Canada

# Science.gc.ca Activity Book 6

# Welcome to the SIXTH Science.gc.ca Activity Book!

### Science is all around us and can be discovered, explored and used in so many ways!

This new Activity Book showcases the diversity of the world of science through activities in health, biology, environment, agriculture, meteorology, astronomy, the living world and much more!

Science.gc.ca is the official Government of Canada website for Science and Technology (S&T) information and resources. We have put together this Activity Book to stir your inner scientist. Whether you are in elementary, intermediate or secondary school there are activities for all ages and skill levels. These activities can be done individually or with friends in class, at camp, at home or with your Girl Guides of Canada or Scout Canada clubs.

If you would like to make your own barometer, learn about the formation of our solar system or even test your knowledge of tsunamis, you'll find it all inside this Activity Book!

For more activities, you can visit Science.gc.ca and download our previous Activity Books. While you are there, don't forget to check out our Videos, Games and Educational Resources for more science and technology experiments, activities and facts. You can even submit a question to "Ask a Scientist!"

Science.gc.ca challenges you to go out, explore and look for science everywhere you go.


### We would like to thank our funding partners for their ongoing participation and support:

- Aboriginal Affairs and Northern Development Canada
- Agriculture and Agri-Food Canada
- Canadian Food Inspection Agency
- Canadian Space Agency
- Defence Research and Development Canada
- Environment Canada
- Fisheries and Oceans Canada
- Health Canada
- National Research Council Canada
- Natural Resources Canada
- Natural Sciences and Engineering Research Council
- Public Health Agency of Canada


### Go ahead, get started; discover and explore the fascinating world of science!

Sincerely,
The Science.gc.ca Team

# Table of Contents...

## Elementary Level Activities



## Intermediate Level Activities

## Secondary Level activities



## Answer Key

# 1 Elementary Level Activities

Best suited for ages **5** to **10**

# 1 Air Patrol

Be on the lookout for the words that have something to do with air pollution.

Words can be found forwards, backwards and diagonally

## Find these words!

AIR

BREATH

CAR

CLOUDS

LUNGS

OXYGEN

QUALITY

SICK

SMOG

| | | | | | | |
|---|---|---|---|---|---|---|
| Q | O | X | Y | G | E | N |
| U | C | L | O | U | D | S |
| A | A | K | U | A | I | R |
| L | R | C | Y | N | J | Z |
| I | A | I | K | I | G | I |
| T | D | S | G | O | M | S |
| Y | B | R | E | A | T | H |

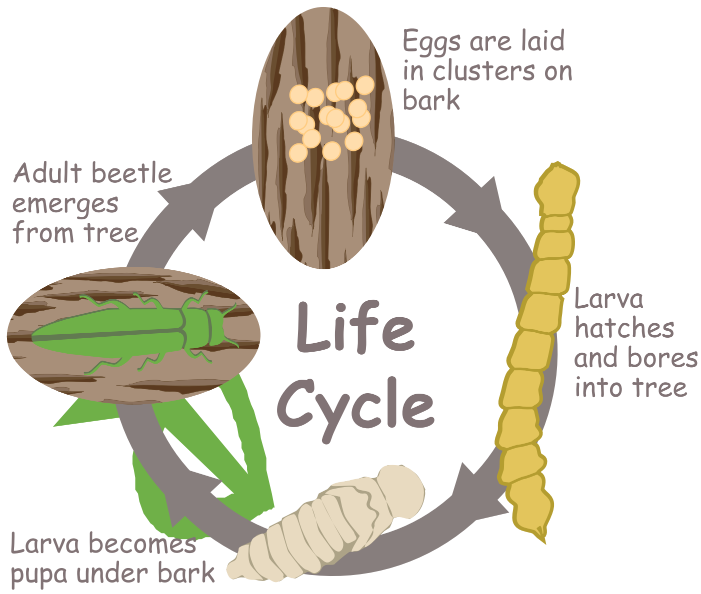


# 2 The Emerald Ash Borer

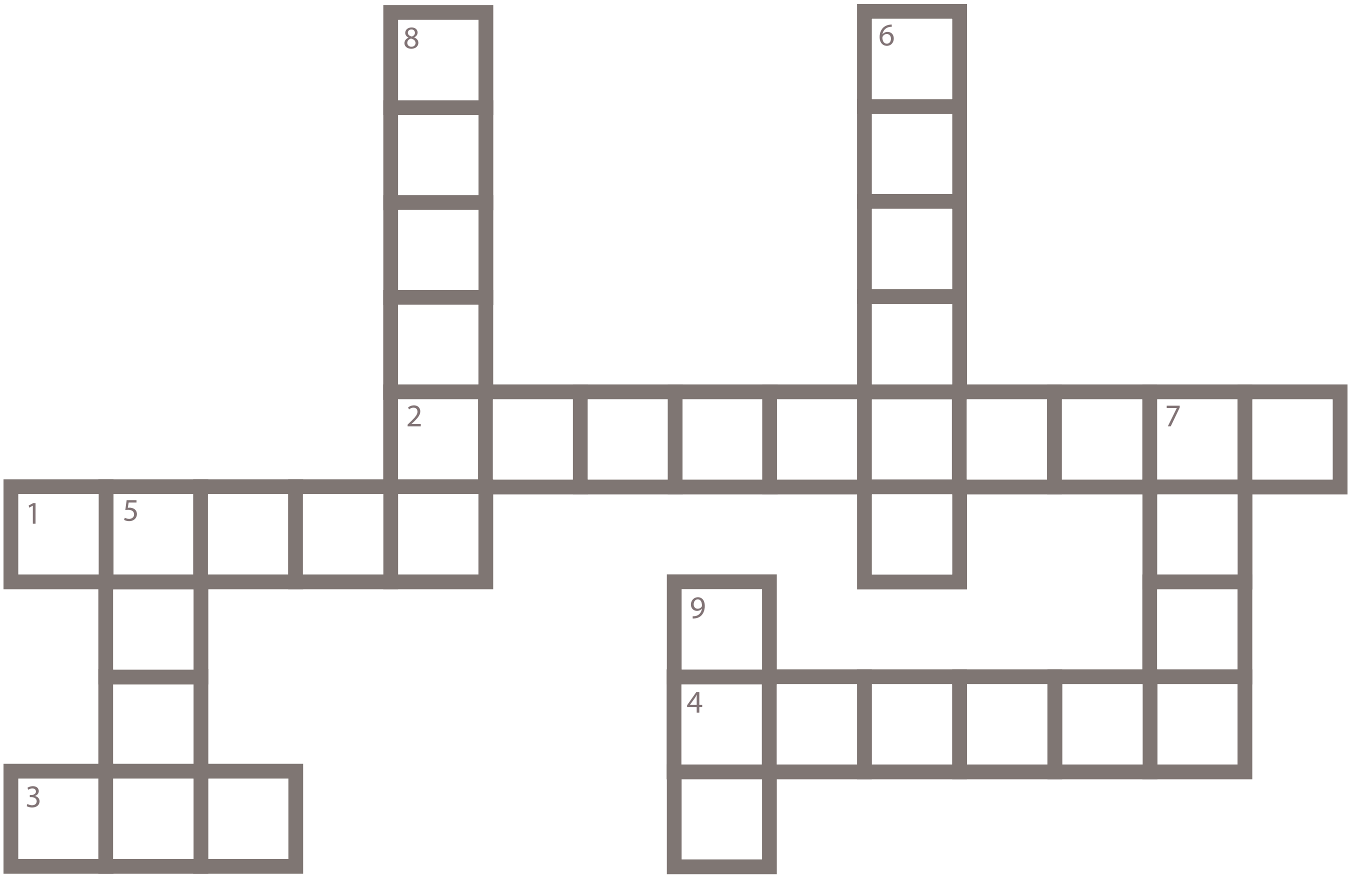
The emerald ash borer attacks and kills all species of ash, except mountain ash which is not a true ash. With artificial spread, where people move infested ash materials and firewood to new areas, this insect can quickly spread to other areas of Canada.

## Life Cycle

1. Eggs are laid in clusters on bark
2. Larva hatches and bores into tree
3. Larva becomes pupa under bark
4. Adult beetle emerges from tree



# Crossword Puzzle




## Across

1. The emerald ash borer munches on ash trees under the bark when it is in this stage of life, before it becomes a pupa. (Hint: look at the life cycle!)
2. The emerald ash borer is a tasty meal to this bird.
3. Typically, in what month does the emerald ash borer begin to emerge from the tree?
4. Ash wood can be used to make furniture, baseball bats and hockey ________.
5. Typically, in what month does the emerald ash borer begin to emerge from the tree?

## Down

5. Which continent is the emerald ash borer from?
6. The emerald ash borer has been found in this French-speaking province. (Hint: It is also Canada's largest province.)
7. The emerald ash borer lays these on the bark of ash trees, which eventually hatch larvae. (Hint: Look at the life cycle!)
8. The emerald ash borer has been found in cities across Ontario, including this city. (Hint: It's Canada's capital!)
9. What tree species does the emerald ash borer attack?

# 3 The Clean Air Game

## Materials

- board game
- one die
- playing pieces for each student
- paper and pencil for keeping score

## Method

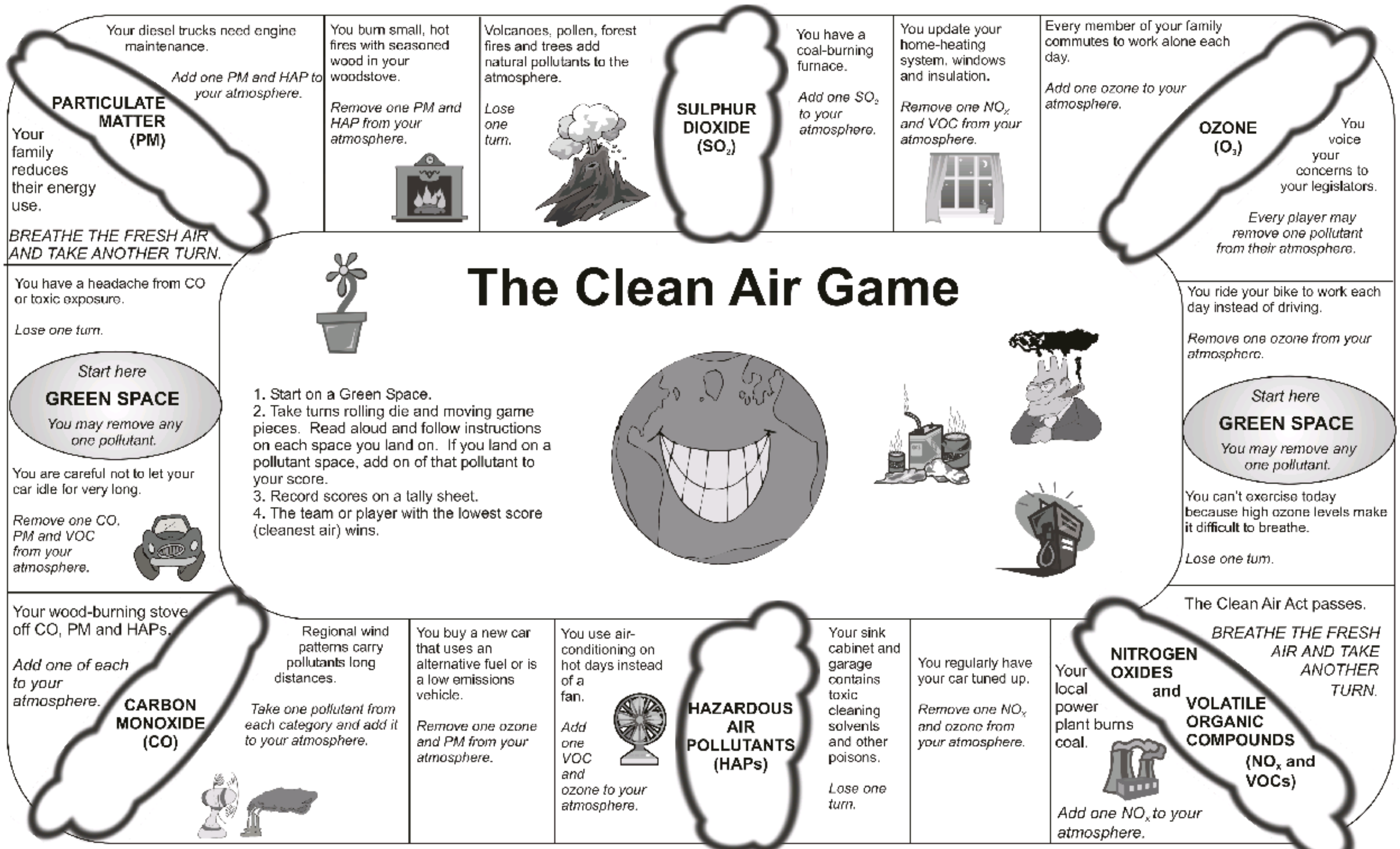
Suggested play time is 20 to 30 minutes.

## To play the game

- Form teams of four or five students.
- Each student has a playing piece and each team has a die.
- Players start on one of the Green Spaces and move clockwise around the board.
- As players land on spaces, they read aloud the description and add or remove pollutants from their 'atmosphere' (or score) as directed.
- When landing on pollutant spaces, players must add one of those pollutants to their atmosphere.
- Players may wish to keep track of their own scores but the team score is what matters.
- The team with the lowest score (cleanest air) wins the game.

# Scoring

Scoring can be done on score sheets or by using manipulatives, such as cheerios and fruit loops, to represent the pollution. When using the cereal, each student starts with 15 pieces of cereal and a handful in the centre of the game. To remove pollutants, players eat the cereal pieces. To add pollutants, they take pieces from the centre of the board and add them to their own pile. Depending on your class, students can keep track of the six individual pollutants and a general pollution score or just the general pollution.



The Clean Air Game
1. Start on a Green Space.
2. Take turns rolling die and moving game pieces. Read aloud and follow instructions on each space you land on. If you land on a pollutant space, add on of that pollutant to your score.
3. Record scores on a tally sheet.
4. The team or player with the lowest score (cleanest air) wins.
PARTICULATE MATTER (PM)
Your diesel trucks need engine maintenance.
Add one PM and HAP to your atmosphere.
Your family reduces their energy use.
BREATHE THE FRESH AIR AND TAKE ANOTHER TURN.
You burn small, hot fires with seasoned wood in your woodstove.
Remove one PM and HAP from your atmosphere.
Volcanoes, pollen, forest fires and trees add natural pollutants to the atmosphere.
Lose one turn.
SULPHUR DIOXIDE ($SO_2$)
You have a coal-burning furnace.
Add one $SO_2$ to your atmosphere.
You update your home-heating system, windows and insulation.
Remove one $NO_x$ and VOC from your atmosphere.
Every member of your family commutes to work alone each day.
Add one ozone to your atmosphere.
OZONE ($O_3$)
You voice your concerns to your legislators.
Every player may remove one pollutant from their atmosphere.
You ride your bike to work each day instead of driving.
Remove one ozone from your atmosphere.
Start here
GREEN SPACE
You may remove any one pollutant.
You can't exercise today because high ozone levels make it difficult to breathe.
Lose one turn.
The Clean Air Act passes.
BREATHE THE FRESH AIR AND TAKE ANOTHER TURN.
NITROGEN OXIDES and VOLATILE ORGANIC COMPOUNDS ($NO_x$ and VOCs)
Your local power plant burns coal.
Add one $NO_x$ to your atmosphere.
You regularly have your car tuned up.
Remove one $NO_x$ and ozone from your atmosphere.
Your sink cabinet and garage contains toxic cleaning solvents and other poisons.
Lose one turn.
HAZARDOUS AIR POLLUTANTS (HAPs)
You use air-conditioning on hot days instead of a fan.
Add one VOC and ozone to your atmosphere.
You buy a new car that uses an alternative fuel or is a low emissions vehicle.
Remove one ozone and PM from your atmosphere.
Regional wind patterns carry pollutants long distances.
Take one pollutant from each category and add it to your atmosphere.
CARBON MONOXIDE (CO)
Your wood-burning stove off CO, PM and HAPs.
Add one of each to your atmosphere.
You have a headache from CO or toxic exposure.
Lose one turn.
Start here
GREEN SPACE
You may remove any one pollutant.
You are careful not to let your car idle for very long.
Remove one CO, PM and VOC from your atmosphere.



# 4 Counting Leatherback Turtles and Marine Mammals

In this activity you will explore how scientists use aerial surveys to study whales and other marine animals. You will also discover some of the challenges involved in using a plane for such surveys.

## Materials

- Legal size envelopes
- 3 or 4 legal size pieces of paper or computer paper that will fit inside the legal size envelope
- Scissors and transparent tape
- Pencil or pen

## Let's get started!

Break into groups of 3 or 4. One student will be the pilot of the plane and the other 3 will be the scientists.

1. Take the legal size envelope and cut off both ends so a piece of paper can slide right through the envelope.
2. In the top third of the envelope cut a square 'window' so that as the paper slides through the envelope you can see it as is passes by the 'window'.
3. Take the legal paper and attach three or four sheets together end to end with transparent tape to make one long sheet, or use an equivalent length of computer paper that will fit through the envelope.
4. At one end of the paper attach a pull-tab to help you pull the paper through the envelope. You can make this out of paper or use a cardboard bookmark.
5. The 'pilot' should go to a separate part of the classroom and draw small circles randomly over the paper.

These circles will symbolize the leather back turtles or whales. The 'pilot' will need to know the final number of spots, but must not tell the scientists.

6. The scientists gather around the 'pilot' who then slides the paper through the envelope at a steady but fast rate.
7. The scientists count the spots as they pass in front of the 'window.'
8. The scientists should then compare their numbers and the 'pilot' can reveal the actual number of marine mammals on the paper.

### Variation:

You can make this exercise more realistic and more difficult by varying the size of the spots. Big spots can be whales and smaller ones can be leatherbacks and small whales. Have scientists count both or try to distinguish the spots from each other.

## Talk about it!

Adapt these questions to further your discussion.

1. Did any of the scientists get the number of leatherback turtles and whales right?
2. What are some of the challenges of counting marine mammals from airplanes?
3. Can you think of other ways to count marine mammals?
4. Why do we need to count marine mammals?

# 5 Environments that Support Life Forms

## Learning Objectives

1. Engage in situational problem solving to learn about bacteria in open and closed environments.
2. Apply the scientific method as an internationally accepted research protocol in situational problem solving and experimentation.
3. Develop an awareness of environments that support life forms.

## Objectives

At the end of this experiment, students will:

- be aware that there are bacteria all around them,
- understand that the search for extraterrestrial life involves using methods that detect the presence of bacteria,
- realize the importance of good hygiene in preventing the transmission of bacterial infections.

## Materials

- 3 sterile Petri dishes containing nutrient agar
- 3 cotton swabs
- 1 felt pen
- Adhesive tape

To get ready for the experiment, the educator should prepare the petri dishes containing nutrient agar in advance.

## Preparation of nutrient agar

- Prepare 100 ml of 2.5% agar aqueous solution in an Erlenmeyer flask.
- Bring to a boil and, after complete dissolution, cool to about 50°C.
- Cover the bottom of each Petri dish with the solution. To avoid contaminating the agar, make sure you only open the lids wide enough to pour in the solution.
- The nutrient agar solidifies at 40°C.

## Experimental procedure

Using cotton swabs, students:

1. Take a sample from a surface that is likely to host bacteria, such as the classroom floor, a door handle, someone's hands, etc.
2. Lightly rub the entire surface of the agar in a Petri dish with the cotton swab.
3. Repeat steps 1 and 2 with the two other Petri dishes.
4. Seal the Petri dishes with adhesive tape and label them.
5. Place them in a warm, dark location.

***Make sure students completely seal the Petri dishes after they have been inoculated.***

## Caution!

Do not open the Petri dishes once they have been sealed. Bacterial cultures can be dangerous.

***Stress with your students the importance of avoiding contact with bacterial cultures, since they will have had the time to develop into potentially harmful concentrations.***

## Disposal of bacterial cultures

Sterilize the agar in the Petri dishes by covering it in alcohol for 5 to 10 minutes. Use a spatula to remove the agar and place it in a garbage bag. Disinfect the Petri dishes by soaking them in bleach. Afterwards, be sure to wash your hands with antibacterial soap.

# Observations

Two or three days later, students observe the Petri dishes and draw what they see.

***Drawings will be rod or generally oblong-shaped with rounded edges, depending on the type of bacteria.***

# Analysis of results

- Which surface had the most bacteria?
- Were all of the bacteria you sampled the same?

# Extension Activity

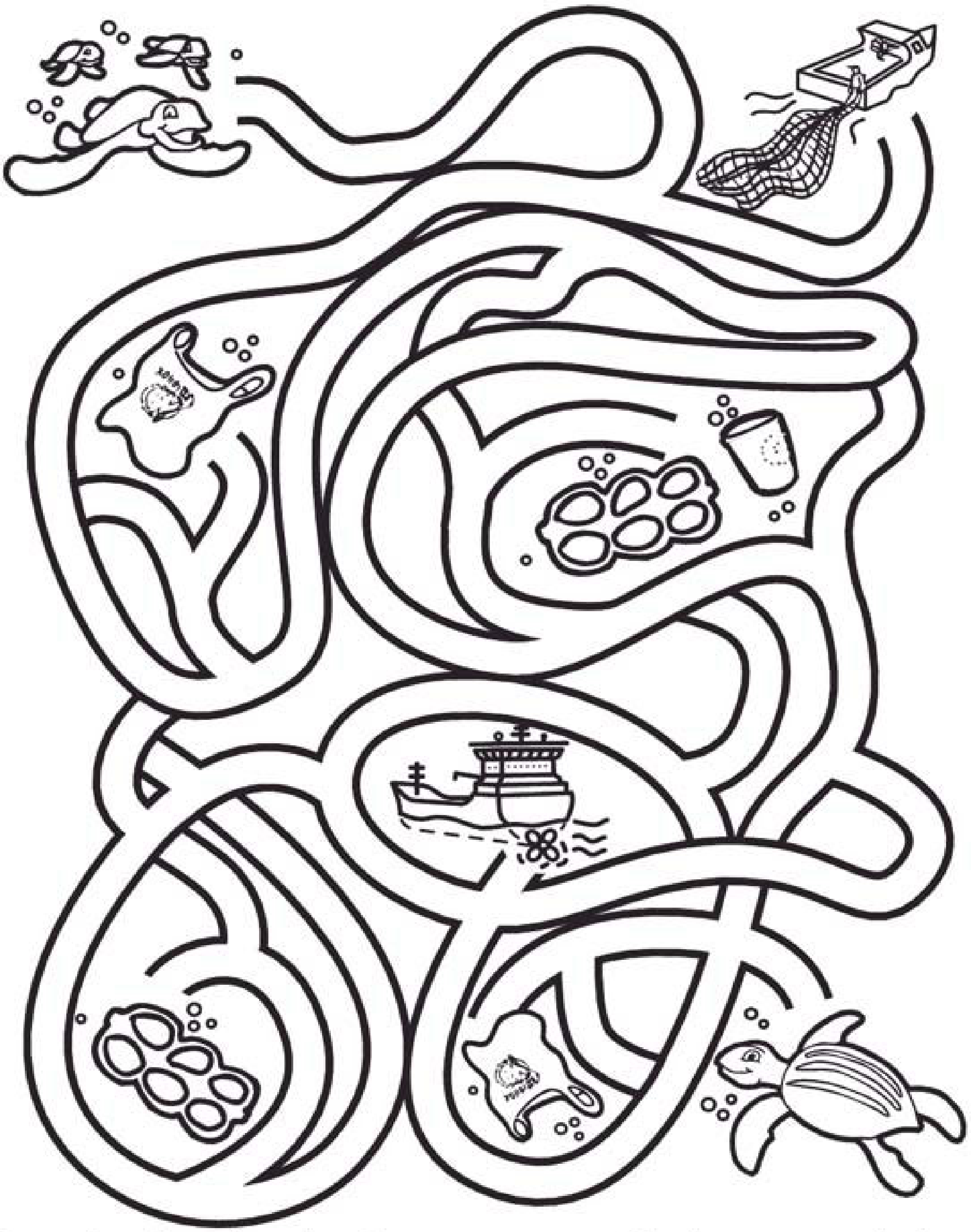
### The effect of soap

Students develop a hypothesis concerning the effect of soap on bacteria, then repeat the activity, using samples taken from their hands before and after a vigorous washing with soap.

# 6 Leatherback Maze

**Get the leatherback turtle back to his friends safely!**

Leatherback turtles are threatened by fishing gear in which they can be entwined, as well as by plastic bags and other garbage.



# 7 The Web of Life

## Goals

- Facilitate participants' understanding of the concept of "ecosystem" and the relationship between species and their habitats.
- Make participants aware of the impacts of habitat modification on the survival of the species that live there.

## Time

- 40–50 minutes

## Materials (per team of four to six students):

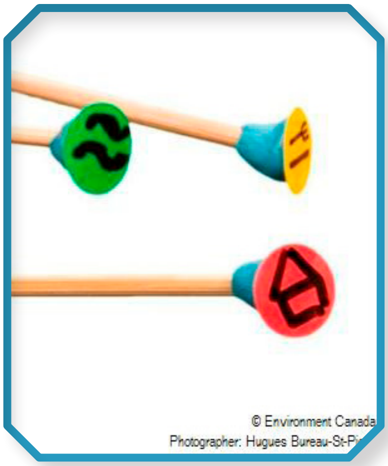
- easily pierceable cardboard (e.g. cardboard box);
- 12 pointed wooden rods (e.g. skewers);
- 10-12 small light balls (e.g. ping pong or styrofoam), ideally of varied diameters (3 to 5 cm);
- sticky tack, paper, sculpting clay or alternative materials (to identify the rods, use whatever is available and a little creativity);
- coloured felt pens; and
- a transparent container, approximately 10-15 cm high (for example food storage containers). The surface must be large enough to serve as a base for the tower.

## Constructing the Game

- **With the cardboard, make a square tower about 10 cm per side and 25 cm high**. Leave both ends open. This tower represents an ecosystem. The participants will be able to draw a natural landscape on it.

- **Turn the transparent container upside down**. Cut an opening at the top that is slightly smaller than the tower's base. Place the tower on the container base.
- **Take between 10 and 12 balls**. On each ball, draw a plant (flowers, trees, etc.) or an animal (fish, insects, birds, mammals, etc.).
- **Draw four representations for each of these habitat components** (water, food and shelter) on paper circles, for a total of 12. Fasten each circle on the unpointed ends of the rods.






**Suggestion: First build a prototype of the game to serve as a model.**

# Home Sweet Home

- Ask the participants if they know the words "**ecosystem**" and "**habitat**".
- Explain the two words:

  A **habitat** is the natural living environment of any living being. The beings that are found there must have access to water, food and shelter or space to live.

  An **ecosystem** is a group of living organisms and their physical environment (soil, air, water, light). All elements of the system are in interaction.

- Ask the participants to give examples of ecosystems (ocean, forest, lake, city, dead tree, pond, etc.).
- **Explain the goal of the game**: understand the relationship between living beings and the environment in which they live.
- **Show the model** of the game.
- **Form groups** of four to six participants and give them the instructions to make the game.

# Let's Play!


- **Show the participants how to pierce** the tower with the rods.
- **The young participants stick the rods** (water, shelter, food) into the lower half of the tower. The 12 rods must pass through the tower and cross one another in the middle in a random manner.
- **The compact trellis created** by the rods will support the balls. This "web" is the image of a rich environment, because water, food and shelter are abundant, so living organisms can survive there.
- **Balls representing different organisms** are added from the top of the tower. Animals and plants begin to populate the ecosystem. When the ecosystem is healthy and the habitat components are abundant, the organisms reproduce. Everything is going well!

# Danger!

When the habitat undergoes changes, this has consequences on the species that live there. Here are some examples of changes and the consequences:

- There is a drought in the region and many plants have died – a **food** rod is removed.
- Pesticides have been spread, contaminating the water – a **water** rod is removed.
- Many trees have been cut down to make way for construction – a **shelter** rod is removed.

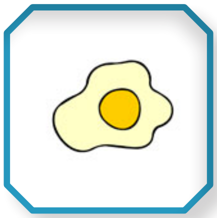
# Chain Reaction

- Each group in turn gives other examples of habitat changes. If the educator validates the example, all the groups remove the corresponding rod.
- The rods that are removed represent habitat degradation. At first, removing one or two rods has no major consequences for the organisms, because the other rods maintain the support. As more rods are removed, we reach a critical point: the holes in the web get bigger and some balls start to slip through the trellis, falling into the transparent container below. These balls represent the organisms that have died. From that point on, the process speeds up and removing just a single rod causes a number of balls to drop. More and more organisms die; a large proportion of the species of this ecosystem are endangered.
- **The game continues** until all the balls have dropped into the container base.

The educator confirms the participants' understanding of the relationship between habitat "richness" and species survival by asking them to explain it in their own words.

# 8 Match the Food

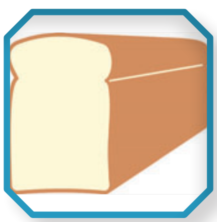
**Do you know where your food comes from? Draw a line from food you eat with where it originally came from.**









# 9 These symbols mean danger!

You can see these symbols on the labels of products in and around your home, things like paint thinners, drain cleaners, windshield washer fluid, different kinds of polish and other household products. When you see these symbols remember these steps:

1. **STOP!**
2. **DON'T TOUCH!**
3. **TELL AN ADULT!**

## How to play

**You'll need:** dice (1) and a playing piece (a coin or marker) for each player.

The youngest player rolls first. Players take turns rolling, moving from start to finish. If a player lands on a square with a hazard symbol, they slide down to the space that is marked with an X. If a player lands on a "Point to…" square, they must find the correct hazard symbol anywhere on the game board and point to it to jump ahead to the square marked with a star. If a player points to the wrong symbol, or forgets to point before moving ahead, they must to stay on the square they landed on.

**EXPLOSIVE**

The container can explode if heated or punctured. Flying pieces of metal or plastic from the container can cause serious injury, especially to eyes.

**CORROSIVE**

The product can burn your skin or eyes. If swallowed, it will damage your throat and stomach.

**POISONOUS**

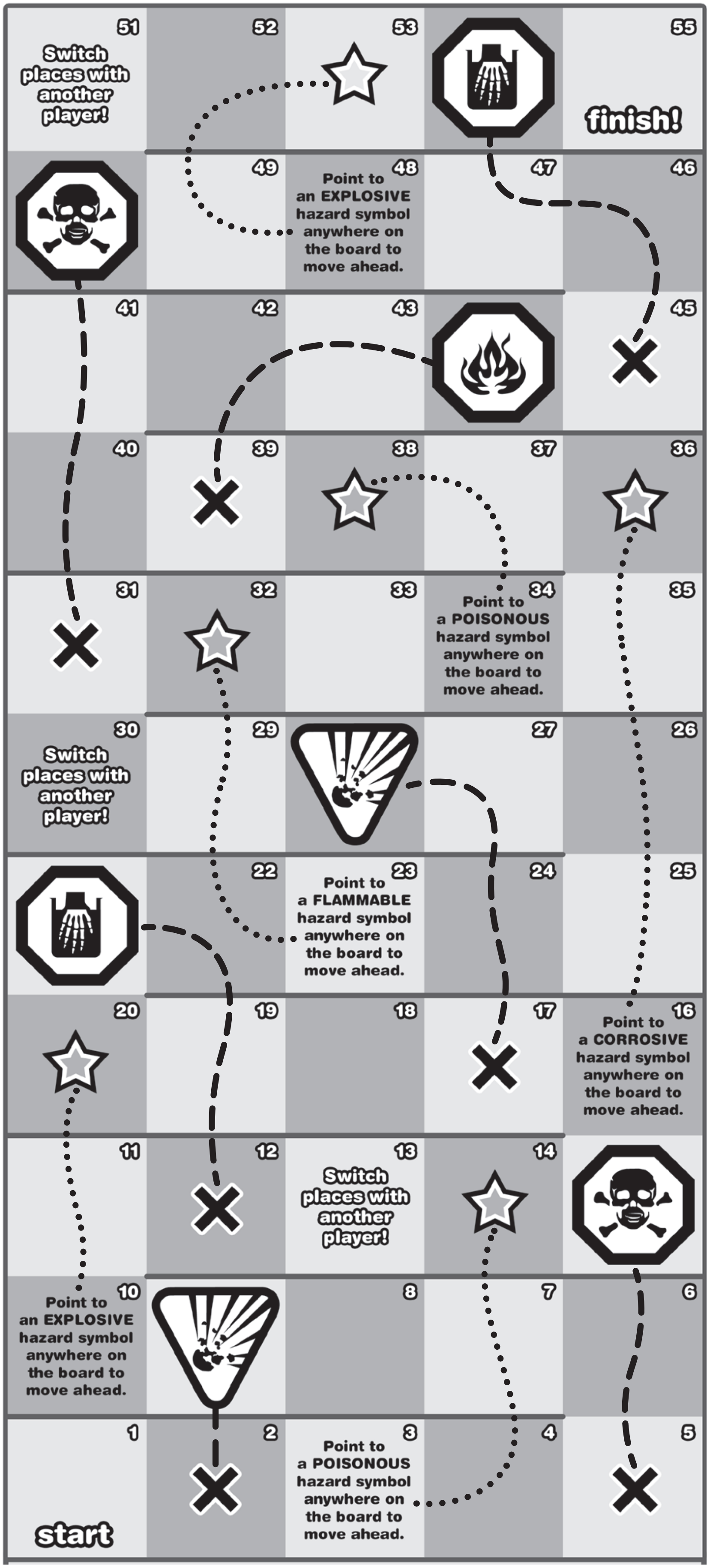
If you swallow, lick, or in some cases, breathe in the chemical, you could become very sick or die.

**FLAMMABLE**

The product or its fumes will catch fire easily if it is near heat, flames or sparks. Rags used with this product may begin to burn on their own.

# Tips for parents

- Keep all products with these symbols locked up in a place where children cannot SEE or REACH them.
- Read the label and follow the instructions. If you have trouble reading the label, ask for help.
- Do not cover up or remove labels from these products.
- Copy emergency phone numbers from the first page of your phone book and keep them next to the phone.
- If someone is hurt by a product that has these symbols on the label:
    - Call the Poison Control Centre or your doctor right away.
    - Tell the person who answers the phone what the label says.
    - Bring the product with you when you go for help.


51
Switch places with another player!
52
53
55
finish!
49
48
Point to an EXPLOSIVE hazard symbol anywhere on the board to move ahead.
47
46
41
42
43
45
40
39
38
37
36
31
32
33
34
Point to a POISONOUS hazard symbol anywhere on the board to move ahead.
35
30
Switch places with another player!
29
27
26
22
23
Point to a FLAMMABLE hazard symbol anywhere on the board to move ahead.
24
25
20
19
18
17
16
Point to a CORROSIVE hazard symbol anywhere on the board to move ahead.
11
12
13
Switch places with another player!
14
10
Point to an EXPLOSIVE hazard symbol anywhere on the board to move ahead.
8
7
6
1
start
2
3
Point to a POISONOUS hazard symbol anywhere on the board to move ahead.
4
5



# 10 Word Search

## Find the words

ALLOY

CASTING

CORROSION

FOUNDRY

FRACTURE

IRON

MATERIAL

METALS

MICROSCOPE

PIPELINE

STEEL

WELDING

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| C | A | F | R | U | N | S | F | A | E |
| C | O | R | R | O | S | I | O | N | P |
| A | P | A | E | L | T | R | U | S | O |
| S | I | C | D | S | E | O | N | L | C |
| T | P | T | R | O | E | N | D | A | S |
| I | E | U | R | A | L | X | R | T | O |
| N | L | R | A | L | L | O | Y | E | R |
| G | I | E | T | C | E | A | U | M | C |
| N | N | G | N | I | D | L | E | W | I |
| A | E | L | A | I | R | E | T | A | M |

# 11 Food Group Medicine Wheel

*By: Annemieke Farenhorst, NSERC Chair For Women in Science and Engineering (Prairie Region). Isca Spillett, Student, Human Nutritional Sciences, University of Manitoba*

Today there are more than 600 First Nations communities across Canada, representing more than 60 languages. Cree is the most widely spoken of these languages in Canada.

For thousands of years prior to European contact, Indigenous peoples had a very sophisticated food system which included items harvested from the lands and waters. Examples of such foods included wild rice, buffalo meat, fish, berries, and squash. These are rich in nutritional value and offer many health benefits.

Traditionally, Indigenous peoples did not eat milk products, which are a source of protein, a nutrient that helps build strong bones and teeth. Instead they obtained calcium from alternatives such as broth and fish head soup.

## Purpose

Students will learn about the four food groups according to Canada's Food Guide and be able to associate a traditional food item with each food group. They will also have the opportunity to learn Cree words.

# Instructions

1. Trace the medicine wheel on a large sheet of paper so that the food cards (next page) fit. Students can colour the medicine wheel.
2. Cut out the food cards (next page) and learn the Cree word associated with the traditional food.
3. Place the food card into the correct food group on the medicine wheel.

# Answers

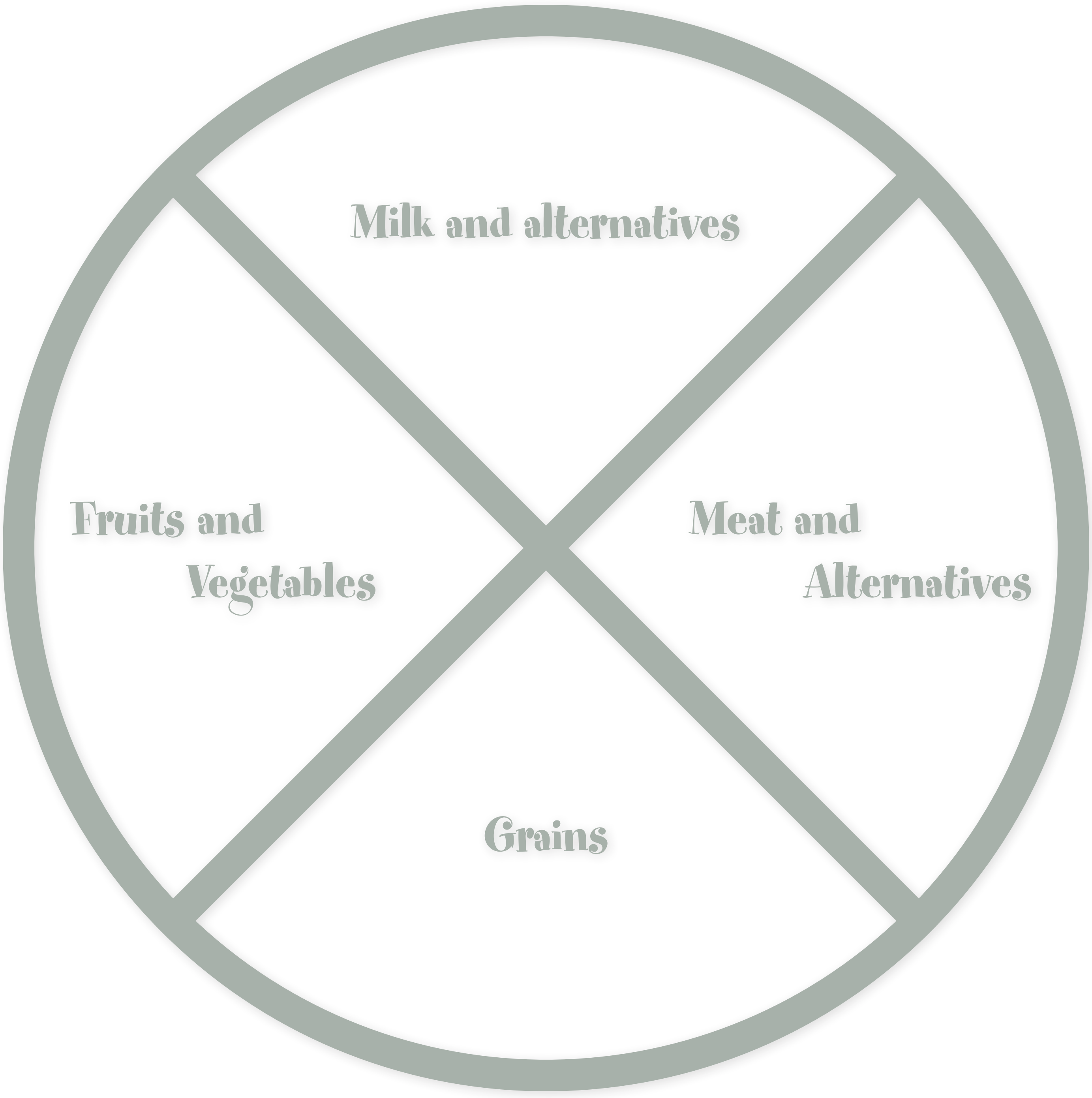
*Fruit and vegetables (Squash and blueberries); Meat and alternatives (Moose and Buffalo),  Grains (wild rice, bannock), Milk and alternatives (bone broth, fish head soup).*

***Dr. Annemieke Farenhorst, PhD***
***NSERC Chair For Women in Science and Engineering (Prairie Region)***
***www.cwse-prairies.ca***

*Dr. Farenhorst focuses on the environmental fate of pesticides, steroid estrogens and antibiotics in soil and water, and on developing community-based research collaborations for strengthening human and ecosystem health. The University of Manitoba soil science professor leads the newly established NSERC CREATE H2O program for First Nations Water and Sanitation Security.*

***Isca Spillett, Student, Human Nutritional Sciences, University of Manitoba***

*An Indigenous woman with roots in the Northern Manitoba Wekusko community, Isca Spillet explores the impacts of colonialism on traditional Indigenous food systems, to re-establish a connection to the land and traditional food harvesting methods*


Milk and alternatives
Fruits and Vegetables
Meat and Alternatives
Grains

All of these are traditional foods of the Cree people. Cut out the cards and place them on the medicine wheel

**Squash**
**Cree translation: wawiye-okosiman**

**Wild rice**
**Cree translation: manomin**

**Moose**
**Cree translation: moswa**

**Bone broth**
**Cree translation: Oskana micimapoy**

**Bannock**
**Cree translation: pahkwesikan**

**Blueberries**
**Cree translation: sipihkomin**

**Fish head soup**
**Cree translation: kinosewi micimapoy**

**Buffalo**
**Cree translation: paskwaw mostos**



# 12 It All Adds Up

**These problems will challenge both your math skills and your energy knowledge.**

## Give them a try!

1. Julie, her brother and her mother each take a shower every day. Julie's dad takes a bath every day. Each shower uses 40 litres of water and each bath uses 75 litres.

   a) How many litres of water does the family use to bathe each day?_______________

   Each week?_______________

   b) If Julie's dad switched to showers too, how much water would the family save each day?

   _______________

   Each week?_______________

2. David's mom drives a hybrid car that uses 1 litre of fuel for every 20 km driven. She drives to work 30 km each way, 5 days a week. How much fuel does she use to get to work every week?

   _______________

3. Marie's dad drives an SUV that uses 2.5 litres of fuel for every 20 km driven. He drives to work 20 km each way, 5 days a week. How much fuel does he use to get to work every week?

   _______________

4. If Marie's dad replaced his SUV with a hybrid car like David's mom has, how much fuel would he save every week?

   _______________

# 13 Flower Power

Where does your plant water go? Discover what happens to your flower when it drinks up coloured water.

## Materials

- A white carnation
- Two small vases of water
- Two food colouring dyes
- Knife
- Adult helper

## Instructions

1. Add 20-30 drops of your first colour to the first vase. Do the same with your second colour and second vase. The more colour the better!!
2. Have your adult helper use a sharp knife to slit the flower stem straight down the middle, about half way up the stem.
3. Put each half of the stem into a vase of different colored water.
4. Watch what happens! The carnations will soak up the water and take on the new colors. This can show in only hours, but may also need a few days.

# 2 Intermediate Level Activities

Best suited for ages **11** to **15**

# 1 Build your own Barometer

This project explains how to make a barometer to show changes in air pressure.

## Materials

- Empty glass container or soup can
- Elastic band
- Glue
- Adhesive tape
- Balloon
- Drinking straw
- Index card about 8 cm by 13 cm (3 inches by 5 inches)

## Method

1. Cut a piece out of the balloon large enough to cover the top of the glass jar or soup can.
2. Stretch that piece of the balloon tightly over the top of the jar or can and secure it in place with the elastic band.
3. Cut the straw so that it is about 10 centimetres long and trim one end to a point.
4. With the sharpened end pointing out, lay the straw on the balloon with the flat end at about the centre of the balloon.
5. Glue the straw in place.
6. Draw reference marks on one of the long edges of the card at roughly half-centimetre intervals. Tape the

opposite (unmarked) side of the card to the jar, with the narrow end of the rectangular card extending above the jar top and the marked edge just behind the straw. The marked edge should stick out so that the sharpened end of the straw points to the reference marks.

# Points of discussion

- The piece of the balloon that is stretched across the jar will act as a membrane. When the air pressure outside the jar rises, it will push down on the balloon, forcing it slightly into the jar. This, in turn, will cause the end of the straw to rise. Similarly, when the air pressure outside falls, the air pressure in the jar will be greater than the air pressure around it forcing the balloon to bulge slightly. This will cause the end of the straw to drop.
- You can chart the position of the straw against the reference marks on the card each day. This will not give you a numeric reading but it will tell you whether the air pressure is rising or falling. The pressure trend is an important tool in forecasting.
- Please remember to keep your barometer away from sources of heat such as radiators and sunny window ledges. If it is close to a source of heat, then your barometer will act more as a thermometer, with the air inside expanding and contracting to reflect changes in temperature, not pressure.

# 2 You and the Brewer

Environment Canada uses Brewer spectrophotometers to forecast the UVI levels for each day of the year. These are posted at:

**http://weather.gc.ca/forecast/public_bulletins_e.html?Bulletin=fpcn48.cwao**

## Purpose

To compare UV values from different locations.

## Method/Observations

Use the chart below to record two weeks of UV Index listings from the Web site (obtain the maximum UVI value for the closest Brewer station to you), and your local media. If you have access to a UV meter, you can use it to obtain your own reading as well (use the meter at solar noon to obtain your maximum UVI value).

| Day | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| UV Web | | | | | | | | | | | | | | |
| UV Meter | | | | | | | | | | | | | | |
| UV Media | | | | | | | | | | | | | | |

# Discussion

1. Using your data, plot a graph of the daily UV radiation levels.
2. Continue to record and post a two-week period so that the class can produce cumulative graphs of UV readings over several months.

# Conclusion

What have you learned from your comparison?

- Which month(s) of the school year have the highest UV readings?
- How does this relate to the reported seasonal ozone layer thickness?

# 3 Using Your Centre of Gravity

Gravity is one of the forces that control how the physical world works. It keeps trying to pull things towards the centre of the Earth. Without realizing it, we've learn to outsmart gravity. Otherwise, we would fall over every time we took a step. We "outsmart" gravity by positioning our centre of gravity - an imaginary spot in the middle of the stomach about 8 cm below the belly button. It's the point around which all our weight seems to be centred. As long as we keep the centre of gravity over our feet, we can stand and walk.

## Purpose

To experience how gravity works on Earth

## Materials and Equipment

- Wall
- Chair
- Partner

## Method

### Activity #1

Work with a partner. Tell your partner that you are going to glue his or her foot to the floor with a special glue. Have your partner stand so that one foot and the side of their head are against the wall. Tell your partner that the foot farthest from the wall is "glued" to the floor.

Ask your partner to raise the "glued" foot out to the side. Record the results.

Where is your centre of gravity when you are leaning against the wall? How does this affect your ability to move sideways?

### Activity #2

Next, ask your partner to sit in a chair with his or her head tilted backwards. Put one finger on his forehead and press lightly. Challenge him to get up. Record the results.

What happens to your partner's centre of gravity when he is sitting in the chair?  How would he have to change it in order to move?

### Activity #3

Have your partner rest his head against the wall while his feet are at least 45 cm away from the wall. Pretend to "glue" his head to the wall. Challenge your partner to move his head away from the wall while keeping his feet flat on the floor. No hands are allowed. Record the results.

Switch roles and try the activities again.

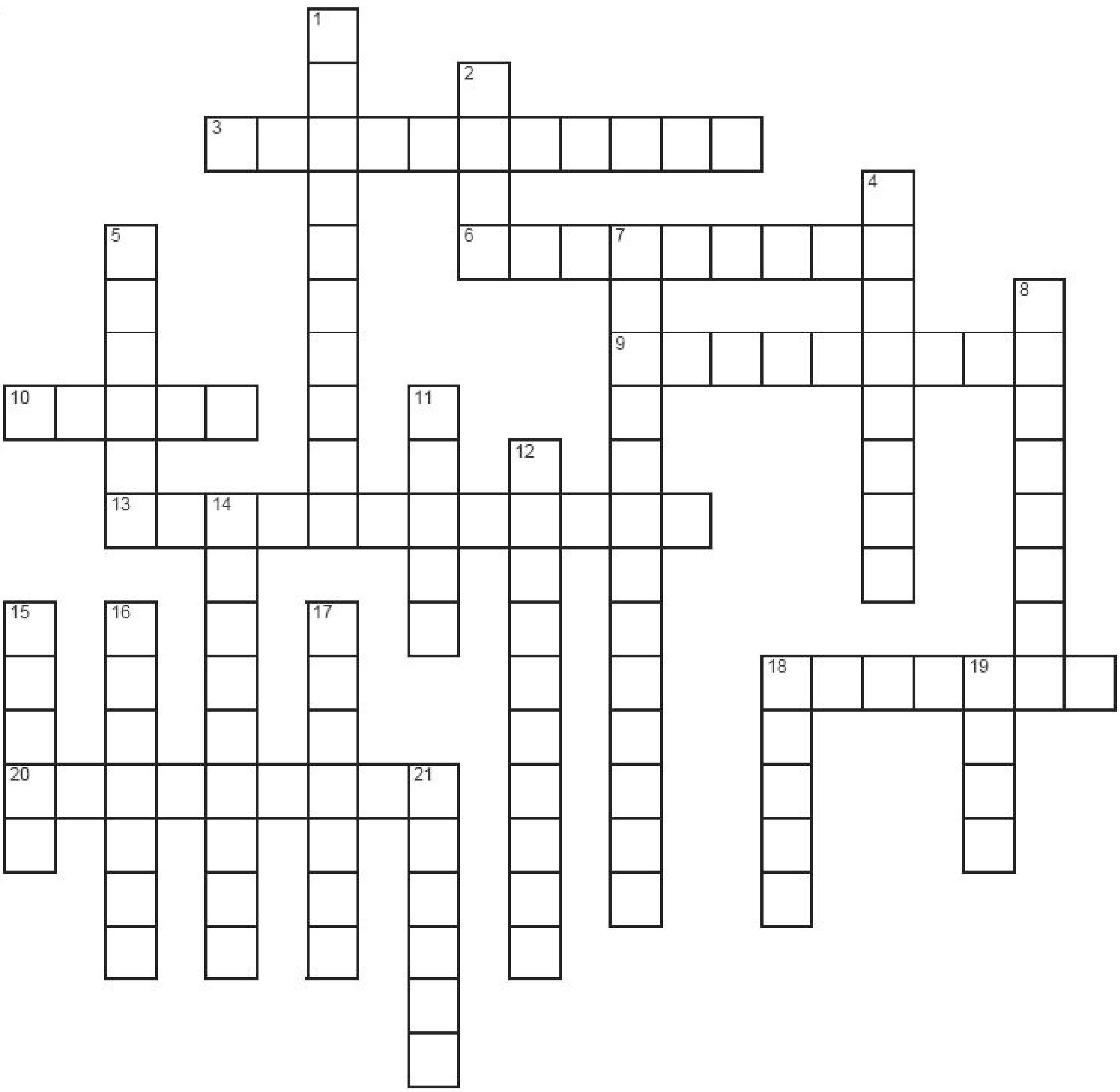
Where is your partner's centre of gravity in this experiment? In what direction does gravity want to pull your partner? What is keeping your partner from falling over?

How will changes in gravity affect astronauts aboard the Space Station?

## Observations/Results

Record your conclusions. Conduct the activities several times and record the changes in the results.

# 4 Earthquake Vocabulary Crossword



# Across

**3.** Sensitive instrument used to record and measure earthquakes

**6.** The point on the earth's surface directly above the subsurface location of the earthquake

**9.** The unique measure of the amount of energy released during an earthquake

**10.** The S wave is also called the _____ wave

**13.** How earthquake energy is transmitted (2 words, ignore the space)

**18.** The 'Ring of Fire' encircles this ocean

**20.** An abrupt downhill movement of rock and soil, possibly triggered by an earthquake

# Down

**1.** Recording of ground motions

**2.** A region in which earthquakes are common is a seismic ____________________

**4.** Large segments of the earth's crust and upper mantle are known as ______________ plates

**5.** Force which can lead to sudden movement along a fault

**7.** The P wave is also called the _______________ wave

**8.** A numeric scale from I to XII that describes earthquake effects

**11.** The subsurface location at which the energy of an earthquake is released

**12.** Sudden shaking of the ground

**14.** How the earthquake was felt locally

**15.** Zone of fractures or breaks in rocks where movements occur

**16.** A series of huge ocean waves that might be caused by an earthquake

**17.** The time at which a particular wave phase arrives at a seismograph station is known as the _________________ time

**18.** Many earthquakes in western North America are associated with the Juan de Fuca _____________.

**19.** The Mercalli Scale is based on people's reports of what was ______________ locally

**21.** An earthquake is the result of a sudden release of ____________________

# 5 Take a Deep Breath

In this activity, students learn that air quality on board the International Space Station (ISS) is a major concern. In the open environment of the classroom, the $CO_2$ from the students' respiration poses no threat to air quality because it is removed by the ventilation system. In a closed environment such as the ISS, however, $CO_2$ can be harmful because it reduces the amount of available oxygen. The suggested experiment is qualitative in nature. The reaction of lime water to $CO_2$ becomes more pronounced as the gas's concentration in the air increases.

## Hypothesis

Formulate a hypothesis about the relative levels of carbon dioxide in the atmosphere and in the air you exhale.

## Materials

- 3 100 ml beakers
- 1 syringe
- 1 straw
- 150 ml of lime water

## Experiment Procedure and Observations

- Label the three beakers.
- Pour 50 ml of lime water into each beaker.
- Use the syringe to make air bubbles in the water of the first beaker and record your observations.
- Use the straw to gently blow bubbles into the water of the second beaker and record your observations.
- Let the third beaker sit in the open air until the next day and record your observations.

## Analysis

Compare the appearance of the lime water in each beaker.

## Conclusion

What do you conclude about the relative amounts of carbon dioxide in the atmosphere and in the air we exhale?

Why did the water in the first beaker become cloudy more quickly than the water in the third beaker?

# 6 How Dirty is the Air?

Try this **experiment** to **find out** about...

## Particulate Matter

what's that word?

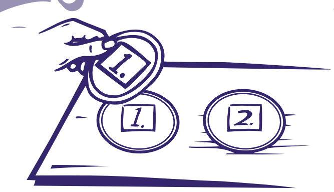
It's a fancy word for all the little things like dust, dirt, soot, smoke that are too small to see.

## What you'll need:

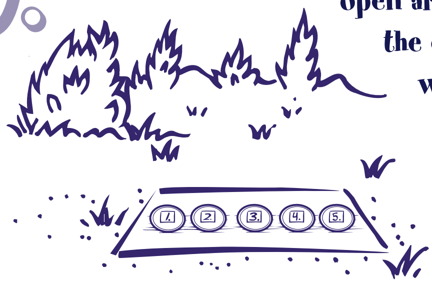
- coloured markers
- white cardboard
- magnifying glasses
- labels
- five jar lids

**1.** Write the numbers 1 through 5 on the labels, then attach a label to the top of each jar lid.

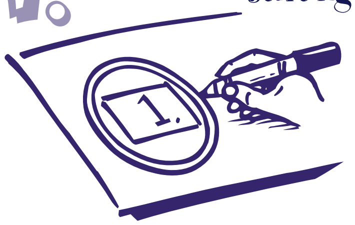

**2.** Place the jar lids on a piece of cardboard. Carefully trace around the jar lids, then number these circles to match the numbers on the lids.



3. Take the cardboard and lids outside. Place them flat in an open area. (Rain or high winds will spoil the experiment, so keep an eye on the weather reports!)




4. At the end of the first day, remove one lid, starting with number one. For the next five days take away one lid each day. Are the circles different?




5. At the end of the fifth day, take away the last lid and look at the circles. If the air is dirty, the circles covered by the low-numbered lids will have more specks of dirt than the others. Use a magnifying glass to count the dirt specks.

## Is our air clean or dirty?

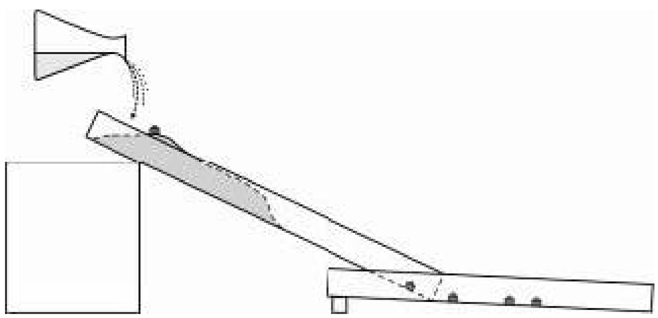
# 7 Make a Debris Flow

Description: This lab demonstration is an easy and fun way to effectively produce a model debris flow landslide in the classroom. It can be used once as a simple demonstration or can become an experiment comparing the results of different slope angles and different sediment textures.

## Purpose

To demonstrate the effect of saturated groundwater conditions and heavy rainfall on unstable slopes and to observe the process of landslide movement and resulting landforms.

## Materials



- ~ 75 cm length of eaves trough or split pipe.
- Large flat pan
- Beakers of water
- Pail of earth

  **Note**: Use whatever loose sediment can be found locally. The demo works best if sand or a mixture dominated by sand is used and is particularly effective if some granules and very small pebbles are mixed in with the sand. It is important that the sand is wet in advance, but not soggy, so that the sediment can pack together.

- Empty boxes of various heights that can be used to support or tilt the trough and pan
- Protractor
- Small plastic houses from Monopoly game (optional)

# Teacher instructions

## Introduction:

1. Inform class that one type of landslide is known as a debris flow. In a debris flow, loose material, in a saturated state, loses cohesion and flows downslope in a fluid-like manner, carrying with it any trees, buildings etc. that were on the slope. The flow loses momentum when the slope becomes gentle and the debris spreads out in a fan shaped deposit and the water drains out of the debris. This type of failure is very common in western Canada and can be associated with heavy losses if it occurs in a populated area or along a transportation route. These landslides are generally triggered by heavy or prolonged rainfall or heavy snow melt.

2. Set up as in diagram.

   - Slightly elevate one side of the large pan to help drain water. The pan represents a break in slope and the flat land at the bottom of the slope.

   - Tilt the eaves trough at ~ 25° angle, supporting the high end with a tall box and placing the other end in the pan. Trough represents a steep bedrock slope.

   - Pack dampened sand mixture tightly in the upper end of the trough, as shown. Sand represents loose sediment on the slope.

   - Monopoly houses can be placed on the sediment and out on the 'flat land' of the pan to represent a community.

3. Slowly and gently pour water (representing rainfall) onto the sand at the top of the trough. Pause regularly to observe results.

4. Clean out the pan and refill the trough with more damp sand and repeat. Try different slope angles and observe the results.

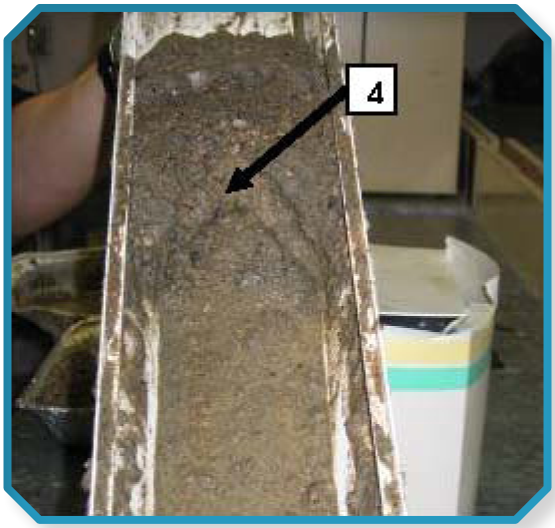
## Observations: See photos

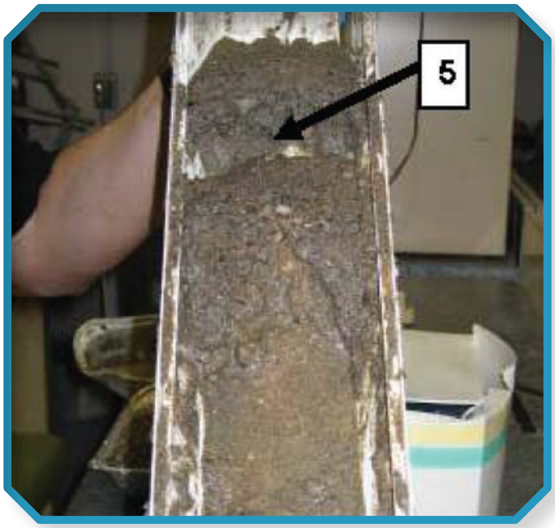
- Sand does not move until additional water is added (saturation).
- Much of the water sinks into the sand, moves through it and emerges at the lower end.
- The lower end of the sand becomes totally saturated and begins to move.
- Concave tension cracks may develop on the surface near the lower end, followed by a complete collapse of a saturated 'block' of sediment which then flows downslope in a slurry of wet mud. This action is repeated sequentially as the failure scarp moves back upslope. The flow may assume a lobate shape.
- Once it starts, the debris flow moves quickly.
- If addition of water stops, the landslide slows or stops. This is a laboratory case. In reality, the landslide is not so closely controlled by the rainfall of the moment.
- The debris flow stops at the break of slope, forming a fan-shaped landform. Some size sorting of the sediment may be visible. Concentric ridges may form on the fan.

**Note:** Results may vary depending on the angle of slope and the texture of sediment. If the sediment is very cohesive, like clay, water may flow downslope on the surface or between the packed sediment and the trough wall. If the sand is too dry at the start, water may only wet the surface layer and flow on the surface. If the slope angle is too low, water may flow on the surface. All the above would create a model of a fluvial system with little or no landsliding. On the other hand, if the slope angle is very high, a different type of landslide will occur. This type, known as a 'translational slide', moves as a more-or-less intact body, sliding on the underlying hard substrate.

## Demonstration of a debris flow



## Movement of a model debris flow:

1. Failure does not start at the top of the slope.
2. The top of the debris flow retrogresses upslope. Debris forms a fan at the bottom.
3. Most sediment has flowed downslope.
4. Close-up of a failure scarp (arrow) as a block begins to move as a mud slurry.
5. Separation and movement of a large mass.

# 8 The Formation of our Solar System

This hands-on activity examines the Solar Nebular Theory as the solar wind begins to blow. Using materials to represent elements in the interstellar dust cloud, students will develop a model of how the solar system formed and will begin to compare characteristics of the planets.

## Hypothesis Phase

- Introduce the activity by presenting the Solar Nebula Theory to students.
- Divide class into groups of 4-5 students.
- Give the groups time to discuss the information presented and develop a hypothesis statement about interaction of the solar wind and the interstellar dust cloud. Students should propose an explanation to support their prediction.

The Solar Nebula Theory is the most widely accepted hypothesis of the formation of our solar system. According to the theory, the Sun and planets were formed from a giant rotating cloud of interstellar dust and gas. Scientists believe that billions of years ago the centre of the spinning cloud collapsed in on itself, forming the Sun, with the remaining orbiting matter taking the shape of a spinning disk.

When the Sun burst on the scene at the centre of our solar system so did the solar wind. It was so strong that some of the matter was pushed out beyond the snow line of our solar system. The snow line, roughly in the middle of the asteroid belt, is the point where temperatures are cold enough for gases to become liquid and icy water. It can be compared to the snow line on a mountain on Earth where liquids are permanently in the form of snow and ice due to the extreme cold.

**Questions to consider:**

What type of matter blew away? What elements stayed closer to the Sun? What was the overall effect on the characteristics of the planets?

# Experiment Phase

- Students will conduct a simple experiment to test their hypothesis.
- If space is limited, create a solar wind simulation area in the class room and have groups take turns running their simulation.
- It is recommended to test the position of the fan and elements as well as the duration of the "solar wind" prior to conducting the activity in-class.

# Materials

- Solar Wind Simulator
  - Fan (8-10 inch diameter)
- Interstellar Cloud
  - Materials to represent the heavier elements in the cloud (4) – pebbles, marbles, beads
  - Materials to represent the lighter elements in the cloud (4) – fluffy cotton balls, pompoms
- Roll of paper (white or brown Kraft paper at least 60cm wide)
- Colour markers (at least 4)

# Procedure

1. Roll out a swatch of paper (approximately 3 meters) along the floor and place heavy objects on the corners to hold it in place.
2. Position the solar wind simulator at one end of the paper and draw a circle around it. This represents the Sun.
3. Mix the elements of the interstellar cloud and position the materials in front of the fan.
4. Turn on the solar wind simulator for 10 seconds.
5. Use different colour markers to circle the resting place of the elements and create a legend to identify heavy versus light elements in your diagram.
6. Record observations.

# Analysis Phase

To complete the analysis phase, students should:

- Describe the distribution of the interstellar cloud elements as a result of the solar wind simulation
- Determine if their 'solar system' is in line with the actual solar system

# Conclusion Phase

Based on the analysis of the experiment, students should conclude that the heavier elements remained closer to the Sun while the lighter elements were blown away.

The presence of the solar wind during the formation of the solar system is one of the most plausible theories to explain why the gas giants, made from lighter gases such as hydrogen and helium, are further away from the sun and the smaller terrestrial planets, made of heavier elements, are positioned closer to the Sun.

*Here is how scientists explain this phenomenon:*

When the solar wind began to blow, the lighter elements orbiting the newly formed star were pushed into the far reaches of the solar system while the remaining heavier elements stayed closer to the Sun and went on to form the rocky planets of the inner solar system – Mercury, Venus, Earth, and Mars. When the lighter dust and gas molecules reached the outer solar system, beyond the snow line, the solar winds became too weak to keep pushing the light elements away from the Sun. At this point the dust and gases condensed into liquid and ice crystals to form the planets known as the gas giants – Jupiter, Saturn, Uranus, and Neptune.

# 9 UV Radiation and Clouds

Cloud cover can greatly affect the amount of UV radiation received at the earth's surface.

Scattered clouds reflect UV, increasing the amount of UV radiation reaching the Earth's surface.

Mainly cloudy conditions partly reduce UV transmission.

Heavy overcast conditions greatly reduce UV transmission.

## UV Index Adjustment for Cloud and Precipitation

| Type | Factor | % UV |
|---|---|---|
| Scattered Clouds | 1.1 | +10% (transmitted) |
| Hazy | 0.9 | |
| Mainly cloudy with/without precipitation | 0.7 | -30% (absorbed) |
| Cloudy | 0.6 | -40% (absorbed) |
| Cloudy with/without precipitation | 0.4 | |
| Overcast | 0.3 | |
| Heavily overcast with/without rain/drizzle | 0.2 | -80% (absorbed) |

Note: The factor shown is determined by statistical analysis of weather effects.

# Questions:

1. Complete the chart. What relationship do you see between cloud type and UV filtration?
2. From your knowledge of science, in what ways could water vapour or droplets affect the amount of UV radiation reaching the earth's surface?

# 10 Make a Rain Gauge

## Materials

- A plastic 2-litre pop bottle with straight sides
- Ruler at least 15 centimetres in length
- Scissors
- Stones or large gravel
- Clear tape
- Water

## Method

1. Cut the bottle about 10 centimetres from its top. Save the top part.
2. Place stones or gravel in the bottom of the bottle until they fill the little bumps in the bottom and come up to the part of the bottle where the sides are straight. This will add weight to the gauge to make it more stable.
3. Tape the ruler to the side of the bottle so that the zero mark on the ruler is a centimetre or two above the stones.
4. Pour enough water into the bottle so that the water level is at the zero mark on the ruler.
5. Take the top of the bottle (the part you cut off earlier), turn it upside down, and put it into the bottom portion so that it looks like a funnel.
6. Set your gauge in an open area away from trees or buildings, which may affect the amount of rain that falls into the bottle.

7. When it has rained, take a reading using the ruler taped to the side of the bottle. Then pour out the excess water until the water level is once again at zero. (If you pour out too much water, simply add more until the water level again reaches zero on the ruler.)

## Points to discuss

If you leave your rain gauge out in the sun for a day, be sure to check the gauge as some of the water may evaporate. If that happens, just add water until the level is at zero again.

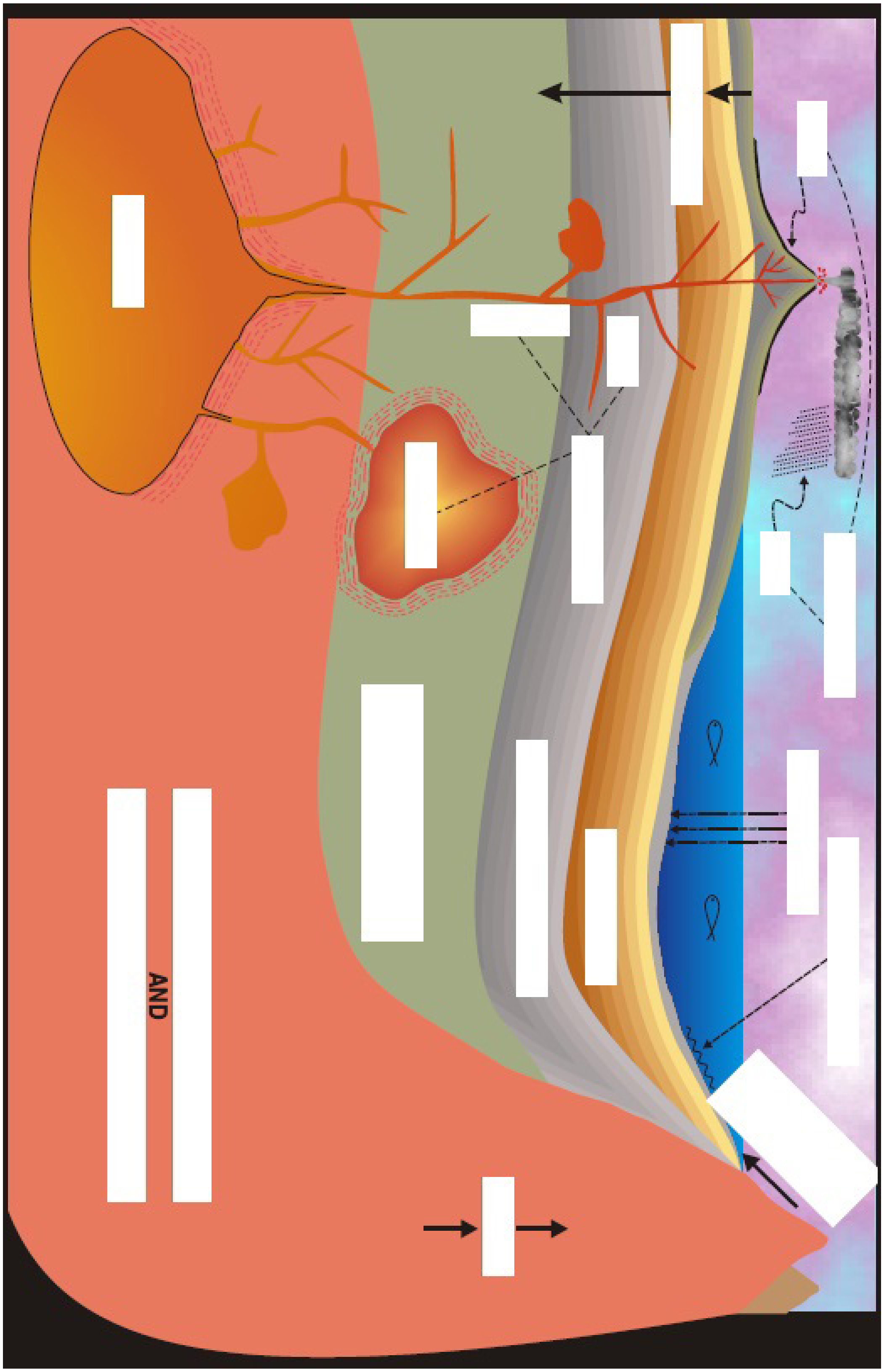
As a further exercise, you may want to tape a coffee filter into the funnel part of the gauge to collect any particles that fall into the gauge. The rainwater will drip through the filter and into the bottle eventually. You can then look at the filter through a microscope and see what it captured.



# 11 The Rock Cycle

The illustration in this activity depicts the rock cycle. Insert the terms, in the correct box to better understand how geological processes generate materials that eventually become the three main rock types.

1. High-grade metamorphic rock and igneous rock
2. Magma
3. Low-grade metamorphic rock
4. Sedimentary rock
5. Sediments
6. Granite
7. Dyke
8. Sill
9. Intrusions
10. Lava
11. Ash
12. Volcanism
13. Subsidence
14. Transportation
15. Uplift
16. Weathering and erosion
17. Deposition




Credit: illustration - S. Colman-Sadd

# 12 A Tasty Experiment!

This experiment has two parts… And even if you don't get the first one, the second one is delicious!

The experiment consists in growing sweet potatoes, Jerusalem artichokes or potatoes.

## Materials

- A sweet potato bought at the grocery store (or Jerusalem artichoke or potato) in the spring and on which there is at least one small bud;
- A five-gallon bucket;
- A 35-L bag of earth (or a 40-L bag, if that's all there is);
- The spring and summer sun (hardly optional!).

## Instructions

It's so easy! First, weigh all of the materials on a scale. With a pencil, record the weight on a sheet of paper you will leave close to the bucket, but out of the rain.

Pour one third to one half of the earth in the bucket, plant the sweet potato (or Jerusalem artichoke or potato), and water sufficiently.

As the plant grows, add more earth to the bucket. Remember to water the plant if, to the touch, the top two centimetres of earth is dry.

At the end of the summer, weigh all the materials on the scale again, and record the weight.

# What do you observe?

To what is the difference in weight due? Is it perhaps simply the water you added? It can't be the earth you added, since you weighed everything before starting…

So, what caused the difference? Might there be something in the air that combined with the plant like Lego, to make it so heavy?

Now begins the second part. Make sure the earth isn't soaked. Pull the stalk with all of its leaves and put it on the compost pile. Bring the bucket indoors, preferably to the basement. You now have your own supply of sweet potatoes (or Jerusalem artichokes or potatoes) to last you till winter… maybe!

# 13 Tsunami Demonstration

## Description

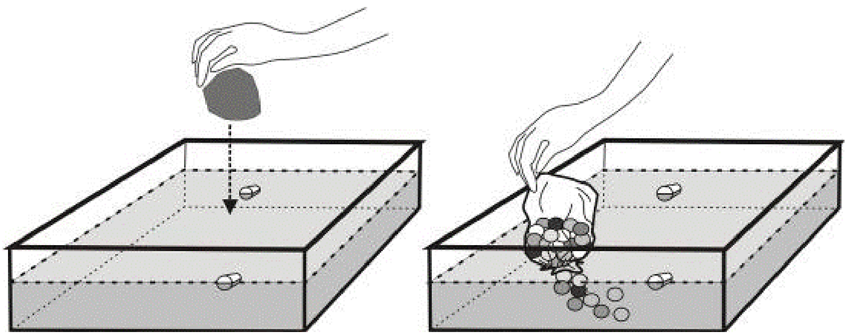
A short lab demonstration of tsunami waves.

## Materials

- large basin of water
- wax crayon
- several corks
- rock to represent a meteorite
- bag of marbles

## Teacher instructions and notes:

1. Fill a large basin with water to half its depth. Draw a line around the inside of the container at water level to represent 'sea level'. Float several corks in the water. Corks help to show the wave motion.
2. To simulate a tsunami caused by a meteorite landing in the ocean, drop a rock into the basin and watch the ripples (tsunami waves) move outward from the impact site.



3. To simulate a tsunami caused by a landslide, hold the mouth of a bag full of marbles at water level. Quickly release the marbles into the water, simulating the submarine movement of a landslide.

4. It is harder to simulate an earthquake, but sharply hitting the basin can create a wave that will slosh up on one side of the basin.

5. Have the students observe the simulation or simulations.

6. Divide the students into small groups and allow them to produce their own tsunamis.

7. Have the students draw the waves that are generated in their experiment and summarize their observations in a brief written or oral report.

# 14 "Make Before Break"

Try this activity to discover some of the challenges astronauts face while working in space!

This activity illustrates the "make before break" strategy used in all Extravehicular Activity (space-walk)/Payload operations in space. "Make before break" means that whenever a tethered person or payload is moved from one location to another, one must always **make** a secure connection at the new location **before** one can **break** the connection at the original location. This insures that any item that has the potential to drift free is always tethered.

## Concept

1. Students' desks are arranged in groups or "clusters".
2. The students will have various tasks to perform, requiring them to move from group to group.
3. A student cannot move to another group unless the student is tethered at all times.
4. A tether must only be long enough to reach an adjacent group, but not long enough to reach other groups.

## Equipment needed

1. Tethers made from lengths of light nylon cord (each about 2m long).
2. 2 buckles for each tether, one at each end (with spring clips).
3. 1 sturdy (immovable) anchor point for each student group. (TIP: Used 4L paint cans, filled with dry sand or gravel and with their lids hammered on make good objects to use as anchor points)

# Procedure

Prepare the following materials.

1. Make up sheets of paper (enough for each group) with the words "Solar Panels" written on them.
2. Repeat step one with pages for
   a. Food Supply.
   b. Life Support Equipment.
   c. Scientific Equipment.
   d. Rocket Fuel.
   e. Habitation Modules.
   f. Communications Equipment.
   g. Emergency Equipment.
3. Give one set of each of the pages to each group. In other words, one group gets all the "Solar Panel" pages, another group gets all the "Food Supply" pages and so on, so that each group has a monopoly on a specific resource.
4. Give each group two tethers.

# Challenge

To assemble a space station.

1. Decide, as a class, the basic items required to build the space station.
2. Each group must collect (from the other groups) the items needed to complete their space station.
3. **VERY IMPORTANT** Review the strategy and tether protocol outlined below. It is essential that everyone understand the rules.
4. **Strategy:**
   a. No more than three persons can be standing (call this "in EVA mode") at any one time.
   b. Resources must be collected directly from their source. i.e. They cannnot be passed from group to group.
   c. Tethers between groups can never cross.
   d. The "Make Before Break" rule must be adhered to at all times. No exceptions.

# Conclusion

When all space stations have been completed discuss;

1. any problems that may have arisen.
2. possible solutions to such problems.
3. how you might design a safety protocol that you could apply to make this construction simulation safer and more efficient.

**TIP: The number of resources can be modified to suit the number of groups in the activity.**

Also, this activity can be modified in many ways. For example, it might be combined with an art class whereby each group builds models of the resource package and they are "delivered" to a single group for assembly.

# 3 Secondary Level activities

Best suited for ages **16+**

# 1 Periodic Table Scavenger Hunt

How much do you know about the elements of the periodic table? Use your knowledge and research skills to find the answers to these questions!

1. Which element makes up the core of stars?
2. Which is the lightest metal?
3. Which element is known as the "king" of all elements?
4. Which element makes up approximately 78% of the Earth's atmosphere?
5. Which well-known plastic is made of fluorine and carbon?
6. Which white metal is so soft that it can be cut with a knife?
7. Which element burns in both air and nitrogen?
8. Which element has the highest malleability (can be pounded into very thin sheets) and ductility (can be pulled into a thin wire)?
9. Which element is an important component of haemoglobin?

# 2 Science aboard the ISS

The Canadian Space Agency research program aboard the International Space Station examines the behaviour of colloids in microgravity. Colloids are mixtures with properties that make them especially hard to separate. Here is an activity on the separation of mixtures. You will have to apply several separation techniques in order to identify which of three mixtures is a colloid.

## Experiment Objective:

Identify the colloid among the following three mixtures: (1) vegetable juice, (2) 3.25% milk, (3) vinaigrette.

## Separation Techniques - Decantation, paper filtration and centrifuging

1. Decantation - This process makes use of the principle of sedimentation, i.e., the property of non-mixable liquids to form layers according to their relative densities.
2. Paper filtration - Filter paper has numerous tiny holes that allow liquids to pass through while trapping solid particulates on the paper.
3. Centrifuging - A rotating body tends to be projected toward the outside of the circle it describes. The components of a heterogeneous mixture subjected to rapid rotation will form layers according to their relative densities. In a sense, centrifuging is an acceleration of the sedimentation process.

## Materials needed for each of the three mixtures:

### A. Decantation

- 1 separating funnel
- 1 metal ring

- 1 universal holder attachment
- 2 100 ml beakers
- 50 ml – vegetable juice, 3.25% milk, vinaigrette

### B. Filtration

- 1 funnel
- 1 metal ring
- 1 universal holder attachment
- 2 100 ml beakers
- 50 ml – vegetable juice, 3.25% milk, vinaigrette

### C. Centrifuging

- 1 centrifuge
- 2 conical centrifuge test tubes
- 1 100 ml beaker
- 50 ml – vegetable juice, 3.25% milk, vinaigrette

#### *A warning about centrifuging*

*Make sure that the conical centrifuge test tubes are placed opposite one another and filled exactly to the same level (i.e., two-thirds) to avoid unbalancing the centrifuge.*

*Let the centrifuge spin for about five minutes.*

*Allow the centrifuge to slow gradually with no external influences.*

*Do not try to stop it manually.*

# Experimental procedure

Suggest an experimental procedure to apply the three separation techniques to each mixture.

*Tip: shake the vegetable juice and vinaigrette thoroughly before applying the separation techniques.*

# Observations

Record your observations in the table below.

| | (1) Vegetable juice | (2) 3.25% milk | (3) Vinaigrette |
|---|---|---|---|
| Decantation | | | |
| Filtration | | | |
| Centrifuging | | | |

## Analyze your observations.

Analysis (1): ______________________________________________

______________________________________________

______________________________________________

Analysis (2) ______________________________________________

______________________________________________

______________________________________________

Analysis (3) ______________________________________________

______________________________________________

______________________________________________

## Form a conclusion for each hypothesis.

Conclusion (1): ______________________________________________

______________________________________________

______________________________________________

Conclusion (2) ______________________________________________

______________________________________________

______________________________________________

Conclusion (3) ______________________________________________

______________________________________________

______________________________________________

Which of the three mixtures is a colloid?

______________________________________________

What are the components of this mixture?

______________________________________________



# 3 Calculating travel time of a tsunami

On November 18, 1929, a magnitude 7.2 earthquake, with an epicentre about 250 kilometres south of Newfoundland, generated an extremely large submarine landslide off the Continental Slope. The displacement of mass during this landslide caused a tsunami that struck the southern coast of Newfoundland. Tsunami waves travelled at a speed of 140 kilometres per hour across the Grand Banks.

1. Using the map scale and a ruler, measure the distance from the source (use the earthquake epicentre) to each station and landfall at Burin. Record the distances below.
2. Calculate the time travel of the tsunami to each station, using the formula below.

   **Time = Distance / Velocity**

3. Assuming that the tsunami began at 5:00 pm at the epicentre, enter the actual time of arrival at each station.

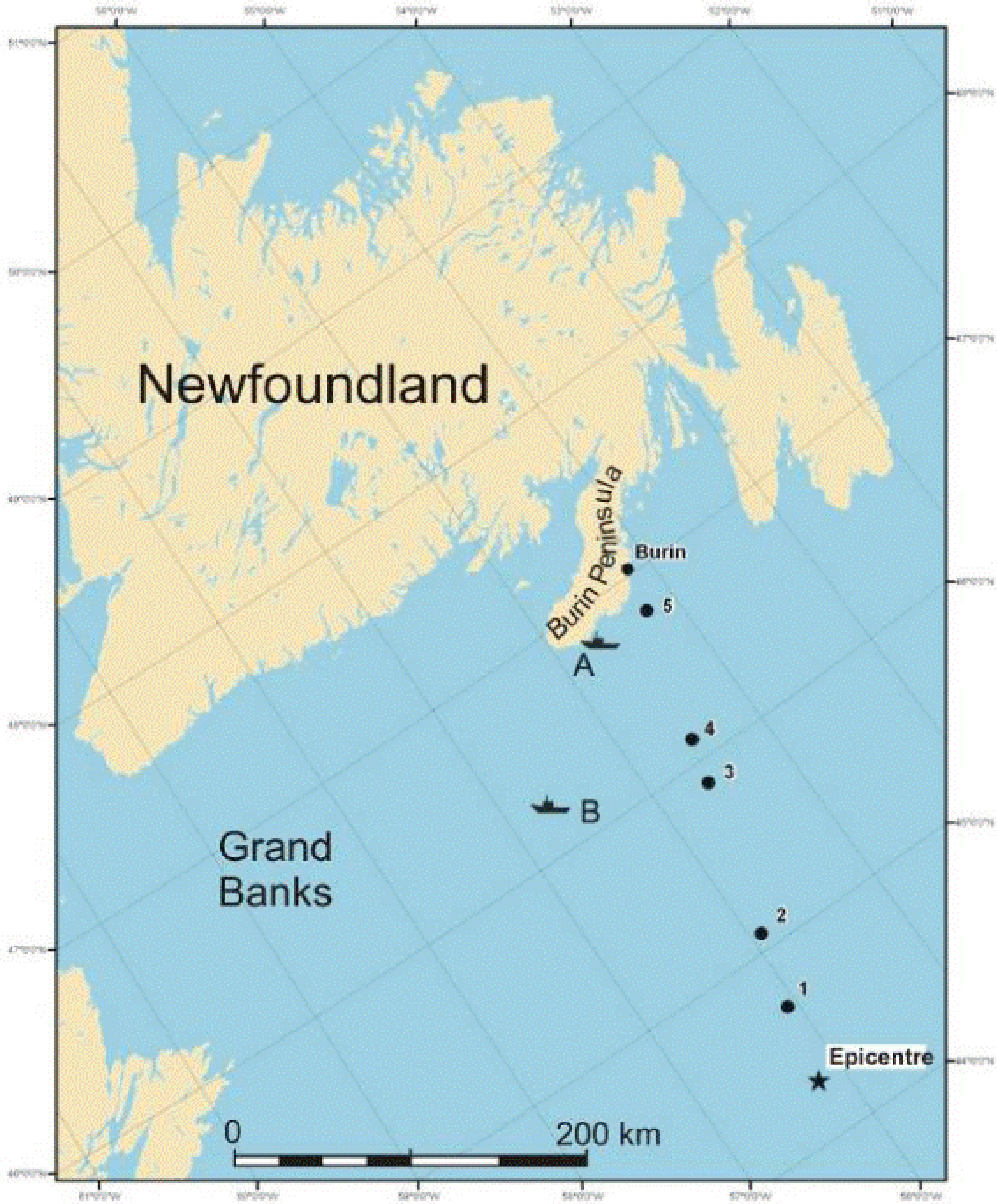
| Station | Velocity (km/h) | Distance (km) | Travel Time (hr) | Actual Time |
|---|---|---|---|---|
| Station 1 | 140 | | | |
| Station 2 | 140 | | | |
| Station 3 | 140 | | | |
| Station 4 | 140 | | | |
| Station 5 | 140 | | | |
| Burin, NFLD | 140 | | | |

4. On the map draw in travel time lines from the epicentre to Burin, NFLD. With a set of compasses, place the point on the epicentre and draw an arc through each of the stations. Indicate the time at which the tsunami would reach each station if it began at 5:00 pm at the epicentre.

# Answer the following questions.

5. Considering the travel time that you calculated, if the wave had been interpreted as a tsunami at station 1, would there have been enough time in 1929 to warn residents of the Burin Peninsula, NFLD, about the approaching tsunami? Explain.
6. If this event had happened today, what means could be taken to warn the shoreline communities of the approaching tsunami?
7. If a town needs to be evacuated, it is very important to know exactly how much evacuation time exists. The tsunami struck Newfoundland approximately 2.5 hours after the earthquake. Compare to your travel time calculations. If there is a difference, what are some reasons for your inaccuracy?
8. Examine the locations of fishing boats A and B on the map. Which of the boats will be more affected by the waves of the tsunami? Explain in detail why one boat experiences the full effects of the tsunami while the other only experiences a small wave.

# Grand Banks Tsunami



# 4 Agriculture Crossword

## Across

**4.** Agriculture and Agri-food Canada's scientists in western Canada have developed many varieties of this small fruit

**7.** Used to measure moisture, nitrogen or phosphorus levels in soil

**9.** Combination of sensations perceived in the mouth

**10.** An English writer said of this fruit: "Doubtless God could have made a better berry, but doubtless God never did."

**12.** Considered a bad thing in the Middle Ages but seen today as insulating against change

**14.** Describes all strategies used to ensure long-term production without depleting resources

**17.** Bacteria isolated from the gut flora of breastfed babies that can, in some cases, protect against disease

**20.** Main component of both air and fertilizer

**21.** A necessity of life

**23.** Another word for cows

**25.** Also known as a fermenter, device used to grow microorganisms

**26.** Determination of the sequence of genes

**28.** Science of protecting plants

**29.** Beneficial insect used by Agriculture and Agri-Food Canada to control leafy spurge, or insect pest controlled by hairy canola

**30.** Organism resulting from cross-breeding two individuals of different varieties, subspecies (intraspecific cross), species (interspecific cross) or genera (intergeneric cross)

**31.** Canada's __________ is used in the best Italian pastas

**32.** Cooked tomatoes contain more of this substance

## Down

**1.** Just one of these heroes produces enough to feed 100 Canadians

**2.** _____________ species

**3.** Insecticides, fungicides and herbicides are examples

**5.** Probiotics undergo this process before being added to foods

**6.** Rapeseed, sunflower seeds, peanuts and soybeans are examples

**8.** Canada's ____________ is used to make a famous French condiment

**11.** The action of removing excess water from crops

**13.** Canada's ___________ is recognized by beer brewers worldwide

**15.** This vitamin is better absorbed through milk and can boost both metabolic efficiency in cows, resulting in more nutritious milk, and fertility in sows, resulting in healthier piglets

**16.** Scientific study of insects

**18.** What seeds are planted in

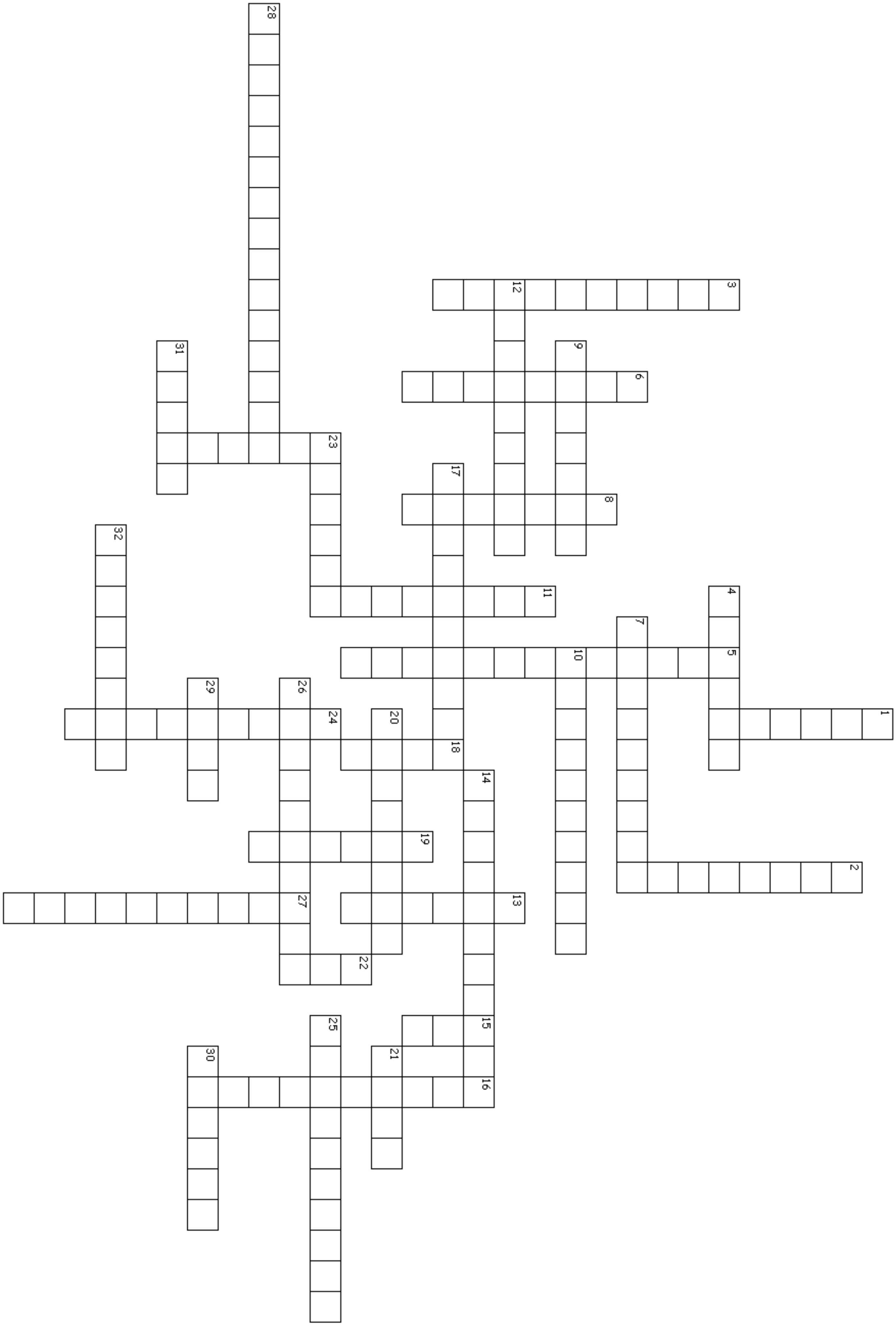
**19.** Weed control method

**22.** Another word for pig

**23.** Rapeseed bred to be fit for human consumption by Agriculture Agri-Food Canada and other organizations

**24.** Flaxseed shelling method developed by Agriculture Agri-Food Canada that effectively separates the hull from the kernel

**27.** The action of watering crops

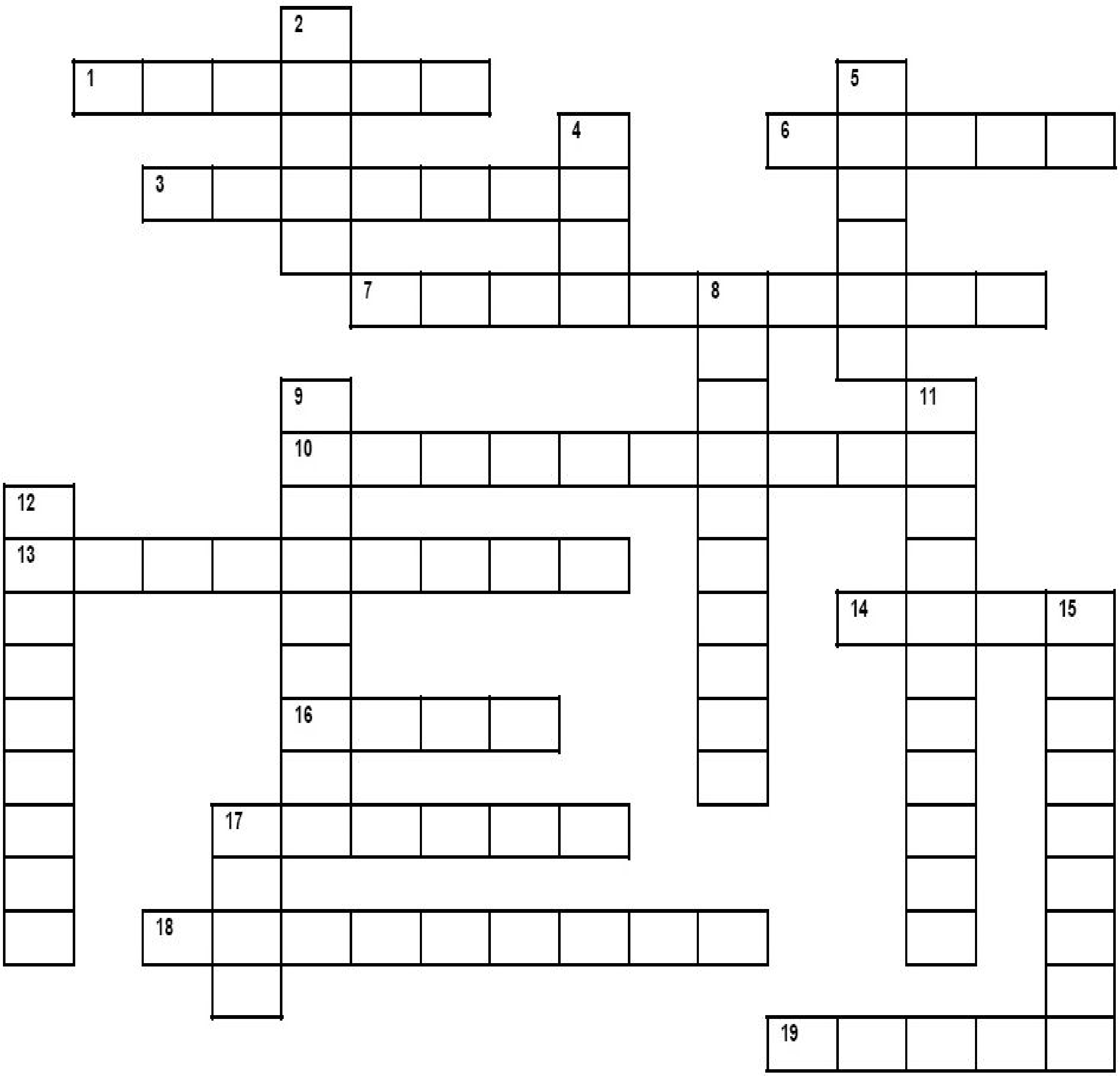


# 5 Cell Structure Scavenger Hunt

**Use your knowledge of cell structure to answer the following questions.**

1. This material within the nucleus contains hereditary or genetic information called genes: ________________
2. These are a stack of flattened membrane-bound sacs involved in the storage, modification, and secretion of proteins and lipids: ________________
3. This organelle is the site of aerobic respiration and ATP production: ________________
4. These organelles are the sites of protein synthesis: ________________
5. These extend from the envelope of some viruses and help the virus attach to a living organism: ________________
6. This membrane-bound, fluid-filled space in plant and animal cells stores food, water, and waste material: ________________
7. This cellulose layer surrounds the plasma membrane of plant cells: ________________
8. This is a complex system of membrane-bound channels extending throughout the cytoplasm of cells: ________________
9. This layer encloses the genetic material of a virus: ________________
10. This is a whip-like tail that helps some bacteria to move: ________________
11. This membrane surrounds the cytoplasm: ________________
12. This layer surrounds the protein coat of some viruses: ________________

# 6 Tsunami Crossword



## Across

**1.** In deep water, wave height is less because energy is transferred over the entire water _______.

**3.** A series of catastrophic ocean waves generated by submarine movements.

**6.** Highest part of wave above the still-water line.

**7.** The vertical distance between 2 consecutive wave tops or 2 consecutive wave bottoms.

**10.** Emergency movement of people to avoid a hazard.

**13.** _______ impact can trigger a tsunami.

**14.** 'Tsunami' is Japanese for harbour _____.

**16.** Province (abbrev.) hit by deadly tsunami in 1929.

**17.** The amount of time between successive waves.

**18.** An abrupt downhill movement of soil and/or bedrock.

**19.** Wave velocity decreases and size increases as the wave approaches the_____.

## Down

**2.** Maximum height of the water onshore observed above the 'normal' sea level.

**4.** The Pacific Ocean is encircled by a zone of frequent earthquakes and volcanic eruptions known as the Ring of ____.

**6.** Lowest part of wave the below still-water line.

**8.** The most common cause of a tsunami.

**9.** The continuous reflection (bounce) of waves off of the sides of a harbour or bay, leading to amplification of wave heights and increase in duration of wave activity is known as harbour ____.

**11.** Location of deadly tsunami that killed over 230,000 people in December 2004.

**12.** Measurement of the height of the wave above the still-water line.

**16.** The point on the earth's surface directly above the focus of the earthquake.

**17.** Every family living in low lying coastal areas should have an emergency _____ to help them react safely to possible tsunami events.

# 7 Radioactive Students

This activity explores exponential decay, radioactive decay processes, half-lives, and absolute dating.

While you can perform this activity with a class of any size, it works best with large groups – the bigger the better!

## The Science

Isotopes are different forms of the same element where an atom has the same number of protons, but a different number of neutrons. For example, every isotope of Carbon has 6 protons, but can have anywhere from 2 to 16 neutrons! Of all these isotopes, only carbon-12 ($^{12}C$, with 6 protons and 6 neutrons), carbon-13 ($^{13}C$, with 6 protons and 7 neutrons) and carbon-14 ($^{14}C$, with 6 protons and 8 neutrons) occur in nature, and the rest are only formed artificially in laboratories.

Some isotopes are stable: they can remain indefinitely in nature without changing. Other isotopes are unstable, and will undergo radioactive decay where the atom nucleus will emit energy and sometimes even particles until it reaches a stable state. Carbon-12 and Carbon-13 are stable, while carbon-14 is unstable, decaying into stable nitrogen-14 ($^{14}N$, with 7 protons and 7 neutrons). The original radioactive isotope is the parent isotope ($^{14}C$), and the isotope the parent decays into is the daughter isotope ($^{14}N$).

A radioactive parent isotope has a 50% chance of decaying into its daughter product within its half-life. By measuring the ratio of parent to daughter isotopes, scientists can determine the age of a material for approximately six half-lives. Different isotopes have different half-lives, so they are useful for measuring different time frames. For example, carbon-14's half-life is approximately 5730 years, which means it can be used to date objects for approximately 34,000 years (6 x 5730 = 34,380 years), or sometimes longer with increasing error. This is why carbon-14 dating is often used to date human artefacts. By contrast, the decay of potassium-40 ($^{40}K$) into argon-40 ($^{40}Ar$) occurs over a half-life of 1.3 billion years, making it suitable to measure geological events since the formation of the Earth.

# The Activity

Students will demonstrate the process of radioactive decay by acting out the changing ratio of isotopes present in a substance over time.

1. Make a table with three columns: Half-life, Parents, Daughters. Fill out the first row as half-life = 0, parents = total number of students, daughters = 0.  Add other rows for additional half-lives.

### Sample table:

| Half life | Parents | Daughters |
|---|---|---|
| 0 | [Total number of students] | 0 |
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |
| 5 | | |
| 6 | | |

2. All students start the activity seated. They represent radioactive parent isotopes.
3. To represent the first half-life, every student flips a coin once. Anyone who flips a "heads" remains a parent isotope and stays in their seat. Anyone who flips a "tails" has decayed into the daughter isotope, and comes to the front of the class. Record the new count of parents and daughters in the second row of the table. If desired, assign one of the "daughters" to act as the recorder.
4. Repeat for additional half-lives. For each half-life, all seated students flip their coin once. "Heads" remain parent isotopes and stay seated; "tails" become daughters and move to the front. Record the results in the table. Repeat until all students have decayed into daughters.

### Variants & Extensions

1. If a student arrives mid-way through the activity (or leaves during the activity), use that as an opportunity to discuss the limitations of radioactive dating with respect to closed systems.
2. Randomly select some students (parents or daughters) and ask them to leave the room, skewing the table numbers. Use this as an opportunity to discuss the limitations of radioactive dating with respect to closed systems.
3. Randomly pick some students to start off at the front of the room. These represent daughter-isotopes present in the initial composition, not produced by decay. Discuss how this composition would affect the accuracy when using isotopes to determine the age of material.

4. Have daughters flip coins to produce decay chains of multiple radioactive reactions. An example of a decay chain is the uranium series, where uranium-234 ($^{234}U$) decays into thorium-230 ($^{230}Th$), a radioactive isotope which eventually decays into lead-206 ($^{206}Pb$).

5. Have students roll dice, where odds decay into daughters, and events remain as parents until the next half-life. Assign each odd number a different place in the room, representing different daughter isotopes that can be produced from the same parent decaying through different radioactive processes. For example, thorium-212 ($^{212}Th$) can decay through emission of alpha particles into radium-208 ($^{208}Ra$), or through emission of beta particles into actinium-212 ($^{212}Ac$).

6. Divide the class into two groups, and conduct the experiment with two different parent/daughter isotope chains with different half lives. E.g. group 1 flips a coin every minute; group 2 flips a coin every 3 minutes. Use the results to discuss cross-validating data and/or the impact of half-life duration on appropriate dating age ranges and error ranges. An example of simultaneous paired decay chains are uranium-235 ($^{235}U$) decaying into lead-207 ($^{207}Pb$) with a half-life of 700 million years, while uranium-238 ($^{238}U$) decays into lead-206 ($^{206}Pb$) with a half-life of 4.5 billion years.

7. Compare the ratio of parent isotopes to daughter isotopes from your activity with the theoretical perfect 50:50 ratio expected by exponential decay. Use any variations to discuss error ranges: remind the class that although it is statistically a 50% chance of decay each half-life, the results are not precisely a 50% decay rate every time interval. This is a great way to discuss real-world error in radiometric dating with advanced students.

8. For advanced students, use the data to try to derive the age equation, or use the age equation to determine the decay constant λ:

$$D = D_o + N\,(e^{\lambda t} - 1)$$

*where D is the number of daughter isotopes at the current time (the $t^{th}$ row in the table), $D_o$ is the original number of daughter isotopes (0), N is the number of parent isotopes at the current time (the $t^{th}$ row in the table), t is time (the table row), and λ is a decay constant related to the half-life.*

9. For advanced students, plot an isochron to solve the equation graphically. An isochron is a method of visualizing the daughter and parent isotopes with respect to the normal abundance of a stable isotope of the daughter element. Then, the y-axis illustrates an increasing enrichment of the daughter isotope with respect to the background, and the x-axis represents an abundance of the parent isotope with respect to the background, eliminating the need to know the starting quantity of parent or daughter isotope. For example, rubidium-87 ($^{87}Rb$) decays into strontium-87 ($^{87}Sr$), and strontium-86 ($^{86}Sr$) is a naturally-occurring stable isotope of strontium.  An isochron of rubidium–strontium decay plots $^{87}Sr/^{86}Sr$ on the y-axis, and $^{87}Rb/^{86}Sr$ on the x-axis. In your classroom, a stable isotope of the daughter isotope may be the number of people who usually sit in the front of the class (1, if only the teacher is normally at the front of the class). It is unlikely that every student will reach the front of the classroom at the exact same time. Bring this to the students' attention and discuss that not all the parents decay into daughters at exactly the same time within the half-life. The margin of error will vary depending on when the count is taken.



# 8 Going South for a Tan?

The intensity of solar radiation depends partly on the latitude of a given place and time of year.

We know the sun is directly overhead at the:

- Equator (0°) on/about March 21 and September 21 (spring and autumn equinoxes);
- Tropic of Cancer (23.5°N on/about June 21 (summer solstice);
- Tropic of Capricorn (23.5°S on/about December 21 (winter solstice).

The sun therefore moves through a latitude range of 47° every six months (182.5 days) or about one degree of latitude every four days.

Knowing this, we can calculate when the sun will be directly overhead in different latitudes.

For example, the sun will be directly overhead at 10°S latitude on:

> 23.5°S - 10°S = 13.5°S
>
> 13.5°S x 4 days/degree = 54 days after December 21 (when the sun was overhead at 23.5°S)
>
> Adding 54 days to December 21, the date is February 13.

Use the steps from the previous page to calculate when the sun's rays will be directly overhead for the following popular vacation spots:

| Vacation Site | Latitude ( ° ) | Date of Overhead Sun |
|---|---|---|
| Montego Bay, Jamaica | | |
| Cancun, Mexico | | |
| Acapulco, Mexico | | |
| Rio de Janeiro, Brazil | | |
| Havana, Cuba | | |
| San Jose, Costa Rica | | |
| Ambergris Caye, Belize | | |

# Questions

1. What is the relationship between UV radiation and the angle of the sun's rays?
2. At what time of year are you most susceptible to UV radiation in these places?
3. What is the second time in the year when the sun's angles will be directly overhead?
4. Trick question: When are the sun's rays directly overhead in your home latitude?

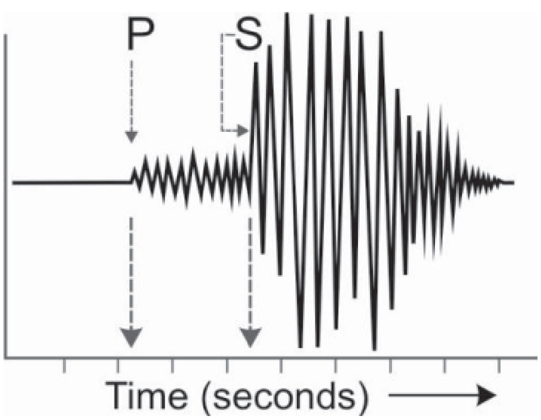
# 9 Locate the Earthquake

## Background

When an earthquake occurs, vibrations initiated by fracturing of the earth's crust radiate outward from the point of fracture.

> **P wave:** Also called primary or compressional waves, P waves carry energy through the Earth as longitudinal waves, moving particles in the same line as the direction of the wave. These waves are the fastest body waves. P waves are generally felt by humans as a bang or thump.
>
> **S wave:** Also called secondary or shear waves, S waves carry energy through the Earth in very complex patterns of transverse (crosswise) waves. These waves move more slowly than P waves, but in an earthquake they are usually bigger.

Each type appears as a unique signature on a seismogram, the visual record produced by a seismograph. At the recording station, the difference in arrival time of the P and S waves is used to calculate the distance to the epicentre of the earthquake.




P-wave velocity is 6.2 km/s and S-wave velocity is 3.65 km/s. The difference is 2.55 km/s.

Time taken by P-waves to travel a distance (D) from the epicentre to a seismic station:

$$T_P = D / 6.2$$

Time taken by S-waves to travel same distance from the epicentre to a seismic station:

$$T_S = D / 3.65$$

Difference in arrival time (lag time) between P- waves and S-waves is:

$$\Delta T = T_S - T_P$$
$$\Delta T = D/3.65 - D/6.2$$
$$\Delta T = 2.55\ D / 22.63$$

**$\therefore$ Distance from the epicentre to the seismic station is: $D = 22.63\ \Delta T / 2.55$**

## Answer the following questions to demonstrate your understanding of this process.

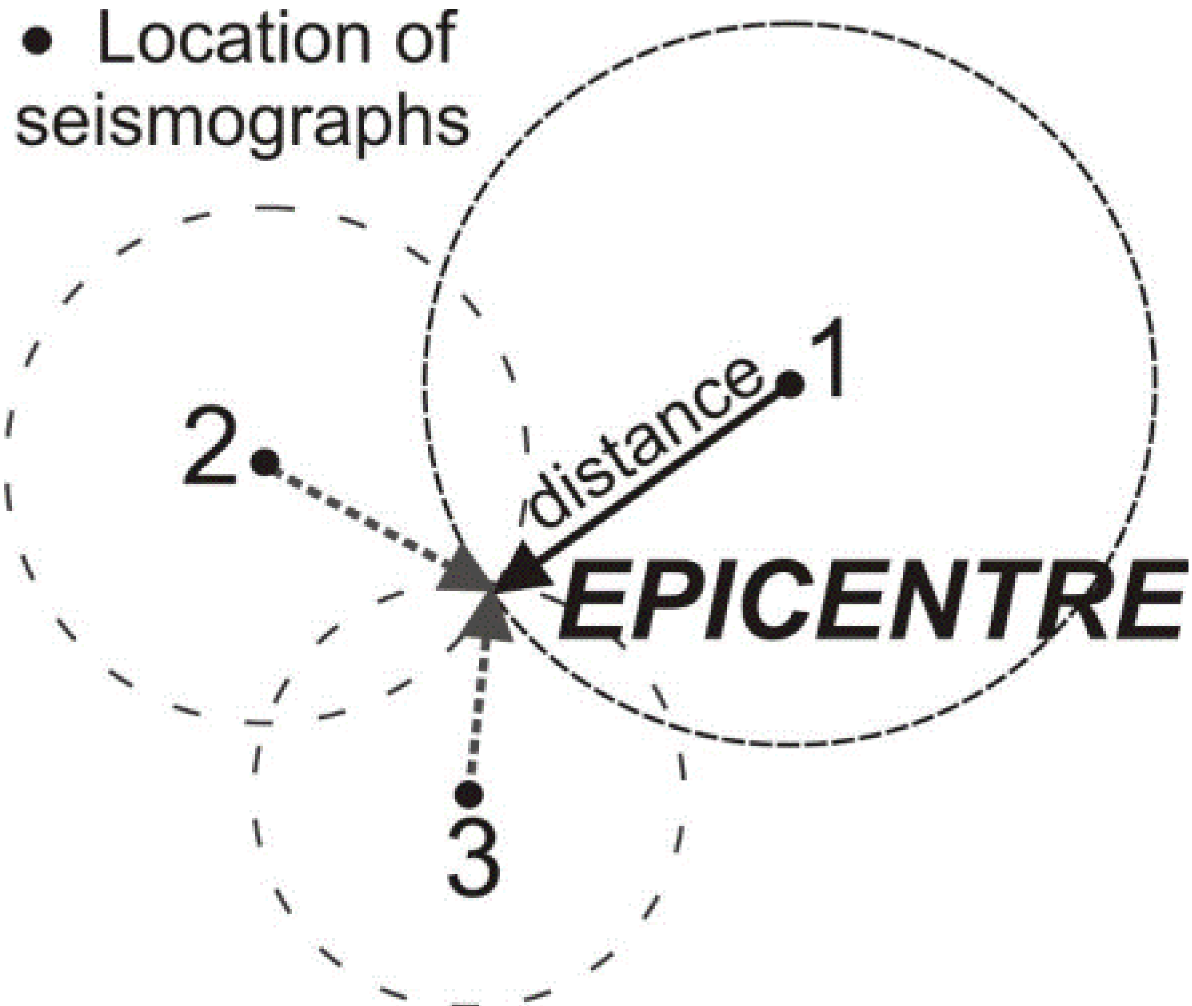
1. How long would it take P waves to travel 100 km?
2. How long would it take S waves to travel 100 km?
3. What is the lag time between the arrival of P waves and S waves over a distance of 100 km?
4. If the difference in arrival time of P and S waves was 20 seconds, what is the distance between the epicentre and the seismograph location?

## Examine the seismograms. Seismographs measured the time between the arrival of P-waves and S-waves.

1. Identify and label the arrival of the P and S waves on the seismograms.
2. Calculate the distance to the epicentre from each station.

| # | Recording station | Difference in arrival time | Distance from epicentre |
|---|---|---|---|
| 1 | | | |
| 2 | | | |
| 3 | | | |
| 4 | | | |

3. Triangulate the epicentre on the map. Inscribe a circle with a compass, such that the point of the compass is on the location of the recording station and the radius of the circle is equal to the calculated distance to the epicentre. Repeat for the other stations. The epicentre of the earthquake is located near the point at which the circles approximately intersect. Mark and label the epicentre on the map.

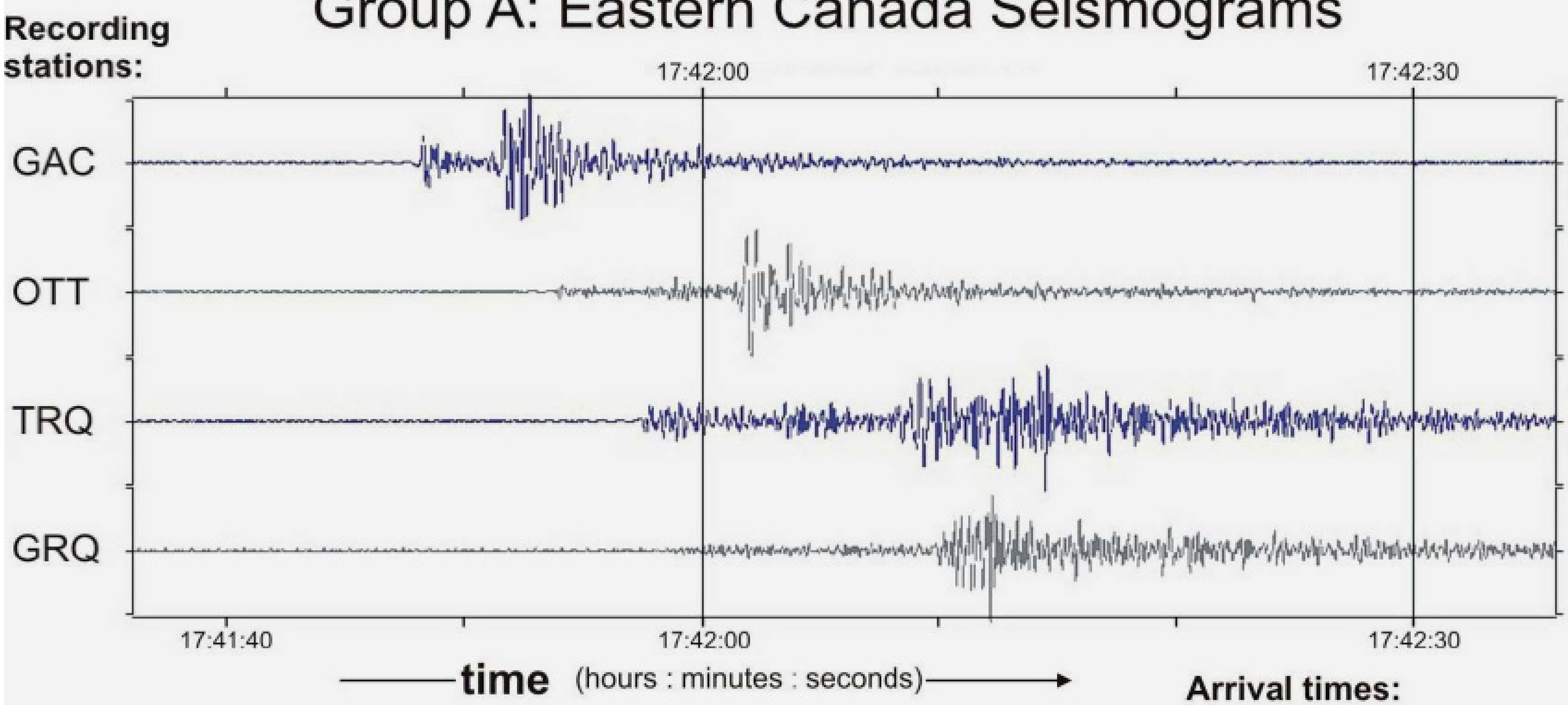



*Compare the location on your map with an Atlas or Google Map.*

Where is the epicentre of this earthquake? Near the town of ___________________________

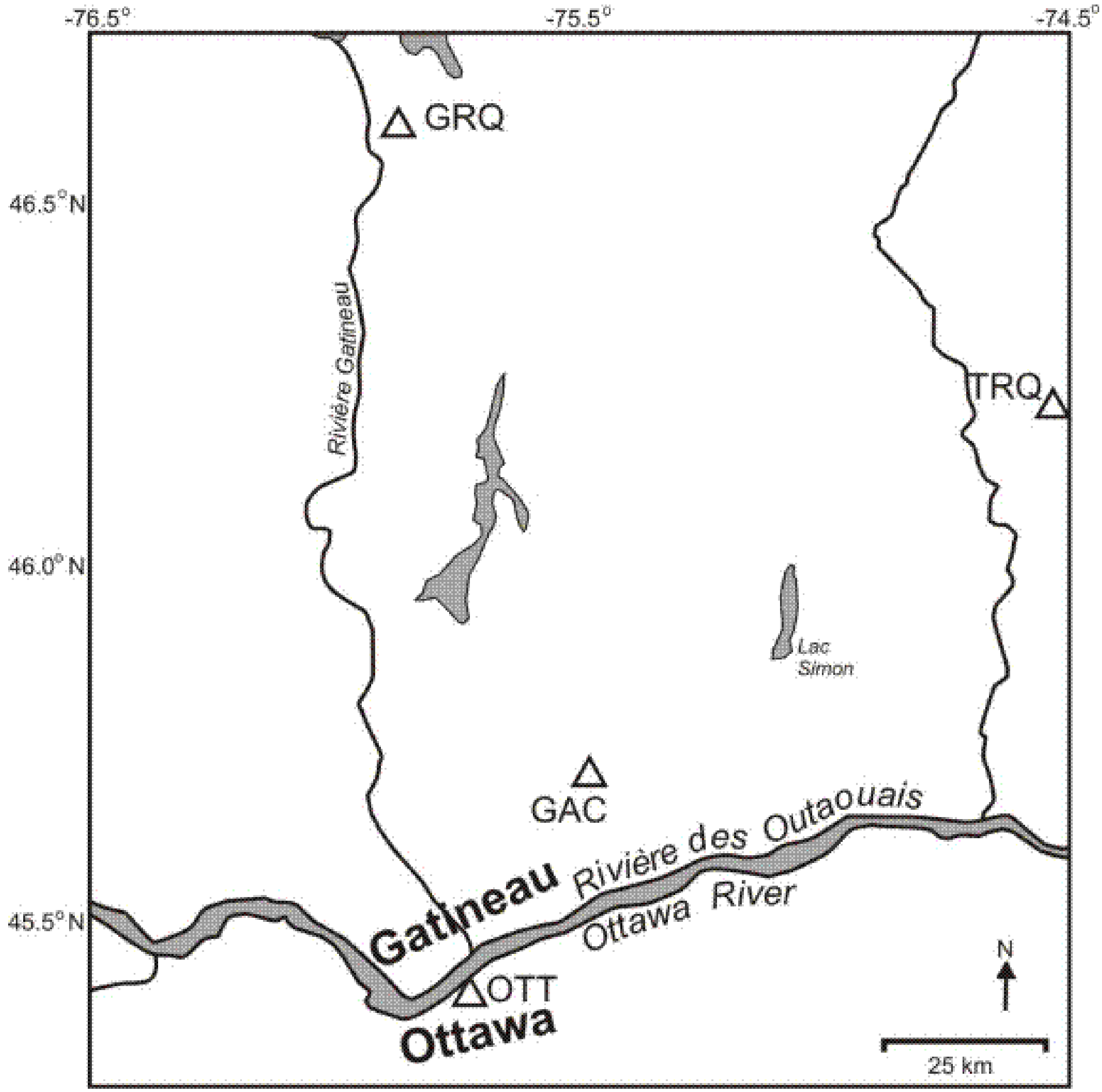
What is the minimum number of stations that are necessary to find an epicentre? ___________________________

# Group A: Eastern Canada Seismograms



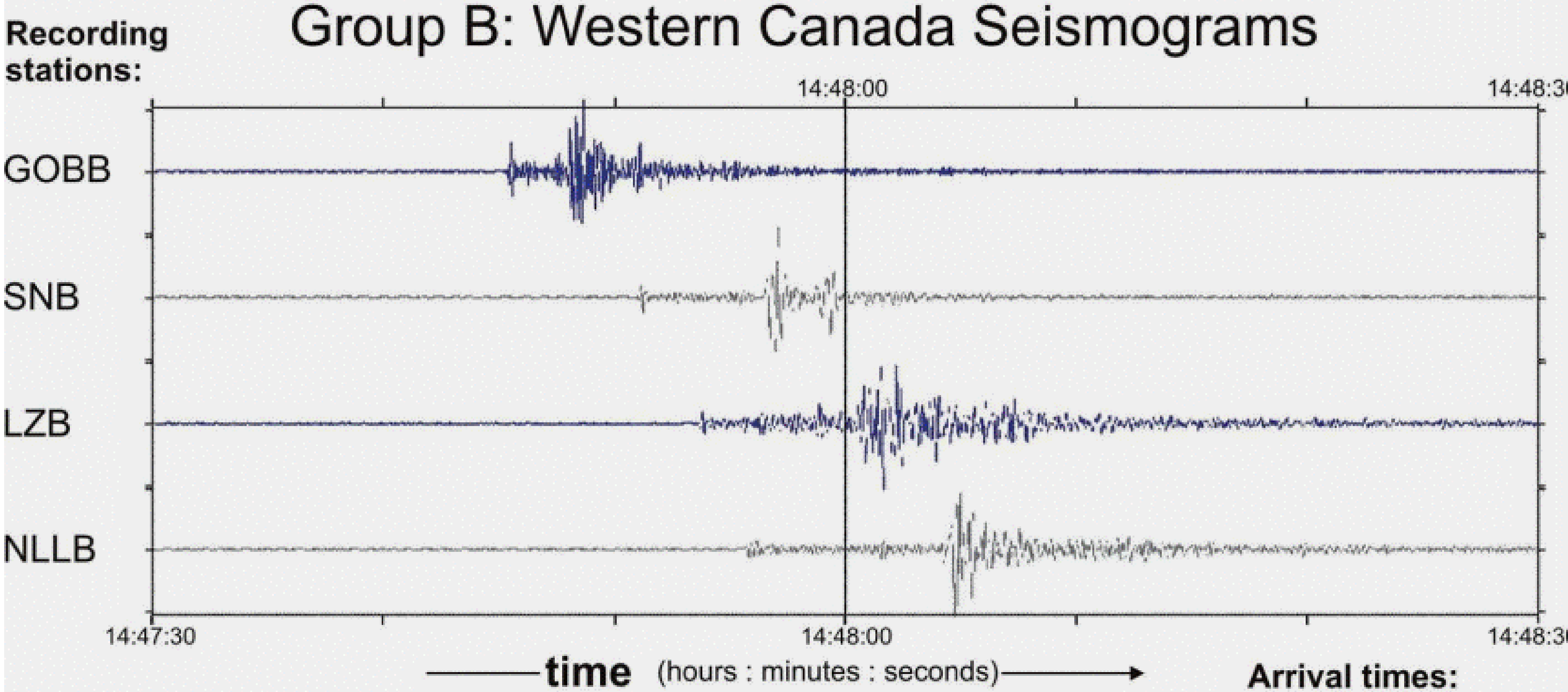

**Arrival times:**

| | P wave | S wave |
|---|---|---|
| GAC: | ............ | ............ |
| OTT: | ............ | ............ |
| TRQ: | ............ | ............ |
| GRQ: | ............ | ............ |


-76.5°
-75.5°
-74.5°
46.5° N
46.0° N
45.5° N
GRQ
TRQ
GAC
OTT
Rivière Gatineau
Lac
Simon
Rivière des Outaouais
Ottawa River
Gatineau
Ottawa
N
25 km

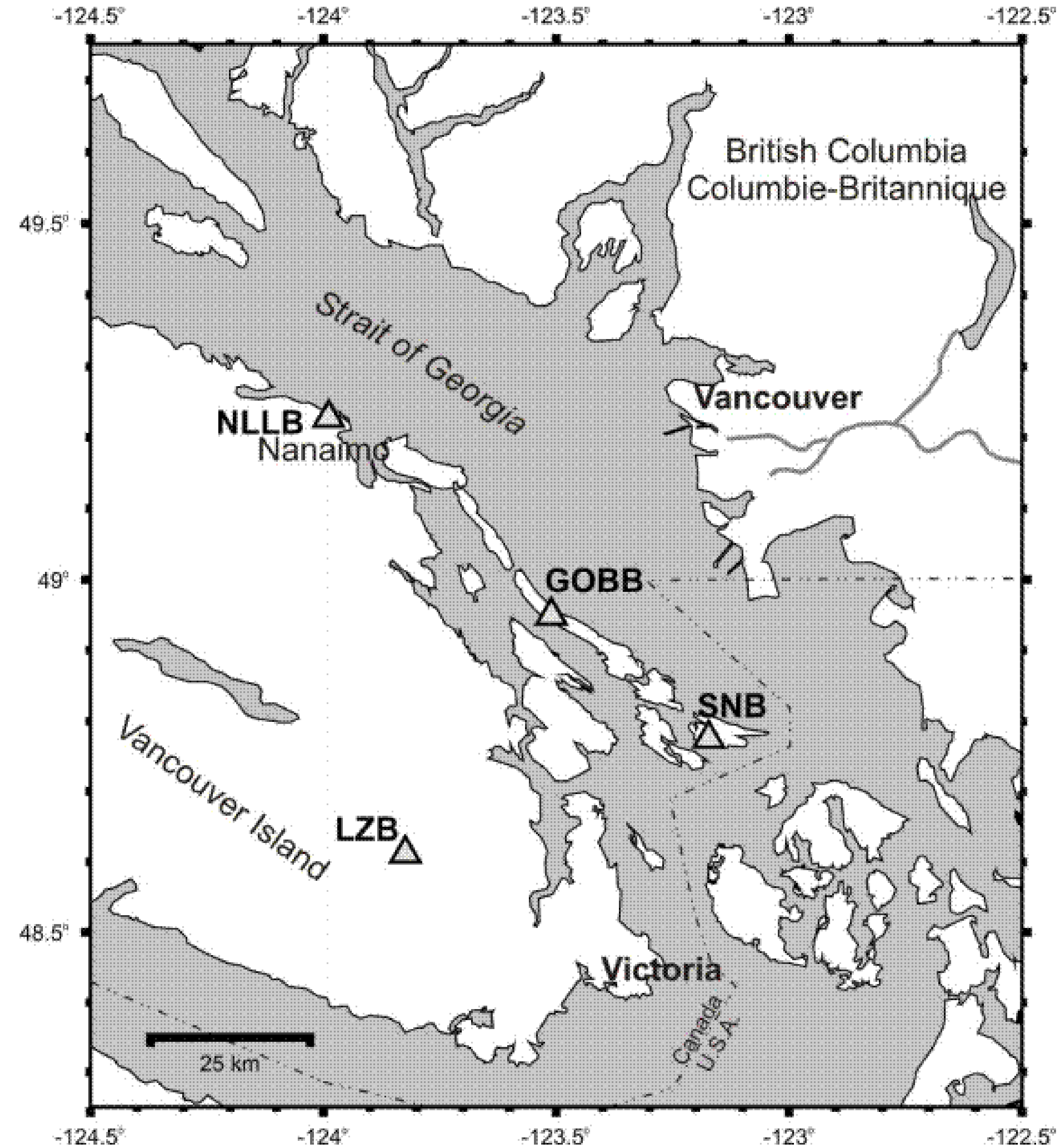
name: ____________________

# Group B: Western Canada Seismograms




**Arrival times:**

| | P wave | S wave |
|---|---|---|
| GOBB: | ........ | ........ |
| SNB: | ........ | ........ |
| LZB: | ........ | ........ |
| NLLB: | ........ | ........ |


-124.5°
-124°
-123.5°
-123°
-122.5°
49.5°
49°
48.5°
British Columbia
Columbie-Britannique
Strait of Georgia
Vancouver
NLLB
Nanaimo
GOBB
SNB
Vancouver Island
LZB
Victoria
Canada
U.S.A.
25 km

# 10 Extracting DNA from Fruit!

*By: Dr. Tamara Franz-Odendaal, PhD, NSERC Chair for Women in Science and Engineering (Atlantic Region)*

## Timing: 60 minutes

## Learning Objectives

- Use proper laboratory equipment and safety rules
- Understand the importance of DNA and why scientists would want to extract it from plants and animals.

## Overview

Every cell in a plant or animal contains DNA or deoxyribonucleic acid. DNA is essential to all life on earth, it carries the instructions to create new life and sustain existing life. Scientists study DNA for several reasons including; to understand how its instructions help our bodies function normally, to modify existing DNA in plants or animals to create medicine or disease resistant crops, and studying DNA can also help solve crimes! In this lab you will extract, isolate and observe DNA from fruit using common household materials!

## Materials

- Piece of soft fruit such as strawberry or banana
- 1 zipper-lock bag
- Two 50 ml tubes or jars (with lid)
- 5 ml (1tsp) of clear dish soap

- ¼ teaspoon of table salt
- 80 ml of distilled or bottled water
- Coffee filter
- Elastic band
- 250 ml beaker or jar
- Chilled rubbing alcohol (about 30 ml)
- Plastic Pipette (optional)

# Procedure

1. Place your rubbing alcohol in the freezer to chill.
2. Making your fruit mash:
   a. Break fruit into chunks and place into the zipper-lock bag.
   b. Add 60 ml of distilled water into the bag.
   c. Seal the bag very tight and use your hands to mash the fruit with the water.
3. Making a buffer:
   a. Place ¼ tsp of salt into a 50 ml tube or equivalent jar with lid.
   b. Add 1 tsp of dish soap.
   c. Add 4 tsp of distilled water.
   d. Add 2 tsp of fruit mash.
   e. Seal the tube or jar and invert about 20 times. *do not shake as this causes too many bubbles to form!
   f. Place tube or jar in warm water for about 5 minutes.
4. Filtering:

   a. Place a coffee filter over the top of a 250 ml beaker or jar and secure with a rubber band as pictured below.
   b. Retrieve your fruit buffer mixture from the warm water and pour all contents of tub or jar into the filter slowly and wait.

5. Precipitating:
    a. Fill your other clean 50 ml tube or jar with 30 ml (6 tsp) of the chilled rubbing alcohol from the freezer.
    b. Add 1 pipette full or 2 tsp of filtrate liquid at the bottom of the beaker or jar into the jar with the rubbing alcohol.
    c. Watch the DNA precipitate out of solution; it will look like a clear, stringy substance.

# Important Concepts

- Each component of the DNA extraction plays an important role. The soap helps to dissolve the cell membranes, the salt helps break up the protein chains that hold the DNA together, and the rubbing alcohol is used to precipitate out the DNA strands because DNA is not soluble in this substance.
- DNA is essential because it contains the code to build living things.

***Dr. Tamara Franz-Odendaal, PhD***
***NSERC Chair for Women in Science and Engineering (Atlantic Region)***
***www.wiseatlantic.ca***

*A biologist and a previous NSERC University Faculty Awardee, Dr. Tamara Franz-Odendaal, has established a vibrant growing research group at Mount Saint Vincent University. Her research program focuses on the comparative development of the vertebrate skeleton, with particular focus on the neural crest derived craniofacial skeleton.*

# 4 Answer Key

# 1 Air Patrol

Be on the lookout for the words that have something to do with air pollution.

Words can be found forwards, backwards and diagonally

## Find these words!

- AIR
- BREATH
- CAR
- CLOUDS
- LUNGS
- OXYGEN
- QUALITY
- SICK
- SMOG

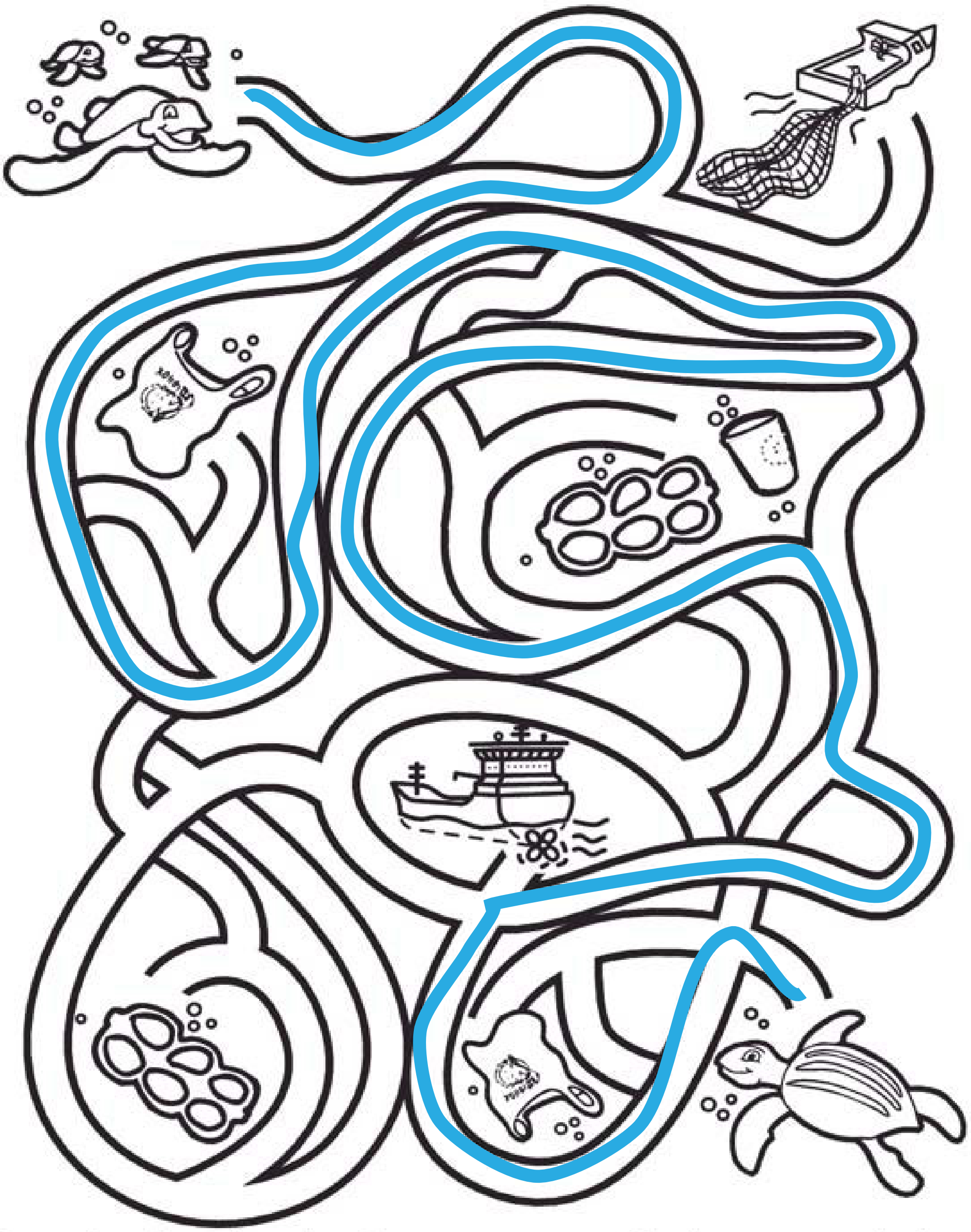
| | | | | | | |
|---|---|---|---|---|---|---|
| Q | O | X | Y | G | E | N |
| U | C | L | O | U | D | S |
| A | A | K | U | A | I | R |
| L | R | C | Y | N | J | Z |
| I | A | I | K | I | G | I |
| T | D | S | G | O | M | S |
| Y | B | R | E | A | T | H |



# 2 The Emerald Ash Borer

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | [8]O | | | | | [6]Q | | | | |
| | | | | T | | | | | U | | | | |
| | | | | T | | | | | E | | | | |
| | | | | A | | | | | B | | | | |
| | | | | [2]W | O | O | D | P | E | C | K | [7]E | R |
| [1]L | [5]A | R | V | A | | | | | C | | | G | |
| | S | | | | | | [9]A | | | | | G | |
| | I | | | | | | [4]S | T | I | C | K | S | |
| [3]M | A | Y | | | | | H | | | | | | |

# 3 Leatherback Maze

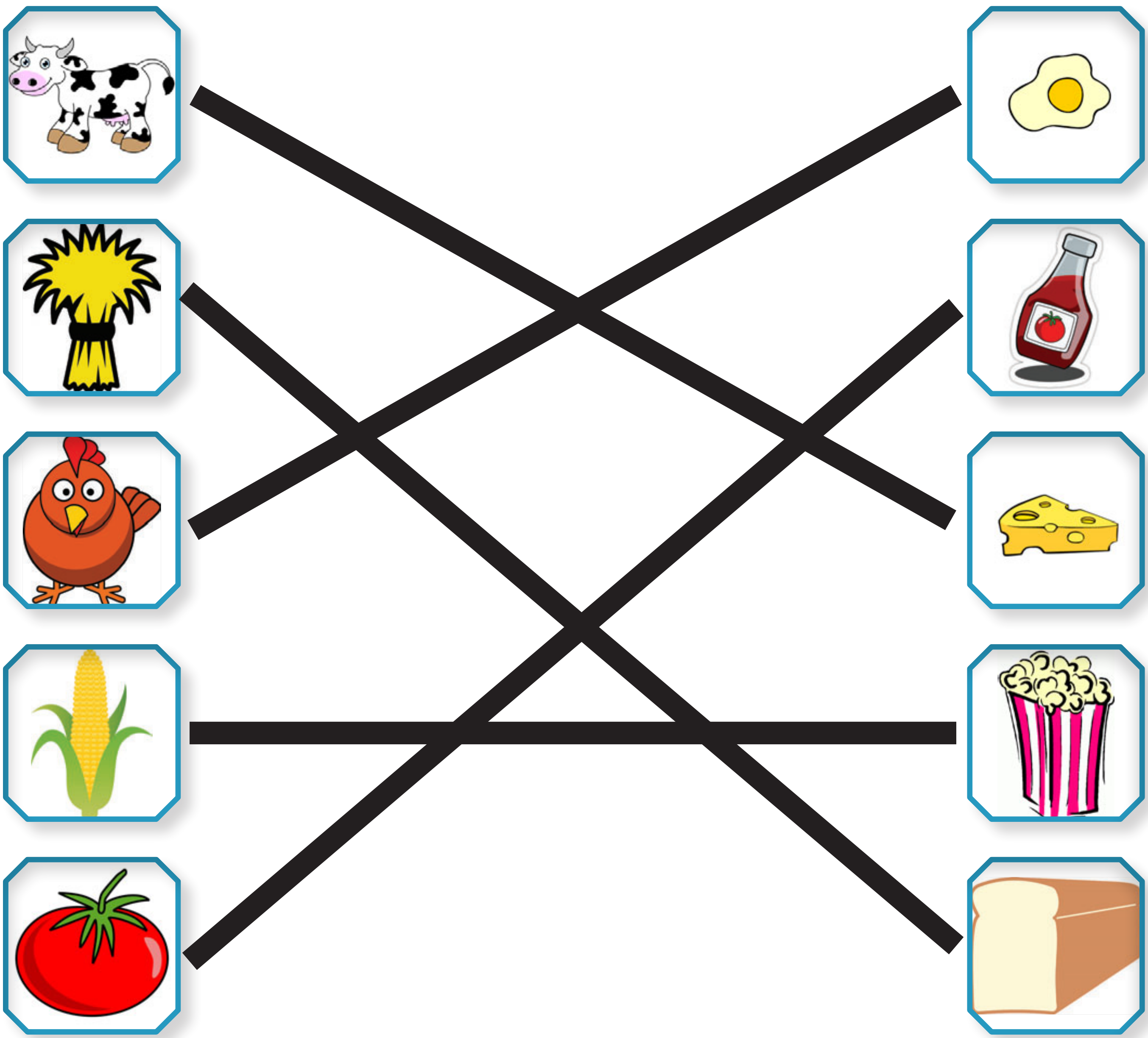


## Get the leatherback turtle back to his friends safely!

Leatherback turtles are threatened by fishing gear in which they can be entwined, as well as by plastic bags and other garbage.

# 4 Match the Food

**Do you know where your food comes from? Draw a line from food you eat with where it originally came from.**





# 5 Word Search

## Find the words

ALLOY

CASTING

CORROSION

FOUNDRY

FRACTURE

IRON

MATERIAL

METALS

MICROSCOPE

PIPELINE

STEEL

WELDING

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| C | A | F | R | U | N | S | F | A | E |
| C | O | R | R | O | S | I | O | N | P |
| A | P | A | E | L | T | R | U | S | O |
| S | I | C | D | S | E | O | N | L | C |
| T | P | T | R | O | E | N | D | A | S |
| I | E | U | R | A | L | X | R | T | O |
| N | L | R | A | L | L | O | Y | E | R |
| G | I | E | T | C | E | A | U | M | C |
| N | N | G | N | I | D | L | E | W | I |
| A | E | L | A | I | R | E | T | A | M |

# 6 It All Adds Up

**These problems will challenge both your math skills and your energy knowledge.**

## Give them a try!

1. Julie, her brother and her mother each take a shower every day. Julie's dad takes a bath every day. Each shower uses 40 litres of water and each bath uses 75 litres.

   a) How many litres of water does the family use to bathe each day? **195 litres each day**

   Each week? **1,365 litres each week**

   b) If Julie's dad switched to showers too, how much water would the family save each day? **35 litres each day**

   Each week? **245 litres each week**

2. David's mom drives a hybrid car that uses 1 litre of fuel for every 20 km driven. She drives to work 30 km each way, 5 days a week. How much fuel does she use to get to work every week?
   **15 litres**

3. Marie's dad drives an SUV that uses 2.5 litres of fuel for every 20 km driven. He drives to work 20 km each way, 5 days a week. How much fuel does he use to get to work every week?
   **25 litres**

4. If Marie's dad replaced his SUV with a hybrid car like David's mom has, how much fuel would he save every week?
   **15 litres**



# 7 Earthquake Vocabulary Crossword

## Across

3 Seismograph

6 Epicentre

9 Magnitude

10 Shear

13 Seismicwaves

18 Pacific

20 Landslide

## Down

1 Seismogram

2 Zone

4 Tectonic

5 Stress

7 Compressional

8 Mercalli

11 Focus

12 Earthquake

14 Intensity

15 Fault

16 Tsunami

17 Arrival

18 Plate

19 Felt

21 Energy

# 8 UV Radiation and Clouds

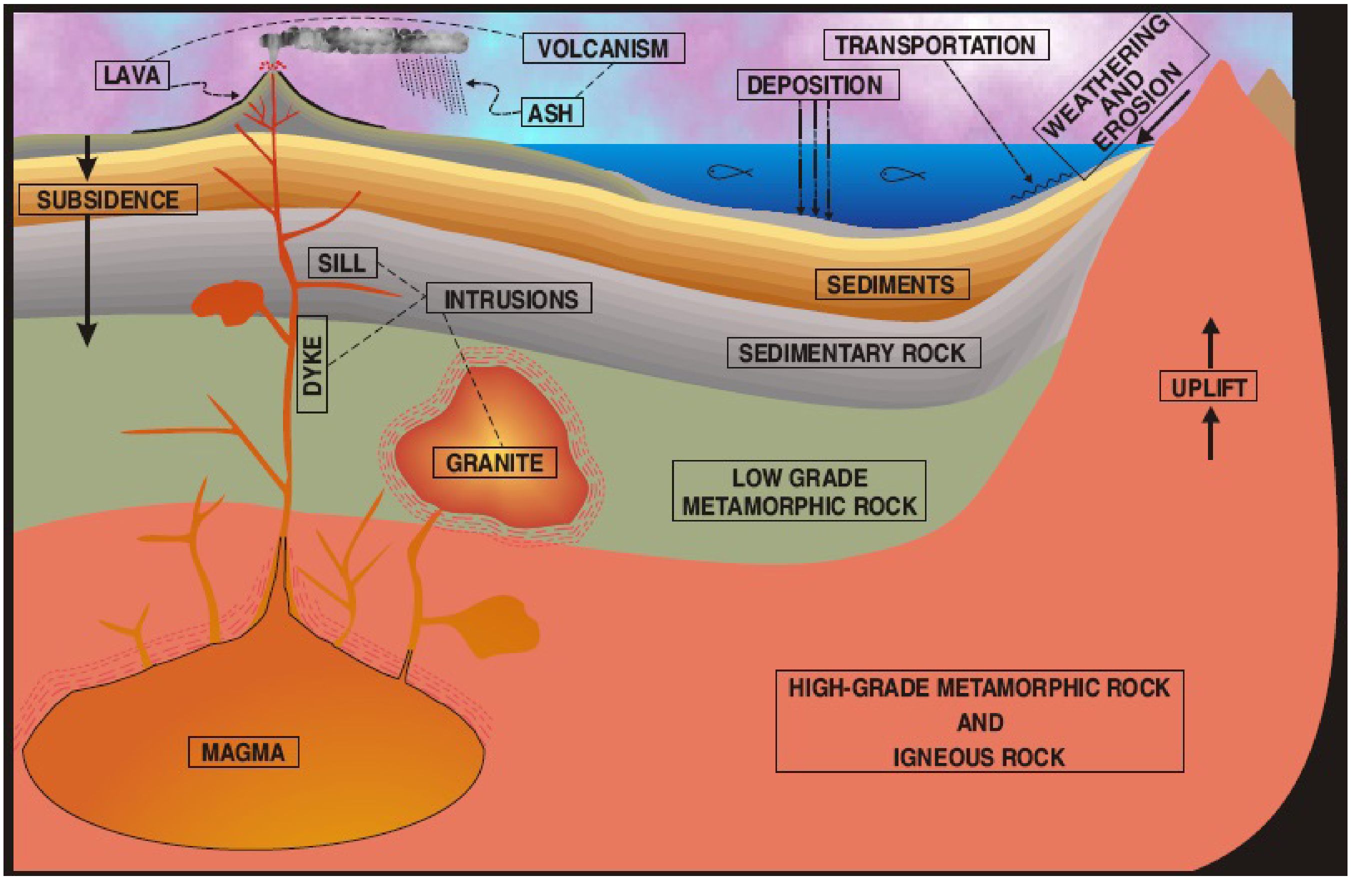
## UV Index Adjustment for Cloud and Precipitation

| Type | Factor | % UV |
|---|---|---|
| Scattered Clouds | 1.1 | +10% (transmitted) |
| Hazy | 0.9 | **-10% (absorbed)** |
| Mainly cloudy with/without precipitation | 0.7 | -30% (absorbed) |
| Cloudy | 0.6 | -40% (absorbed) |
| Cloudy with/without precipitation | 0.4 | **-60% (absorbed)** |
| Overcast | 0.3 | **-70% (absorbed)** |
| Heavily overcast with/without rain/drizzle | 0.2 | -80% (absorbed) |

## Questions:

1. Clouds can have a marked impact on the amount of UV that reaches the Earth's surface; generally, thick clouds reflect and absorb more UV than thin cloud cover.
2. UV radiation is absorbed and scattered on water vapour and aerosols and this leads to decreasing of the UV irradiance. UV can pass through thin clouds. However, sides of clouds can also reflect UV and focus solar energy and can increase the amount received at the Earth's surface in some situations.

# 9 The Rock Cycle



# 10 Periodic Table Scavenger Hunt

1. Which element makes up the core of stars? **Hydrogen**
2. Which is the lightest metal? **Lithium**
3. Which element is known as the "king" of all elements? **Carbon**
4. Which element makes up approximately 78% of the Earth's atmosphere? **Nitrogen**
5. Which well-known plastic is made of fluorine and carbon? **Teflon™**
6. Which white metal is so soft that it can be cut with a knife? **Potassium**
7. Which element burns in both air and nitrogen? **Titanium**
8. Which element has the highest malleability (can be pounded into very thin sheets) and ductility (can be pulled into a thin wire)? **Gold**
9. Which element is an important component of haemoglobin? **Iron**

# 11 Science aboard the ISS

| | (1) Vegetable juice | (2) 3.25% milk | (3) Vinaigrette |
|---|---|---|---|
| Decantation | No significant phase separation over the short term. | No phase separation. | After a certain amount of time, the oil forms a layer over the vinegar. The two components can be separated with the separating funnel. |
| Filtration | The filter contains a solid residue. The filtrate is a thin reddish liquid. | No phase separation | The vinegar passes through the filter and takes some oil with it. The filter captures the particles. |
| Centrifuging | The solid portion of the mixture ends up at the bottom of the test tube. The liquid is quite thin and reddish. | No phase separation | Complete phase separation. The oil forms a layer over the vinegar and particles |

### Which of the three mixtures is a colloid?

3.25% Milk

### What are the components of this mixture?

Water and fatty substances (3.25%)

# 12 Calculating travel time of a tsunami

5. No. Although today we could go on alert and initiate evacuations, communications were very limited in1929. Tsunamis were unknown on east coast.

6. Television and radio warning broadcasts, phone alerts to local officials, emergency vehicle loudspeakers, ship to shore radio, automated warning systems to alarm sirens (still uncommon).

7. Velocity of the waves will vary with changes in water depth but we used a constant velocity of 140 km/hr, which was true for much of the Grand Banks area. Reports state that the tsunami traveled at speeds up to about 500 km/hr through deep water, and about 140 km/hr over the continental shelf, but the tsunami waves slowed to about 40 km/hr near the coast.

   Map imprecision: The scale bar is not very precise, nor are ruler measurements, which result in inaccurate distance measurements.

8. In deep water, energy is transferred through the entire water column, resulting in long wavelengths and small amplitudes, so that the tsunami waves have less impact on Boat B. As the depth of water shallows, the wave energy is transferred through a much shorter water column. This causes wave speed to decrease, wavelength to decrease, and, since energy must remain the same, wave amplitude increases, forming the large destructive tsunami waves that crash onto the shore. Boat A, near the shore in shallow water, would have had a much more dramatic ride.

# 13 Agriculture Crossword

## Across

4. Cherry
7. Satellite
9. Flavour
10. Strawberry
12. Diversity
14. Sustainable
17. Probiotics
20. Nitrogen
21. Food
23. Cattle
25. Bioreactor
26. Sequencing
28. Phytoprotection
29. Flea
30. Hybrid
31. Wheat
32. Lycopene

## Down

1. Farmer
2. Invasive
3. Pesticides
5. Encapsulation
6. Oilseeds
8. Mustard
11. Drainage
13. Barley
15. B12
16. Entomology
18. Soil
19. Mowing
22. Sow
23. Canola
24. Dehulling
27. Irrigation

# 14 Cell Structure Scavenger Hunt

**Use your knowledge of cell structure to answer the following questions.**

1. This material within the nucleus contains hereditary or genetic information called genes: **chromosome**
2. These are a stack of flattened membrane-bound sacs involved in the storage, modification, and secretion of proteins and lipids: **Golgi apparatus**
3. This organelle is the site of aerobic respiration and ATP production: **mitochondrion**
4. These organelles are the sites of protein synthesis: **ribosomes**
5. These extend from the envelope of some viruses and help the virus attach to a living organism: **spikes**
6. This membrane-bound, fluid-filled space in plant and animal cells stores food, water, and waste material: **vacuole**
7. This cellulose layer surrounds the plasma membrane of plant cells: **cell wall**
8. This is a complex system of membrane-bound channels extending throughout the cytoplasm of cells: **smooth endoplasmic reticulum**
9. This layer encloses the genetic material of a virus: **protein coat**
10. This is a whip-like tail that helps some bacteria to move: **flagellum**
11. This membrane surrounds the cytoplasm: **cell membrane**
12. This layer surrounds the protein coat of some viruses: **envelope**

# 15 Tsunami Crossword

## Across

**1.** column

**3.** tsunami

**6.** crest

**7.** wavelength

**10.** evacuation

**13.** meteorite

**14.** wave

**16.** NFLD

**17.** period

**18.** landslide

**19.** shore

## Down

**2.** run-up

**4.** fire

**6.** trough

**8.** earthquake

**9.** resonance

**11.** Indian Ocean

**12.** amplitude

**16.** epicentre

**17.** plan

# 16 Going South for a Tan?

| Vacation Site | Latitude ( ° ) | Date of Overhead Sun |
|---|---|---|
| Montego Bay, Jamaica | 18.5°N | July 11 |
| Cancun, Mexico | 21.2°N | June 30 |
| Acapulco, Mexico | 16.9°N | July 17 |
| Rio de Janeiro, Brazil | 22.9°S | Dec 23 |
| Havana, Cuba | 23.1°N | June 22 |
| San Jose, Costa Rica | 9.9°N | Aug 14 |
| Ambergris Caye, Belize | 18°N | July 13 |

## Questions:

1. The sun is highest in the sky around noon at almost 90 degrees to the surface of the earth. At this time, UV radiation is at its highest level because the sun's rays have the least distance to travel through the atmosphere, allowing more of the UV rays to filter through. In the early morning and late afternoon, the sun's rays pass through more of the atmosphere at a sharper angle, filtering more of the UV radiation greatly reducing its intensity. Similarly, the UV rays are the strongest at the equator, where the sun is most directly overhead.
2. During summer months, the sun is higher in the sky than in winter, and the length of the day is longer, hence UV is more intense.

3. The sun will pass directly overhead at the equator twice a year. The first time this occurs is in March for the vernal equinox which signifies the start of Spring. The second time this happens is in September for the autumnal equinox which signifies the start of Fall. The following chart demonstrates the second date when the sun is overhead for places south of the Tropic of Cancer and north of the Tropic of Capricorn. i.e. June 21 (summer solstice)-July 11 (the first time the sun is overhead for Montego Bay, Jamaica) = 20 days; June 21-20 days = June 1st (the second time the sun is overhead for Montego Bay, Jamaica).

| Vacation Site | Latitude ( ° ) | 2nd Date of Overhead Sun |
|---|---|---|
| Montego Bay, Jamaica | 18.5 °N | 01-Jun |
| Cancun, Mexico | 21.2 °N | 12-Jun |
| Acapulco, Mexico | 16.9 °N | 26-May |
| Rio de Janeiro, Brazil | 22.9 °S | 19-Dec |
| Havana, Cuba | 23.1 °N | 19-Jun |
| San Jose, Costa Rica | 9.9 °N | 28-Apr |
| Ambergris Caye, Belize | 18 °N | 30-May |

4. The sun's rays are never directly overhead in Canada as the whole country lies north of the Tropic of Cancer (23.5 °N) limit.

# 17 Locate the Earthquake

## Group A: Eastern Canada

10 km SE of Val-des-Bois, Quebec. (65 km northeast of Ottawa.) June 23, 2010. Magnitude 5. Strongly felt in Ottawa. Widely felt in a 700-km radius from the epicentre in western Quebec. Felt as far away as Kentucky and Chicago. Triggered 2 landslides. Some minor structural damage.

## Group B: Western Canada

19 km ENE of Duncan, BC. (Vancouver Island) Februrary 15, 2011. Magnitude 2.9. Felt in Duncan, Salt Spring Island, Ladysmith, Cowichan Bay, Chemainus and Richmond, BC. There are no reports of damage, and none would be expected.

**What is the minimum number of stations that are necessary to find an epicentre?**

Three stations are a minimum. Accuracy increases with more stations.