into three sections.
- Standing at one end of the room, throw the small items.
- Notice where these items land, measure the distance each item travelled. Note how many items landed in the third section.
- Repeat the activity three times. Graph the numerical data.
- The items represent pollutant particles. The third section of the class or field represents the Arctic. Items began their journey in one part of the world and landed in another.

Activity 2: Bioaccumulation and Biomagnification

- Construct a food chain and/or food web by assigning each student an animal. Position them by trophic levels.
- Give several small items to animals on the lowest trophic levels. These represent pollutants.
- Pollutants move up the food chain as animals eat.
- What is a contaminant and what is a pollutant? How are these transported to the Arctic? Which animal has the highest concentration of pollutants? What is the difference between bioaccumulation and biomagnification?

HOW IT WORKS

Grasshopper Effect: If a compound is volatile, it will easily evaporate. In warmer climates, pollutants can evaporate and be transported with winds. Once they reach a cooler climate, they will condense and remain in that area. In warmer months, pollutants can 'hop' many times until they reach the colder Arctic region.

Bioaccumulation happens when the rate of uptake of a pollutant exceeds the rate of elimination within a body. Over time, this accumulation increases body burden. **Biomagnification** happens when the body burden increases as the contaminant moves up the food chain. The highest concentrations are found in top predators.

EARLY YEARS

Continue the concept of bioaccumulation by giving each student a small piece of plastic, or item representing plastic. Students will throw the items into a mock-lake or natural water system. Ask students what will happen to the fish and animals in the lake. Add another round of plastics into the mock-lake and repeat the question. Continue this process and discussion until students realize the effect that the build-up of plastic in our water systems has on fish, animals, and humans.

SENIOR YEARS

Create and test an experiment about microplastics within individual homes and within the local community. The complete scientific method will include a study about global microplastics, effects on humans, and where microplastics enter local ecosystems. The experiment may also include the creation of a device for measuring and/or filtering microplastics from local water systems.

CHAPTER 10

FILTER? We Don't Even Know Her

Materials

- Large mixing bowl
- Short glass
- 500ml of tap water
- 250g of soil
- 50ml cooking Oil
- Plastic wrap
- One small stone or weight

EARLY YEARS

Students create 'dirty' water with sand, pepper, or whatever they want! Observe the colour of the dirty water. Measure the amount of dirty water. Pour the dirty water through a coffee filter (you can add cotton balls for extra purification). Make note of the colour of the water that comes out, and how much water remains after filtering.

Method

- Mix the water, soil and oil in the mixing bowl.
- Place the glass in the center of the bowl right side up, ensuring no water gets inside the cup.
- Cover the bowl with plastic wrap. Place the stone directly over the glass so that the plastic wrap dips towards the short glass.
- Place the model in the sunlight, either indoors or outdoors.
- Observe what happens to the water and the empty cup over a couple days.

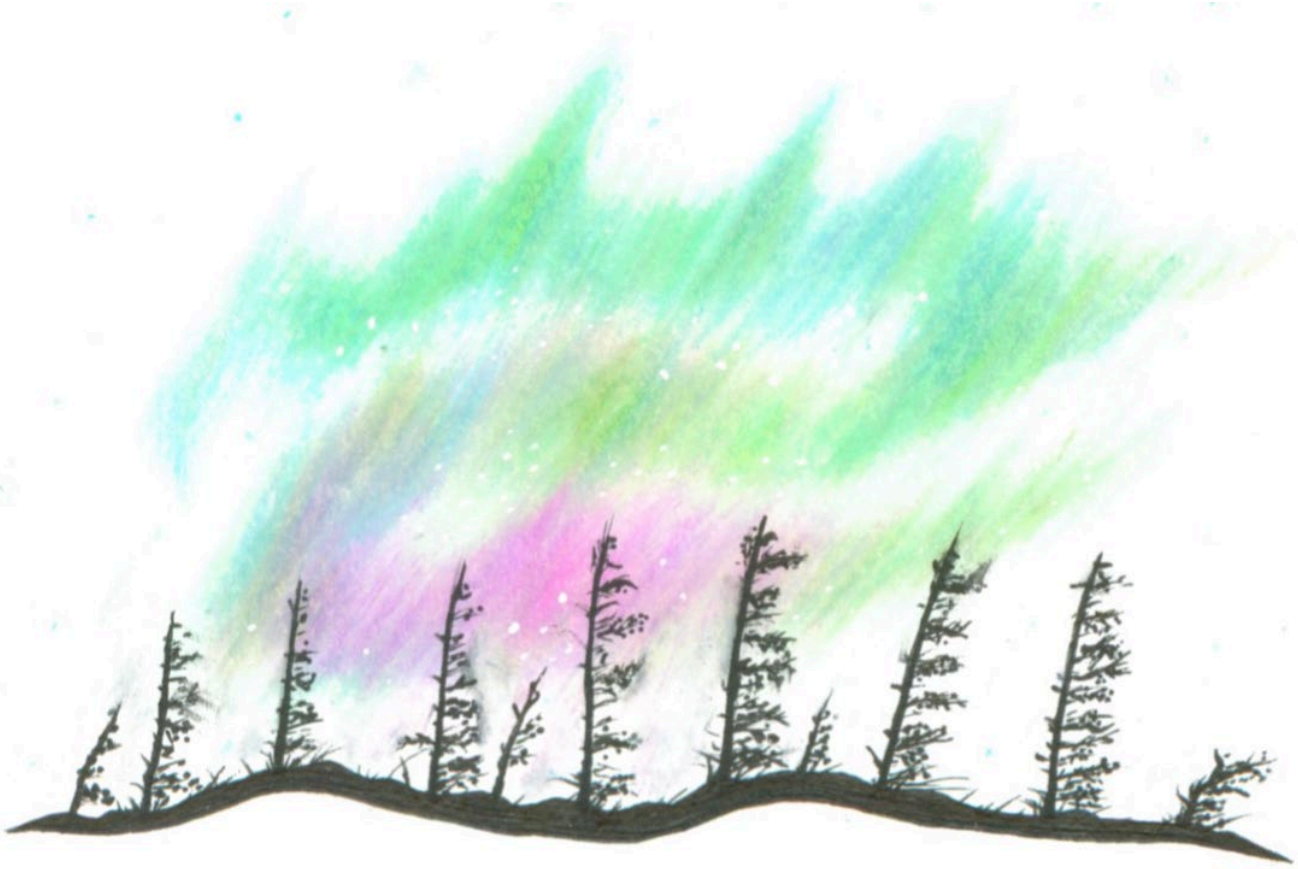
SENIOR YEARS

Using the design process, students can build their very own air purifier. Use common household items such as a shoebox, cotton balls, aluminum foil, and other available materials. Students will discover what types of particles are in the air around them, and in what amounts.

Visit Teach Engineering for full activity:
https://www.teachengineering.org

HOW IT WORKS

This activity demonstrates the purification of water through evaporation and demonstrates one of the processes people can use to clean a polluted resource. When water evaporates due to heat build-up in the closed system, it does not bring 'heavy' substances like sand or oil. The pure evaporated water collects on the plastic wrap and flows down towards the lowest point, collecting under the rock and falling into the cup. Students can conceptualize the process of purifying water and how long/difficult of a process it is.



Lesson Plans

ARCTIC ADAPTATIONS

EXPEDITION CHURCHILL CONNECTION:

Chapter 6: Anchors of the Living Bay
Chapter 7: Living Icons of the Arctic

OBJECTIVE

Students will explore animal adaptations by creating a Tri-O-Rama. This Tri-O-Rama will give an in-depth description of an Arctic animal, its habitat, and the adaptations, which allow it to thrive.

MATERIALS

- Scissors
- Glue
- Tri-O-Rama template
- Various Colours of clay
- Collection of natural materials

Leading Questions:

What are adaptations?
How do adaptations develop?
Do animals become adapted to their environments?
How do adaptations help animals survive?

ACTIVITIES

Activate:

- As a group, identify adaptations of animals from around the world. For example, camels have extra fat to store water, and have long eyelashes to protect their eyes from blowing sand. Use photos of animals to help prompt discussion and ideas.

- Showcase animals that live in Manitoba, particularly the far north. Discuss their food chain and/or food web.

Acquire:

- Introduce a completed Tri-O-Rama for students to see and handle.
- Have students choose one Arctic animals, which they will create a Tri-O-Rama for.
- Students will conduct research on their chosen Arctic animal. Students will need to discover:

✓ 10 fun facts specific to their animal
✓ 2-3 adaptations that enable their animal to survive in the Arctic
✓ Habitat details

Apply:

- Using the Tri-O-Rama template, have students cut out the square and follow the folding instructions on the sheet. They will fold accordingly to create a standing triangle shape.
- Once the shape has been created, students will need to fill in all three sides of the Tri-O-Rama:

✓ Create a replica of the habitat. Be sure to use clay and any other available natural materials to create background details as well as the chosen animal itself.
✓ List the researched fun facts about the animal.
✓ Draw, list, and identify adaptations in a fun, creative way.

Extension:

Once one Tri-O-Rama has been completed, students can then create 3 more Tri-O-Rama pieces to arrange into a circle and show a completed food chain, or different animals in the same habitat. Students will choose 3 animals from different habitats, or different levels of the food chain to deepen understanding.

LITERACY CONNECTIONS

- Research and selection of utilized information
- Summary skills
- Extended writing opportunities

NUMERACY CONNECTIONS

- Geometry and measuring angles
- Calculation of species within different trophic levels in Manitoba

CAREER LINKS

Environmental Scientist: Environmental scientists work in applied fields and interdisciplinary settings analyzing the effects that humans have on our environment and the plants and animals that populate it. From agriculture to healthcare to industry, environmental scientists teach, research, and work in business to help humans understand our work

Ecologist: Ecologists study the interrelationships between organisms and their environments. For example, they may research how the creatures in forests, deserts, wetlands, or other ecosystems interact with each other, as well as their environments.

Biologist: Biological Science and Biology is the study of life - living or dead, on land and at sea. They may work with microscopic life right up to the largest living specimens. Biologist and Biological Scientist are generic terms though; most will specialize during the course of their studies.

MANITOBA CURRICULUM LINKS

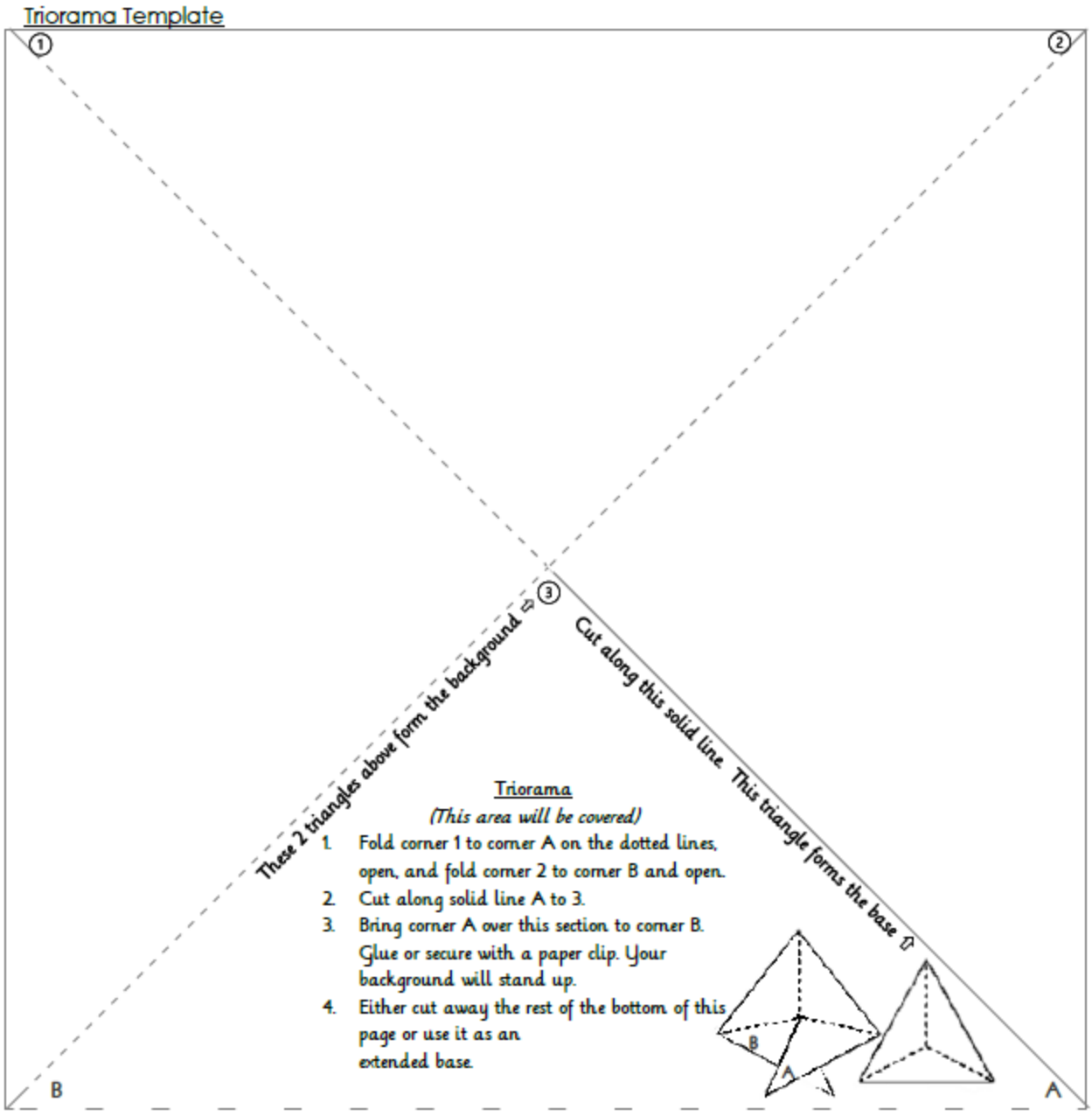
4-1-09	Recognize that plant and animal populations interact within a community.
4-1-13	Recognize that the food chain is a system in which some of the energy from the Sun is transferred eventually to animals.
4-1-14	Construct food chains and food webs, and classify organisms according to their roles. Include: producer, consumer, herbivore, omnivore, carnivore, predator, prey, scavenger
4-1-15	Use the design process to construct a model of a local or regional habitat and its associated populations of plants and animals.
6-1-02	Describe various kinds of classification systems used in everyday life, and identify related advantages anddisadvantages.
6-1-03	Develop a system to classify common objects or living things into groups and subgroups, and explain thereasoning used in the system's development.
6-1-04	Identify living things using an existing classification key, and explain the rationale used.
6-1-06	Identify the five kingdoms commonly used for the classification of living things, and provide examples oforganisms from each to illustrate the diversity of living things.
6-1-08	Observe and describe the diversity of living things within the local environment.
6-1-11	Compare and contrast adaptations of common arthropods, and describe how these adaptations enablethem to live in particular habitats

6-1-13 Compare and contrast the adaptations of closely related vertebrates living in different habitats, and suggest reasons that explain these adaptations.

7-1-01 Use appropriate vocabulary related to their investigations of interactions within ecosystems.

7-1-02 Define ecosystem, and describe various examples that range from the microscopic to the entire biosphere.

RESOURCES



CHAIN LINKS

EXPEDITION CHURCHILL CONNECTION:

Chapter 6: Anchors of the Living Bay
Chapter 7: Living Icons of the Arctic

OBJECTIVE

Students will identify the different parts of the food chain and create a food pyramid depicting trophic levels.

MATERIALS

- Chart paper
- Coloured markers
- Magazines *(preferably nature related)*, or an assortment of printed pictures
- Scissors
- Glue

Leading Questions:

- What is a food chain?
- What is a food web?
- What is the difference between a food chain and a food web?
- Where do people fit into the food chain?
- What are trophic levels?
- Where does energy originate? How is it transferred?
- How are Carnivores and Herbivores related?
- How does the food chain handle population imbalances?

ACTIVITIES

Activate:

- Introduce producers. Producers get their energy from the sun and are at the base of the food chain *(ie. grass)*.
- Demonstrate an Arctic food chain by drawing a triangle separated into 4 sections: Producers, Herbivores, Omnivores, Carnivores. Alternatively, divide students into four groups to represent the sections. Producers are at the bottom of the triangle. Explain that the base of the triangle is largest to demonstrate that producers have the most individuals followed by herbivores, which have less individuals, omnivores with even fewer individuals and finally carnivores with the fewest members.

- Explore the link between the food chain and depict how energy is absorbed by producers (*from the sun)* and then transferred through the chain vertically.

Acquire:

- Organize students into small groups. Each group will receive chart paper, glue, scissors, markers and an assortment of magazines.
- Students will be asked to create their own food pyramid on chart paper. Students will then browse the available magazines to search for living things. These living things will be cut out and placed appropriately on the food pyramid in the correct category.
- Students can have the option of drawing their food pyramid animals. They can also focus on animals local to the area, or focus on Arctic animals.
- Students will then present the food pyramid that they have created to the class to demonstrate understanding of the activity.

Apply:

1. Discuss with the class what the repercussions would be if the food chain received a massive influx of herbivores, carnivores, or omnivores. Explore the connection between the trophic levels and begin to understand the balance that must be maintained in a food chain and how an imbalance can be catastrophic to an ecosystem.

2. Using knowledge from an Indigenous Perspective, create a food chain that is not in the shape of a triangle. What would a food chain look like using a circle as a shape? How would you demonstrate a food web for Arctic animals? What are some other ways to represent a food chain, trophic levels, or food webs with animals in your area?

LITERACY CONNECTIONS

- Choose an animal on the food chain and research 10 facts about it
- Create a short story or poem about a local food chain.

NUMERACY CONNECTIONS

- Find numerical data that identifies how much of a producer is needed to support an herbivore, how many producers and herbivores are needed to support an omnivore, and what is needed to support a carnivore.
- Create a second food pyramid that is mathematically accurate.

CAREER LINKS

Environmental Scientist: Environmental scientists work in applied fields and interdisciplinary settings analyzing the effects that humans have on our environment and the plants and animals that populate it. From agriculture to healthcare to industry, environmental scientists teach, research, and work in business to help humans understand our work

Ecologist: Ecologists study the interrelationships between organisms and their environments. For example, they may research how the creatures in forests, deserts, wetlands, or other ecosystems interact with each other, as well as their environments.

Biologist: Biological Science and Biology is the study of life - living or dead, on land and at sea. Biologists may work with microscopic life right up to the largest living specimens. Biologist and Biological Scientist are generic terms though; most will specialize during the course of their studies.

MANITOBA CURRICULUM LINKS

4-1-9	Recognize that plant and animal populations interact within a community.
4-1-10	Recognize that the food chain is a system in which some of the energy from the Sun is transferred eventually to animals.
4-1-11	Construct food chains and food webs, and classify organisms according to their roles. Include: producer, consumer, herbivore, omnivore, carnivore, predator, prey, scavenger.
4-1-12	Use the design process to construct a model of a local or regional habitat and its associated populations of plants and animals.
6-1-02	Describe various kinds of classification systems used in everyday life, and identify related advantages and disadvantages.
6-1-03	Develop a system to classify common objects or living things into groups and subgroups, and explain the reasoning used in the system's development.
6-1-04	Identify living things using an existing classification key, and explain the rationale used.
6-1-06	Identify the five kingdoms commonly used for the classification of living things, and provide examples of organisms from each to illustrate the diversity of living things.
6-1-08	Observe and describe the diversity of living things within the local environment.
7-1-01	Use appropriate vocabulary related to their investigations of interactions within ecoysystems.
7-1-02	Define ecosystem, and describe various examples that range from the microscopic to the entire biosphere.

GETTING FLAKEY

EXPEDITION CHURCHILL CONNECTION:
Chapter 4: A Frozen World

OBJECTIVE

Students will preserve snowflakes to observe under a microscope. They will discuss dissolving snow, the relationship between snow and ice, and air quality.

MATERIALS

Snowflake Fixing:
- Snow *(essential for best results)*
- Non-gel superglue – new or unopened
- Fine-tipped paintbrush
- Flashlight *(optional, but very useful)*
- Glass microscope slides and slips *(two slides can be used if slips are unavailable)*
- Magnifying glass *(optional, but useful)*

Ice Work:
- Freshwater ice cubes
- Marine *(salt)* water ice cubes
- Green food colouring *(or any food colouring, but green mimics algae)*
- Flashlights

BACKGROUND INFORMATION

The following is very helpful to understand what is needed to preserve snowflakes:
https://www.instructables.com/id/How- to-preserve-a-snowflake-forever/

ACTIVITIES

Activate:

- With prepared ice cubes, a string and some salt, challenge students to pick up the ice cubes with nothing more than the materials provided.
- Activity Preparation: Have students prepare freshwater and “marine” (salt) water ice cubes to be frozen overnight. Emphasize the use of precise measurements and tool use and controls in their preparations.

Acquire:

Activity 1: Snowflakes

- Use the step-by-step guide from: https://www.instructables.com/id/How-to-preserve-a-snowflake-forever/ to fix snowflakes. This is a week-long process. Discuss the process.
- Talk briefly about the physical structure of snowflakes, including their formation in clouds. Include liquid to solid formations.
- Discuss how snowflakes act like an air purifier, sponging up impurities, such as harmful byproducts of vehicle emissions as they fall. Discuss the pollutants in the first fresh snowfall.
- Have students create a hypothesis with a partner on how snow becomes ice.

Activity 2: Saltwater and Freshwater Ice

- Distribute their fresh water and marine water ice cubes, bottle of green food colouring and a flashlight for each table group. Green food colouring represents algae, and can be dripped on the top of each ice cube.
- Observe the ice cubes as they melt. Record observations, measurements, and other relevant data.

Apply:

- Use Google Keep, a concept map, or a three-point approach to express understanding of freshwater vs. marine ice, as well as information regarding snowflakes. Their descriptions should include the particle theory of matter.

LITERACY CONNECTIONS

- Read through Ch.4: Key Points
- Curating a Google Keep file

NUMERACY CONNECTIONS

- Basic calculations *(i.e. the amount of solute (salt) dissolved in the solvent retroactively)*
- Scale

CAREER LINKS

Aquatic Biologist: Aquatic Biologists study life in aquatic environments, from the coral reefs to the Greenland ice sheet and everywhere in between. This career has incredible travel opportunities and a chance to work outside in all conditions as well as in an office. It is a career of exploration and conservation.

Meteorologist: Meteorologists study weather and climate using data and models. If you have a passion for helping people plan their days and weeks, and what the atmosphere may bring, then this is ideal. It is very dynamic and appreciated by the public.

Outdoor Adventure Leader: These leaders are often conservationists and outdoor enthusiasts who are passionate about the Earth and environment. They have extensive knowledge based on experience, culture and/or upbringing. Their skills are typically learned through generations of experience and self-directed study. They have a deep knowledge of specific lands.

MANITOBA CURRICULUM LINKS

7-2-01	Use appropriate vocabulary related to their investigations of the particle theory of matter.
7-2-16	Identify solutes and solvents in common solid, liquid, and gaseous solutions.
7-2-21	Describe the concentration of a solution in qualitative and quantitative terms and give examples from daily life when the concentration of a solution influences its usefulness.
7-2-23	Discuss the potential harmful effects of some substances on the environment and identify methods to ensure their safe use and disposal.

EXPEDITION CHURCHILL
Middle Years Lesson Plan

COMING UP IN THE WORLD

EXPEDITION CHURCHILL CONNECTION:

Chapter 2: Hudson Bay: A Sea of Change

OBJECTIVE

Students will develop an understanding of the process of isostatic rebound through inquiry and experimentation. They will become scientists to unravel a mystery going on in Churchill that will require some understanding of the kinetic molecular theory.

MATERIALS

- Any natural smelly substance.
  Note: Avoid any synthetic fragrances due to allergy concerns *(perfumes, colognes, fragrant aerosols, and fragrant candles).*
- Play Doh, putty
- Sponges, Memory Foam
- Soaked wood *(or marginally compressible solid)*
- Ruler

ACTIVITIES

Activate:

- Build up a story that talks about farts (*a teenage favourite*) and use something smelly *(not including synthetic fragrances)* to demonstrate particle spacing. This will have the class talkative and goofy, which lends well to the next activity.
- Students stand up and model solids, liquids and gases. When they are side by side, arms linked, they are solid. Have one student at the end of the line lean into the person immediately beside them. The individual down at the end of the line should feel this.
- Repeat as liquids by standing shoulder to shoulder, arms not linked. This time the motion won't be felt all the way down.
- Repeat as gases and have students spread out to fill the hall. Ask the same person to lean left, right, etc. Of course, they contact nobody, and the disturbance is not felt by others.
- Connect these kinesthetic hooks to the discussion of particle spacing.

Acquire:

- Showcase a variety of photos of rocks along the coastline in Churchill.
- Inform students that the rocks seem to be slowly growing. Their challenge is to explain this mystery.
- Have 2-3 different materials that can be shared in small groups – Play Doh, sponge, Memory Foam, wet wood *(soft wood, like spruce/poplar is ideal)*. Have students use their items in a way that they think can unravel the mystery of the rocks/coastline in Churchill. They are effectively creating a hypothesis and testing it with model materials. Provide a ruler so that students can gather data that they feel is relevant.
- Encourage students to consider the activities that they participated in regarding particle spacing to help solve the mystery.

Apply:

- Students will present their theories about the mystery in Churchill. They will present their complete process including created hypothesis, data, and conclusions.
- Watch the video Isostatic Rebound in Churchill: https://www.youtube.com/watch?v=maxo0acJSeg

LITERACY CONNECTIONS

- Reading Ch. 2 in Expedition Churchill
- Writing out hypothesis, results and conclusions

NUMERACY CONNECTIONS

- Measuring compression depth
- Measuring rebound per unit of time
- Graphing data if desired

CAREER LINKS

Geologist: Effectively a rock scientist. Geologists do research on the Earth's crust. Geologists are currently popular and in-demand that often takes you to rural and remote locations. They are offered opportunities to observe and discover incredible anomalies of the Earth. A considerable amount of education is needed to pursue this at the highest level. Very academic.

Geographic Information Systems Technician / Remote Sensing Technician: They use data and/or gather dataperhaps by satellite, drone, etc. to create detailed layered maps. These maps relay detailed information over largeareas, pinpointed to specific spots on the land. There is a mixture of office and outdoor work, though it is mostly computer and technology based. This field of work and study is rapidly emerging.

Environmental Assessment: You are working to gather environmental data to aid in answering questions about processes of the planet, the health of ecosystems or impacts from industry. They often travel with the opportunity to go tounique locations. No day is ever truly the same. Fitness and frequent outdoor activity is expected.

MANITOBA CURRICULUM LINKS

7-2-01 Use appropriate vocabulary related to their investigations of the particle theory of matter.

7-2-05 Explain what scientific theories are and provide some examples. Include: a scientific theory helps to explain an observation; when this explanation has been repeatedly tested and shown to be consistent it is generally accepted in the scientific world.

7-2-06 Describe the particle theory of matter and use it to explain changes of state.

EXPEDITION CHURCHILL
Middle Years Lesson Plan

CO_2 & YOU

EXPEDITION CHURCHILL CONNECTION:
Chapter 3: Up in the Air

OBJECTIVE

Students will experiment with the solvation process and temperature to learn of carbon holding capacity of the ocean. Students will be able to predict the effects of rising CO_2 on the sub-Arctic.

MATERIALS

- Safety googles
- Universal indicator
- Two clear 10 oz plastic cups
- Two clear 3 oz plastic cups
- Masking tape/Scotch tape
- Baking soda
- White vinegar
- Two Petri dishes – to use as lids on the plastic cups or other transparent plastic sealing material

ACTIVITIES

Activate:

- Start the class outside if it is winter (*in a cold weather location*) and have them begin by exhaling and looking at their breath. Although most of their breath is sublimating water vapour, discuss the colorless CO2 and have them hypothesize where CO2 goes especially from large emitters. Present the discovery as something *taboo*.
- Effectively, one could position the *answers* to uncover as a little-known secret.
- Note: Water vapour starts as a gas and condenses into liquid in the air as vapour.

Acquire:

- Arrange students in small groups with prepared materials.
- The following link is helpful to gain an idea of the next hands-on activity. This lesson is a twist on the Khan Academy'socean acidification experiment.
  https://www.khanacademy.org/partner-content/exploratorium-ddp/exploratorium-chemistry/ocean-acidification/a/ocean- acidification-in-a-cup-complete-activity-guide

Explain and have them complete the investigation below with a brief explanation of the indicator. Include a short explanation of universal indicator.

- Tape a small cup to the inside of a large cup (effectively hanging).
- Put water in large cup, add a few drops of concentrated universal indicator.
- One should have room temperature water, the other should have cold/ice water.
- Put baking soda into small cup and add a small amount of vinegar (DON'T allow to overflow)
- Immediately "cap" the system
- Observe not just the colour change of the solution, but the speed it occurs at in each system, as well as WHERE thecolour change begins to happen.

Have students note their understanding, talking about solute, solvent, dissolution and the particle theory of matter.

Apply:

- Tell students to figure out the part the world does not want them to know – *the secret*. Based on their knowledge of the CO_2 holding capacity of water (*note: acidification of ocean water isn't profound in the North*), create a detailed concept map to hypothesize their impacts. Encourage students to be creative and provide hints as needed.
- Compare concept maps to those found in Expedition Churchill Chapter 3.

LITERACY CONNECTIONS

- Reading for understanding
- Curating notes on dissolution
- Creating concept map

NUMERACY CONNECTIONS

- Measuring of chemicals
- Record the pH based off a colour indicator chart; extend the conversation into the pH scale and logarithmic exponents

CAREER LINKS

Environmental Chemist: Using analytical tools, these individuals monitor environmental data. It is a career with a strong math and problem-solving foundation where you are trying to discover the puzzle. There is the chance to travel to novel locations and be on the cutting edge of what we know about the world.

Ecologist: Ecologists paint the picture of our living world, and how people interact with the environment. Ecologists are consistently in the field gathering data or interpreting data, which can specialize in an abundance of ways. For example, polar bear populations, ring seal behavior, bird migrations, and more.

Statistician: Statisticians use math to create models of what is happening in the world. Extrapolating and interpolating data are tools of the trade that allow for predictions to be made to inform researchers, politicians and policy makers to best chart the pathway forward. This is a very computer/software-oriented career, and is in a high demand field with multiple transferrable skills.

MANITOBA CURRICULUM LINKS

7-2-01	Use appropriate vocabulary related to their investigations of the particle theory of matter.
7-2-16	Identify solutes and solvents in common solid, liquid, and gaseous solutions.
7-2-17	Describe solutions by using the particle theory of matter. Include: particles have an attraction for each other; the attraction between the particles of solute and solvent keeps them in solution.
7-2-20	Experiment to determine factors that affect solubility.
7-2-23	Discuss the potential harmful effects of some substances on the environment and identify methods to ensure their safe use and disposal.

EXPEDITION CHURCHILL
Senior Years Lesson Plan

WEATHER OR NOT

EXPEDITION CHURCHILL CONNECTION:
Chapter 3: Up in the Air

OBJECTIVE

Students participate in a lab activity to investigate what happens when cold meets hot air. Students will explain the effect of weather on a community *(personal, economic and environmental)* and the role weather has on our lives.

MATERIALS

Cloud in a Jar Materials

- Clear glass or plastic jar, preferably large *(1 gallon)*
- Warm water *(about ½ cup, warm tap water will do)*
- Matches
- Bag of ice
- Flashlight *(optional)*
- Black paper *(optional)*

Density Lab Activity

- Two empty medium sized flasks
- Artificial food colouring *(red and blue)*
- Cold and hot water
- Aluminum foil sheet
- Clear tub to hold water spillage
- Water supply: hot and cold
- Toothpick *(to illustrate the flow of the water movement)*

ACTIVITIES

Activate:

Demonstration: Cloud in a Jar

- Students remember the different components needed to form clouds and other weather formations which can facilitate the conversation about extreme weather conditions.
- Pour warm water into the jar to just cover the bottom.
- Place the bag of ice on top of the mouth of the jar *(the mouth needs to be covered completely – the air inside staysclear).*

- Remove the bag.
- Light a match holding it just inside the jar. Blow out the match and allow some smoke to enter the jar.
- Replace the ice bag of ice and wait 30 seconds.
- A cloud will form inside the jar and when you remove the bag fog will exit out the jar.

Acquire:

Lab Activity: Density of Hot vs. Cold

Have students complete an investigation that determines what happens when water of one temperature comes in contactwith water of a different temperatures.

Cold over Cold

- Fill two flasks with cold water and drop blue food colouring in one and red food colouring in the other
- Place aluminum foil over the flask with blue food colouring, and place it upside over the second flask
- Carefully remove the foil and observe what happens. Why does it happen?
- The density of the cold water in both flasks are the same

Hot over Cold

- Fill one flask with cold water and drop blue food colouring in it, In the second flask fill with hot water and drop red foodcolouring in it
- Break a toothpick into small pieces and place it into the blue flask
- Place aluminum foil firmly over the top of the flask with the hot/red water in it. Holding it firmly flip the flask upside down on top of the blue water flask so the openings are together. Carefully remove the foil between the flask.
- Discuss why the two liquids do not mix The density of the two liquids are different
- Then add ice on top of the red flask (cooling the flask down)
- Observe what happens to the liquid and the pieces of the toothpick

Apply:

Choose one or more of the following Apply connections:

1. Investigate a Recent Severe Event
   Have students select a community and gather information that assists them in identifying the impact of the weather oneconomic, social and environmental aspects of the community.
   - Students will describe the weather event and its cause and justify its classification as a severe event
   - Students would describe social impact of the event on the area they are investigating
   - Students would describe the environmental impact of the event

2. Comic Strip Severe Event
   Have students create a comic book/strip to describe weather event and justify it as a severe weather event. *(two work periods)*

3. Visual Display
   Have students work in groups to present a description of development of weather events such as thunderstorms,hurricanes, tornadoes, cyclonic storms, and blizzards.

LITERACY CONNECTIONS

- Research skills
- 2nd person reading *(instructions)*
- 2nd person writing *(lab reports)*
- Presentation skills

NUMERACY CONNECTIONS

- Accuracy of measurements
- Precision weight measurements & calculations
- Density numerical data

CAREER LINKS

Meteorologist: Atmospheric scientists analyze data which is used to issue a warning for the forecast. They present the forecast to the public in various formats. Not all meteorologists forecast weather; they also could be involved in the study of biological impacts, atmospheric chemistry or computer modelling.

Environmental Engineer: This is a branch of engineering that focuses on protecting people from adverse environmentaleffects and improving environmental quality. An environmental engineer uses the principles of soil science, chemistry, engineering and biology to develop solutions to problems in the environment. They work on programs to improve public health, waste disposal, water and air pollution and recycling.

Tactical Weather Specialist (Military): These specialists gather, analyze and share weather based intelligence using weather forecasting tools, international government sites and prediction software. In turn this information is used to advise commanders how the weather could impact their missions.

MANITOBA CURRICULUM LINKS

S2-4-01 Illustrate the composition and organization of the hydrosphere and the atmosphere. Include salt water, fresh water, polar ice caps/glaciers, troposphere, stratosphere GLO: D5, E2

S2-4-02 Outline factors influencing the earth's radiation budget. Include solar radiation, cloud cover, surface and atmospheric reflectance (albedo), absorption, latitude GLO: D4, D5, E2, E3

S2-4-04 Explain the formation and dynamics of selected severe weather phenomena. Examples: thunderstorms, tornadoes, blizzards, hurricanes, extreme temperature events, cyclonic storms…GLO: A2, D5, E1, E4

RESOURCES

Let's Talk Science Weather Educational Resources:
https://letstalkscience.ca/educational-resources/stem-in-context/reaching-arctic

Weather Makers: Climate Change Unit Resource for Teacher:
http://resources4rethinking.ca/en/resource/weather-makers- secondary

Climate Resources: http://science.robertprior.ca/science-10/climate-10/index.html

Podcast: In Our Time by BBC Radio 4 – Meteorology https://www.bbc.co.uk/programmes/p00548v8

Podcast: Discovery: Thin Air by BBC Radio 4 https://www.bbc.co.uk/programmes/p00d0vhg

Grade 10 Simulation of global Warming PDF –
https://www.publicboard.ca/archive/ecoSchoolsARCHIVE/CurriculumResources/Documents/SimulationOfGlobalWarming
-Gr10.pdf

Cloud in the Jar and Density Lab Activity came the Outreach University Manitoba Platform
http://www.umanitoba.ca/outreach/crystal/Grade%2010%20Science.html#cluster4

VIDEO:

Making a Cloud Demonstration https://www.youtube.com/watch?v=AoUgLp6kTQ8

Science Trek: Weather by PBS (29 minutes) https://www.pbs.org/video/science-trek-weather/

Playlist of Weather Videos
https://www.youtube.com/playlist?list=PLjEXIU1f2EZX3O49Zf9fFR93kNi1Zg2Ra

FEELING HOT, HOT, HOT

EXPEDITION CHURCHILL CONNECTION:
Chapter 1: Churchill: A Gateway to Arctic Research

OBJECTIVE

Students will observe the variety of colours produced when different metals or metallic salts are heated in a flame.

Students will identify mystery metals using a flame test.

MATERIALS

- Test tube racks
- Bench mats
- Barium chloride, calcium chloride, copper (II) sulphate, lead (II) nitrate, potassium nitrate, sodium chloride
- 5M hydrochloric acid in labelled test tubes
- 5X Bunsen burners
- Minimum of 10 flame test wires *(clean)*
- Four of the six solutions as unknowns in labelled test tubes: 1, 2, 3, and 4

ACTIVITIES

Activate:

- Have students watch and discuss the following videos:

  A preview of the experiment can be shown here:
  https://www.youtube.com/watch?v=NEUbBAGw14k

  The following videos provide further explanations:

  https://www.youtube.com/watch?v=BjxnQjf6LGw
  https://www.youtube.com/watch?v=czMh3BnHFHQ

Acquire:

Procedure:

1. Dip the loop in chemical #1
2. Heat it in the hot part of the flame
3. Observe the resulting flame colour
4. Record observations in the chart provided
5. Clean loop with dilute acid
6. Repeat steps for the remaining chemicals

Chemical	Formula	Flame Colour
Sodium Chloride	NaCl	
Barium Chloride	BaCl2	
Calcium Chloride	CaCl2	
Potassium Chloride	KCl	
Copper (II) Sulfate	CuSO4	
Copper (II) Chloride	CuCl2	
Unknown…		

Apply:

Complete the following questions:

1. Did you get the results that you expected? Explain.
2. Use your data to support whether or not the flame colour of an element changes when it form a compound.
3. Is it possible to determine the identify of unknown metals or metallic salts? Explain.
4. What are the two equations that relate energy, frequency, wavelength, and speed of light?
5. Is it possible to identify two metals if an unknown substance contained a mixture of two metals? Explain.
6. Pinecones were soaked in a solution, and then allowed to dry. When they were burned in a fireplace, the flame was red and green. Which metal ions were present?

LITERACY CONNECTIONS

- Chemical compound names and respective formulas
- Elements on the Periodic Table *(i.e. metals)*
- General Vocabulary *(i.e. equipment and tools)*

NUMERACY CONNECTIONS

- Measuring mass
- Measuring volume
- Calculating molar mass

CAREER LINKS

Chemist: Chemists investigate the properties of matter at the level of atoms and molecules. They measure proportionsand reaction rates in order to understand unfamiliar substances and how they behave, or to create new compounds for use in a variety of practical applications. To do this they use a wide range of analytical techniques and instrumentation, including chromatography and spectroscopy.

Chemical Engineer: Chemical Engineers develop and design chemical manufacturing processes. Chemical engineers apply the principles of chemistry, biology, physics, and math to solve problems that involve the production or use of chemicals, fuel, drugs, food, and many other products.

Pyrotechnician: A pyrotechnician is a person who is responsible for the safe storage, handling, and functioning of pyrotechnics and pyrotechnic devices such as fireworks and stage flames.

MANITOBA CURRICULUM LINKS

Grade 12 Chemistry

Describe qualitatively the electromagnetic spectrum in terms of frequency, wavelength, and energy

Recognize, through direct observation, that elements have unique line spectra. Include flame tests or gas discharge tubes and spectroscopes or diffraction gratings

Describe applications and/or natural occurrences of line spectra. Examples: astronomy, aurora borealis, fireworks, neon lights…

BIOACCUMULATION, BIOMAGNIFICATION & BIODIVERSITY

EXPEDITION CHURCHILL CONNECTION:
Chapter 9: A New Reality

OBJECTIVE

Students will participate in online and in-class activities so that they learn about the effects of bioaccumulation and biomagnification.

MATERIALS

- Rope or cones to mark game boundaries *(optional)*
- Coloured paper token or other small items
- Small cups to keep paper token during the game

Background Information:

Mercury is natural occurring element, which can be transformed into a methylmercury, which is a toxin that builds up in shellfish and fish. It is taken up by tiny aquatic plants and animals, which are in turn eaten by larger organisms such as fish. The concentration increases at each level of the food chain. Bioaccumulation occurs within an organism while biomagnification is the increase of toxins with each level of the food chain.

Leading Questions:

Are bioaccumulation and biomagnification the same? How are they different?
How might bioaccumulation and biomagnification affect biodiversity? Have bioaccumulation and biomagnification created a new reality?

ACTIVITIES

- Have the students participate in an online simulation such as Ocean Explorer: https://oceanexplorer.noaa.gov/edu/learning/player/lesson13/l13la1.html

- Students will feed the birds by dragging clams and fish until they are full. Have students first only feed the birds clams only, then only fish and the third time both clams and fish. Once they completed the simulation several times have them click the show toxins button to reveal the toxic load.

Acquire:

Bioaccumulation Tag: This activity has many varieties and options within global or local food webs. This example utilizes a food web that consists of shrimp, salmon, herring and grizzly bears. Students play the roles of the animals as follows:

1 Bear	9 Herring
3 Salmon	Shrimp: all remaining students

1. Each student representing shrimp carry 5 paper tokens or other small items to represent toxins (this information is not shared with students before the game is played). The shrimp are spaced all around the play area.

2. Inform students that only herring can consume or tag the shrimp. The herring and the shrimp play tag for 1-2 minutes before other animals enter the game. Once a shrimp is tagged, each person plays Rock Paper Scissors. If the shrimp wins, it continues in the game. If the herring wins, it takes one token from the shrimp. Once the shrimp runs out of tokens, it is out.

3. Repeat the instructions for Step 2 with all animals. Salmon only consumes herring. The bear can consume both salmon and herring. Once a set amount of time is up, have students return to count the number of tokens they have. At this point share what the colour represents (mercury or DDT). Share how smaller concentrations in smaller organisms is toxic enough to cause death so any surviving herring that have one token is dead. In the salmon, any who have 3 or more tokens are dead. The bear is able to survive with a maximum of 10 tokens but is unable to reproduce due to the toxin. If the bear has more than 10 tokens, it cannot survive.

Apply:

1. Transition this activity into a discussion and research about chemical trespass, the lack of labeling/regulation on beauty products, additional products which contain potentially harmful chemicals, and/or the impact of using pesticides and herbicides.

2. **Video:** Watch a documentary like the Slow Poisoning of India *(26 minutes)* https://www.youtube.com/watch?v=_WvoB2gRJbE

3. Have students create an impact statement on their findings, and share orally or visually.

LITERACY CONNECTIONS

- Research and discussion
- Creation of impact statements
- Critical thinking

NUMERACY CONNECTIONS

- Calculation of toxins at each trophic level
- Calculations of toxins found in human-used products, and bioaccumulation in humans

CAREER LINKS

Environmental Toxicologist: Studies how toxic chemicals metabolize in various organisms, how they move through foodchains and ecosystems, and the effect they have on the organism (non-lethal and lethal). It can involve fieldwork, laboratory experiments, and the development of computer models to determine toxic effects. Environmental Toxicologists often help local and federal agencies to develop and enforce laws that govern production and disposal of chemicals.

Eco-toxicologist: Specializes in the harmful effects of biological, physical and chemical agents on living organisms including humans. They draw on various scientific disciplines in order to predict, understand and explain the effects of toxins on living organisms. They assist others in related fields to improve protection for organisms that are exposed.

Hazardous Waste Technicians: Are responsible for processing, handling and tracking hazardous waste for shipment, treatment and eventual disposal in either public or private sectors. They have specialized training on how to handle various waste safely: biohazard, chemical and radioactive waste. Hazardous waste technicians often work for recycling and treatment facilities, or for a large company to pack and ship waste to a facility.

MANITOBA CURRICULUM LINKS

Grade 10 Science

S2-1-02 Discuss factors that may disturb biogeochemical cycles. Include: natural events, human activities

S2-1-03 Describe bioaccumulation and explain its potential impact on consumers. Examples: DDT, lead, dioxin, PCBs, mercury

Grade 10 Geography

KC-002 Describe sustainability issues related to natural resource extraction and consumption

VP-009 Be willing to consider the implications of personal choices regarding natural resources

KH-033 Identify factors that influence the changing use of natural resources over time. Examples: technology, culture…

Grade 12 Biology

B12-5-01 Discuss a variety of reasons for maintaining biodiversity. (GLOs: B2, B5, D2) Include: maintaining a diverse gene pool, economic value, and sustainability of an ecosystem

B12-5-04 Investigate an issue related to the conservation of biodiversity. (GLOs: C4, C6, C8, D2, E2) Examples: heritage seeds, water quality in Lake Winnipeg, land-use designations, hydroelectric development

RESOURCES

Bioaccumulation Activity Resources came from Science Teacher Association of Ontario
https://stao.ca/activity-to-demonstrate-the-process-of-bioaccumulation-in-food-chains/

Biomagnification Simulation:
https://oceanexplorer.noaa.gov/edu/learning/player/lesson13/l13la1.html

Lesson Plan – Bioaccumulation: A Case Study of British Columbia's killer whales *(Fisheries and Oceans Canada*):
https://www.pac.dfo-mpo.gc.ca/education/lessonplans-lecons/whale-epaulard-eng.html

Article Database of bioaccumulation articles and studies:
https://www.sciencedirect.com/topics/chemistry/bioaccumulation

USGS Data Exploration Unit: Food Webs and Bioaccumulation KEY:
https://www.pwrc.usgs.gov/contaminants-online/pages/ToolsTeachers/TTfiles/lesson2/Activity%202_FoodWeb_KEY.pdf

Biomagnification Lab:
https://blogs.cornell.edu/cibt/labs-activities/labs/biomagnification-lab-todd-shuskey/

VIDEOS:

Biomagnification and the Trouble with Toxins:
https://www.youtube.com/watch?v=TZk6vcmLcKw *(6.38)*

What is Bioaccumulation - More Science on the Learning Videos Channel:
https://www.youtube.com/watch?v=nNjhboUYM2c

What's In the Fish? Bioaccumulation and Biomagnification:
https://www.youtube.com/watch?v=DuYDFIGTIWE

Stephen Palumbi: Following the mercury Trail (Ted Talk):
https://www.youtube.com/watch?v=ooAIIeo4AJQ

Dr. Heiko Langner on Birds and Mercury:
https://www.youtube.com/watch?v=dPVMVDXzYrk

EXPEDITION CHURCHILL
Senior Years Lesson Plan

POLLUTION SOLUTION

EXPEDITION CHURCHILL CONNECTION:
Chapter 2: Hudson Bay: A Sea of Change
Chapter 5: One Big Estuary

OBJECTIVE

Students will participate in the activity which illustrates that no one person or organization is responsible for the pollution in the Red River.

MATERIALS

- A copy of the story 'Who Polluted?' To be read *(found on next page)*
- 1 clear gallon jar of water
- 17 small clear plastic containers labelled with the **student role**, and containing the following:

Trees dry crumbled leaves	**Antifreeze** 1 tsp blue-green food colour, diluted	**Washing the Car** ½ container soapy water
Farmer ¼ tsp baking powder	**Family Picnic** Assorted litter (pieces paper napkins, food scraps etc.)	**Commuters** ¼ container vinegar + couple drops of vegetable oil
Coal Pits ¼ container of vinegar	**Motorboat** 1/8 tsp vegetable oil	**Homeowner** Full container of diluted yellow food colouring, toilet paper
Barnyard ½ tsp brown liquid (coffee or food colour)	**Person Fishing** Tangle of fishing line (dental floss)	**Electrical Power Plant** ¼ container of vinegar
Potash Mine ½ container salt	**Beach Party** Assorted litter (pull-tabs, Styrofoam bits, etc.)	**Gardeners** ¼ tsp baking soda
	Mysterious Liquid 1/8 tsp red food colouring	

Background Information:

Discuss the pollution of the Red River, and rivers in general. Showcase the following news clip to prompt discussion:
https://globalnews.ca/video/3008152/focus-manitoba-how-safe-is-the-water-in-the-red-river

Leading Questions:

- Who is responsible for polluting the Red River? Is this problem unique to Manitoba?
- What effect did the increasing population have on the health of the Red River? How might the increasing populationhave helped the health of the river?
- What can each of us do to help the health of the river?
- Is it easier to clean up pollution or prevent it in the first place? Explain.
- How does Manitoba compare to other Canadian provinces in terms of health of the rivers?

ACTIVITIES

Activate:

- Share an image similar to the one in resources. Have students respond to the photo in a discussion format.

Acquire:

- Prepare a one-gallon pail or bin of clear, clean water
- Assign students to play the roles identified in the STORY: Who Polluted? Section below. Student roles can be found in bold under the **MATERIALS** heading.
- Read the story while students dump their pollutant into the clean water at the appropriate time. Be sure to ask questions to encourage thinking and involvement in the activity

Apply:

- Have students complete one or more of the options as an activity

Class Debate: Have students research and debate the pros and cons of this issue or another local issue

Writing Activity: Have students summarize the arguments from the class debate

Journal Writing: Have students reflect on what they have learned through the class or other activities

Project: Have students create a project that focuses on educating people to make better choices or to advertise an alternative way to take care of the environment

Closure: Have the class agree to one or two calls to action that they want to commit to doing for the semester

LITERACY CONNECTIONS	NUMERACY CONNECTIONS
• Storytelling • Debating • Research • Writing activities	• Calculating the total amount of pollutants in the clean water • Calculating the total amount of types of pollutants in the clean water • Researching pollution amounts that are in the Red River annually, and adjusting the activity pollutant amounts so that they are to scale

STORY: Who Polluted?

For many thousands of years, people have lived on the banks of the Red River. They hunted in the forests, harvested foods from the lands around, and caught fish in the river.

- *Imagine that the jar of water in front of you was taken from the Red River by an Indigenous person about 500 years ago. Describe how it looks to you.*
- *Would you drink this water? Eat fish that came from it? Swim in it?*

One of the early explorers to visit The Forks kept a journal of his discoveries. He wrote about the Indigenous people, the "sweet water" of many of the rivers, and seeing many fish, including huge sturgeon, in the Red. For some time only the First Nations people and the few traders from the *Hudson's Bay Company* and the *NorthWest Company* lived by the Red River.

In the 19th century, settlers began to arrive. They found fertile black soil for farming, woodlands for hunting and for firewood, and a river that provided ample food and water. It was a good place for farming, and, in time, the settlers did well and so did the Red River settlement.

- *How do you think the settlers used the river?*
- *Do we use the river the same way today?*

The river has changed a lot since it was first described. This is the story of those changes. Listen for the name printed onyour canister. When you hear your canister named, open the canister, and dump its contents into the water container.

Years went by, and violent summer storms often drenched the area. High winds whipped through the **trees** and blew leaves into the water.

Gradually the city of Winnipeg grew up around the junction of the two rivers. Developers cleared the wetlands and the woodlands to build houses and businesses. Rains washed loose soil from the **construction sites** into the rivers.

- *Is this water safe to drink? (If the response is "no", ask if the river had leaves or soil in it when the explorers first usedriver water?)*
- *Would you swim in it? Is it safe for wildlife?*

At first, the city was small. Upstream, the **farmers** planted crops to feed the city's growing population. Some of those crops grew close to the banks of the rivers, and fertilizer washed off the land and into the water. Other farmers kept pigs and other animals in their **barnyards**. As rainwater drained from barnyards, it carried some of the manure into the little creeks in the area. These little creeks, such as Brown's Creek, Omand's Creek, and Colony Creek flow into the rivers.

- *Would you drink that water now? Would you swim in it? Would you want to fall out of the boat?*
- *Is it safe for wildlife?*

As the city grew, more and more people began to move to the nearby countryside. These rural houses were not connected to the city sewer system. Waste water from those houses flowed into septic tanks under the ground. One **homeowner** did not maintain the septic tank and the untreated sewage seeped into the river.

To meet the electricity needs of the city, area officials decided they would need to generate more power. They obtained coal from Estevan and set up a generating station at Brandon. The **coal** was mined in open pits and rainwater soaked theland, the piles of waste and scraps from mining. This made the rainwater become acidic – sort of like strong vinegar. Then the acid water trickled into the Souris River, a tributary of the Assiniboine.

To burn the coal and produce power, an **electric power plant** was built along the Assiniboine River at Brandon. Gassescoming out of the smokestacks combined with moisture in the air to form acids. The pollution fell back to earth as acid rainor smog.

- *Would you drink this water now? Would you swim in it? Go boating?*
- *Could fish and other wildlife live in water that was like vinegar?*

Later, **potash mines** were opened to provide jobs for people further west along the Qu'Appelle River, a tributary of the Assiniboine. Sometimes some of the potash also leaked into the river system.

Now, Winnipeg is the largest city in Manitoba. Traffic congestion is a big problem for **commuters** who drive their cars to and from work. Car exhaust fumes (just like power plant fumes) cause acid rain. If a car is not kept in good condition, it might also leak oil or other fluids, which will be washed off the pavement when it rains or snows and will eventually go intothe rivers during rainstorms or spring melting.

And, how do the residents of the city and the suburbs spend their time? In one neighbourhood, lots of **gardeners** are out working in their yards. Many of them are using weed killers and insect sprays to keep the lawns pretty. The next rain willwash these poisons into the little creeks nearby, and then into the Red and Assiniboine Rivers.

One father is teaching his daughter how to change **antifreeze** in their truck. They pour out the used antifreeze into the driveway. Antifreeze is sweet-tasting and can poison animals that lick it. It can also get into the nearby creek and poison the fish.

Nearby, a boy **washes the family car.** The soapy water rushes down the driveway into the storm drain; the storm drain empties into the river. The grease and grime on a car contains asphalt from the roads, asbestos from the brakes, rubber particles from the tires. toxic metals, and rust. If the boy had gone to the local car wash, the water would have been treated before it returned to the river.

Next door, a family is cleaning out their garage. They find an old rusty can with a tattered skull and crossbones label still stuck on it. What could it be? It looks dangerous and they want to get rid of it before someone gets hurt. But how? Junior gets an idea: "Let's pour it down the drain out by the curb!" So the **mysterious liquid** goes down the storm drain. The poison is out of sight – but it is headed for one of the rivers.

On nice days, many people head down to the river. Some zoom up and down the river in **motorboats** and don't notice that a little engine oil leaks into the water. A group of friends have spread blankets along the banks for a **beach party**. Lots of families are **picnicking** in Assiniboine and Kildonan Parks, too. Some of these people have left garbage on the shore. With the next storm, their garbage will wash into the river. On the shore, a **person fishing** snags a hook on a log, and breaks off the nylon fishing line.

CAREER LINKS

Hydrologist: Hydrologists analyze how water influences the environment, and in turn how the environment impacts water quality. They consider how pollution, erosion, drought and other problems impact the environment. They also look for ways to minimize the impact of natural and man-made bodies of waters.

Environmental Lawyer: Provides the opportunity to change policy and attitudes, and to assist in finding solutions to environmental problems. Environmental lawyers also use evidence to prosecute and argue the changes needed for individuals breaking environmental laws.

Conservation Scientist: Conservation Scientists are concerned and focused on land use and the effect of using land and its resources. They assist in deciding the correct use of land, creating and implementing plans to manage resources and land.

Program Coordinator: There is a wide variety of organizations who have program coordinators dedicated to outreach and education. Depending on the program one could be focused on agricultural water stewardship and sharing, creating programs to share plans to protect water resources, working with schools to help spread awareness of environmental issues, and more.

MANITOBA CURRICULUM LINKS

Grade 10 Science

S2-1-02	Discuss factors that may disturb biogeochemical cycles. Include: natural events, human activities
S2-1-03	Describe bioaccumulation and explain its potential impact on consumers. Examples: DDT, lead, dioxin, PCBs, mercury
S2-1-08	Observe and document a range of organisms that illustrate the biodiversity within a local or regional ecosystem
S21-10	Investigate how human activities affect an ecosystem and use the decision-making model to propose a course of action to enhance its sustainability. Include: impact on biogeochemical cycling, population dynamics and biodiversity

Grade 10 Geography

KC-002	Describe sustainability issues related to natural resource extraction and consumption
VP-009	Be willing to consider the implications of personal choices regarding natural resources
KH-033	Identify factors that influence the changing use of natural resources over time. Examples: technology, culture…

Grade 12 Biology

B12-5-01	Discuss a variety of reasons for maintaining biodiversity. (GLOs: B2, B5, D2) Include: maintaining a diverse gene pool, economic value, and sustainability of an ecosystem
B12-5-02	Describe strategies used to conserve biodiversity. Examples: habitat preservation, wildlife corridors, species preservation programs, public education
B12-5-04	Investigate an issue related to the conservation of biodiversity. (GLOs: C4, C6, C8, D2, E2) Examples: heritage seeds, water quality in Lake Winnipeg, land-use designations, hydroelectric development

RESOURCES

'Who Polluted the Red River Activity' from Senior 2 Geography Cluster 2 (Manitoba Curriculum)

Lake Winnipeg Foundation: https://www.lakewinnipegfoundation.org/about-us

Pollution: https://www.youtube.com/watch?v=_6zIGYK7GME (1.37)

Air Pollution 101 – National Geographic: https://www.youtube.com/watch?v=e6rglsLy1Ys (3.52)

Khan Academy Pollution: https://www.khanacademy.org/science/biology/crash-course-bio-ecology/crash-course ecology-2/v/crash-course-ecology-11 (8.53)

What is Water Pollution? https://www.youtube.com/watch?v=MEb7nnMLcaA (5.47)

National Geographic Environment and Pollution: https://www.nationalgeographic.com/environment/global- warming/pollution/

World Wildlife Foundation Pollution: https://www.nationalgeographic.com/environment/global-warming/pollution/ Water

Pollution Everything you need to know: https://www.nrdc.org/stories/water-pollution-everything-you-need-knowSafe Water –

Water Pollution: https://www.safewater.org/fact-sheets-1/2017/1/23/water-pollution

Image

https://www.weforum.org/agenda/2019/10/water-pollution-in-india-data- tech-solution/

EXPEDITION CHURCHILL
Senior Years Lesson Plan

WHAT'S THE (FREEZING) POINT?

EXPEDITION CHURCHILL CONNECTION:
Chapter 4: A Frozen World

OBJECTIVE

Students will conduct a laboratory experiment on freezing point depression of a solution when a solute is added.

MATERIALS

Laboratory Exercise A

Each group of two students will need;

- Sodium Chloride (table salt)
- Distilled water
- 4 – 250 ml beakers
- Stirring rod
- Freezer or outside if winter!
- Thermometer
- Electronic scale (2 decimal places is preferred)

Teacher Demonstration

- 1000 ml beaker
- Snow or crushed ice
- Stirring rod
  Optional: Block of wood/plywood

Student Activity B

- Snow or crushed ice
- 250 ml beaker
- Sodium Chloride
- Stirring rod
- Thermometer

  If beakers are unavailable use Styrofoam or plastic cups

Background Information:

Many aspects of this lab can be added or taken away. Adding graphs for the data could allow for extrapolation and connections to other bodies of water and what temperature they freeze at. For example the Dead Sea has over 250g of salt per Litre. It would freeze at around -20°C, which is roughly the same lowest temperature at which the students achieved during their activity.

In the Expedition Churchill app, they go further in to Cold Chemistry and talk about brine, brine channels, ikaite crystals, etc. Saturated and Supersaturated solutions can also be talked about.

Lattice structure and Freezing Point Depression:

When freshwater freezes there is very little solutes inside of it compared to seawater. So freshwater can form a lattice structure by linking the water molecules into place. Once salt is introduced, the lattice structure of ice cannot be formed at the same temperature and needs lower temperatures to achieve the solid state. More salt, the more the freezing point will lower

Leading Questions:

- Why does the highways department or the city workers spread salt on the road in the winter time?
- Why would adding salt allow ice to melt?
- Would this happen for all temperatures below zero?
- How does adding more solute to a solvent actually change the melting point?
- View Expedition Churchill App – Focus on Chapter 4

ACTIVITIES

Activate:

- Review Expedition Churchill Chapter 4: A Frozen World. Find the amount of salt in seawater and at what temperature the seawater freezes. Students read about the idea of ice freezing in a lattice structure, and the fate of the chemical compounds that were dissolved in liquid form.

Demonstration:
Fill up two 1000 mL beakers to 750mL with snow or crushed ice. Add 5 tbsp of salt to one beaker only, and stir. Observe the melting and freezing thresholds of each beaker.

Acquire & Apply:

Whole Class: Students will complete a lab on the freezing point depression and boiling point elevation of salt-water vs distilled water

In this lab activity, you will predict how the addition of a solute (NaCl) effects the freezing point of water.

Prediction: Predict how the addition of salt will affect the freezing point of water.

Procedure

A: Laboratory Exercise A

1. Gather materials
2. Place 50 mL of distilled water in each of the four beakers.
3. Create the following solutions;
   1^{st} beaker – no salt 2^{nd} beaker – 1.75 g salt
   3^{rd} beaker 3.5 g 4^{th} beaker – 7 g salt
4. Label each of the beakers with colour-coded stickers or with masking tape.
5. Place solutions in a freezer or outside in cold temperatures for 30 minutes.
6. Conduct Part B: Student Activity
7. Create a table and record the temperatures of the solutions after 30 minutes.

B: Student Activity B

This activity should take place while the solutions from Part A are in the freezer.

1. Fill 250 mL beaker with 200mL of snow.
2. Record the temperature of the snow.
3. Add 1 tbsp salt, stir, and record the temperature.
4. Repeat Step 3 until temperature becomes stable and does not change.
5. Create a table to plot the amount of salt added and the correlated temperature.

Analysis

A: Laboratory Experiment

1. For each of the three sodium chloride solutions created find the concentration in moles/L.
2. Which one of these three solutions was equivalent to that of sea water as mentioned in Expedition Churchill. How did the freezing point compare?
3. Explain why salt would be added to ice covered roads.

B: Student Activity

1. What evidence do you have that the ice is at its melting point even after the salt has been added?
2. What appears on the outside of the beaker?
3. What minimum temperature was attained?

Conclusion

What effect does salt have on the freezing point of water?

LITERACY CONNECTIONS

- Reading for understanding
- Information expression

NUMERACY CONNECTIONS

- Calculating concentrations / masses of salt
- Measuring masses and volumes

CAREER LINKS

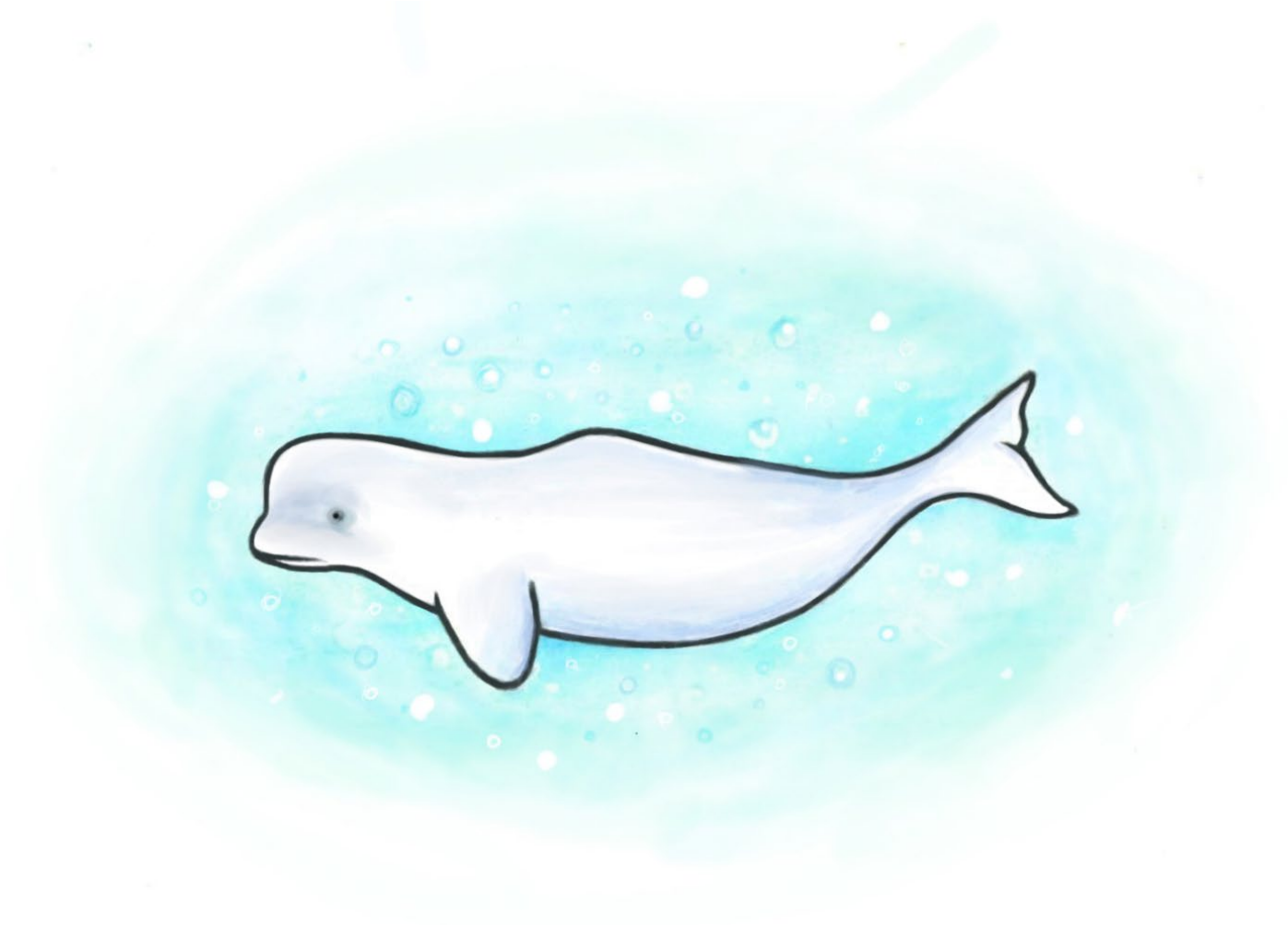
Highways Department: The highways department workers understand the concept of freezing point depression, and apply salt to the roads at the right temperatures. If it is too warm or cold, the salt will not activate and be ineffective.

Atmospheric Scientist: Atmospheric scientists study the relationship between CO2 in the ocean and the atmospheric transfer, even when water is frozen. Atmospheric scientists must have a keen understanding of the connection between multiple land and water based features and how they affect our atmosphere.

Biologist: Biologists are often known for their studies of larger, complex living creatures. However, many biologists study complex molecules that life needs to survive. This includes studying brine concentration, and the beginnings of food webs in the Arctic Ocean.

MANITOBA CURRICULUM LINKS

C11-4-11	Perform a lab to demonstrate freezing-point depression and boiling-point elevation
C11-4-12	Explain freezing-point depression and boiling-point elevation at the molecular level
	Examples: antifreeze, road salt…
C11-4-15	Solve problems involving calculation for concentration, moles, mass, and volume
C11-4-15	Prepare a solution, given the amount of solute (in grams) and the volume of solution *(in millimeters), and determine the concentration in moles/litre)*



THANK YOU TO OUR CONTRIBUTING PARTNERS:

Frontier School Division

University of Manitoba: Centre for Earth Observation Science

Fort Whyte Alive!

FRONTIER SCHOOL DIVISION
Excellence and Experience in Education

University of Manitoba