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ACTIVITY BOOK 4

Canada

Welcome to a SPECIAL SPACE EDITION of the Science.gc.ca activity book!

Science.gc.ca is the official Government of Canada website for Science and Technology (S&T) information and resources. Videos, maps, games, and educational resources are just some of the neat things you can find on our website.

In December 2012, Canadian astronaut Chris Hadfield will be blasting off to space to live and work aboard the International Space Station (ISS) for six months. During this time, he will become the FIRST Canadian Commander of the ISS. Hadfield will also be working on science experiments, the Canadarm2 and other various tasks in robotics.

Also, this year...

It is the 50th anniversary of Alouette I, the first Canadian satellite to be sent to space! So in the spirit of these exciting, **OUT OF THIS WORLD** events, Science.gc.ca has created an activity book with special space-related activities in addition to the regular science activities. With your friends, class, camp group, or by yourself, you can build your own space suit and be just like Chris Hadfield, or learn about the effects microgravity has on the human body.

Science.gc.ca would like to thank our funding partners for their ongoing participation and support:

- Agriculture and Agri-Food Canada
- Canadian Space Agency
- Defence Research and Development Canada
- Environment Canada
- Fisheries and Oceans Canada
- Health Canada
- Industry Canada
- National Research Council Canada
- Natural Resources Canada
- Natural Sciences and Engineering Research Council of Canada
- Public Health Agency of Canada
- Statistics Canada
- Transport Canada

Reach for the stars!

Sincerely,

The Science.gc.ca Team

1 Elementary level activities

Best suited for ages 5 to 10

Table of contents

Elementary level

1 Grapefruit Facts of the Universe

Here is a neat collection of facts about our Solar System to help you put things into perspective. The Atlantic Space Sciences Foundation Inc. provided this list.

- If the Sun were a cookie jar, it would take 1,000,000 Earth-sized cookies to fill the jar;
- It would take a row of 110 Earths to make a line across the diameter of the Sun (1.396 million km);
- If Jupiter were a cookie jar, it would take 1,000 Earth-sized cookies to fill the jar;
- If the Earth were a 12-inch globe, the Moon would be a baseball 40 feet away. Saturn and it rings would just barely fit in between the two;
- If the Sun were a basketball, the Earth would be a split pea located 150 feet away from the basketball Sun. The Moon would be a grain of sand located 4 inches away from the split pea Earth
- The Great Red Spot on Jupiter is a huge storm system that could swallow up 2-3 Earths without even burping;
- The average sunspot (a magnetically cooled region of the Sun's surface) could also swallow Earth without a hiccough;
- If you could fly to the Sun in a 747 at a typical cruising speed of 900-1,000 km/hour, it would take 17 years to get there and another 17 years to get back.

"The night sky with its beautiful stars and its message
of our place in the universe is a precious treasure of all humanity,
on which we rely for our knowledge and understanding of our origins and destiny."

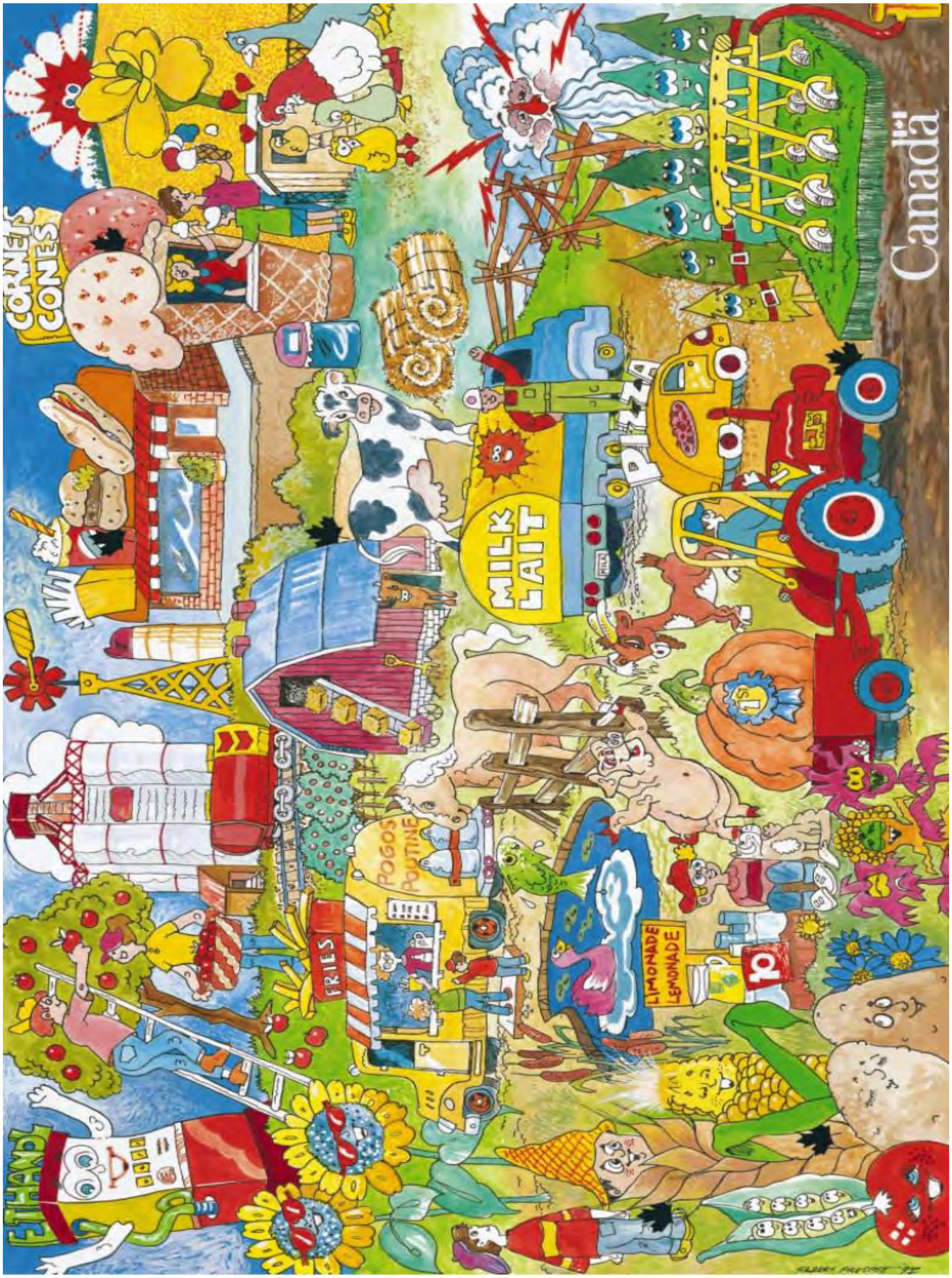
International Astronomical University on Space Research, 1992

2 Word Search

K	A	B	S	D	A	P	U	L	F	C	W	Z	D	I	Q	L	P	C
Q	T	E	Y	O	R	J	Y	B	I	C	H	A	R	T	L	A	Y	W
R	A	A	V	C	Q	C	L	A	S	Y	I	S	E	A	G	U	L	L
D	O	C	M	K	X	A	I	X	H	L	S	K	Z	B	A	P	A	A
Y	B	H	Q	A	N	V	F	N	I	V	T	L	P	U	Q	O	A	L
U	G	Q	I	K	B	A	E	S	N	W	L	M	T	A	B	W	C	R
W	N	C	E	P	S	I	J	E	G	W	E	B	I	X	M	E	P	E
P	I	T	P	T	S	Z	A	B	H	O	T	E	K	A	S	R	Q	L
X	H	D	X	A	A	M	C	I	U	P	E	W	D	I	E	B	P	L
A	S	B	K	O	P	Q	K	Y	T	S	K	C	I	L	A	O	A	E
N	I	A	O	B	M	O	E	K	Z	V	C	T	A	I	D	A	C	P
Q	F	W	F	L	O	A	T	E	R	S	U	I	T	B	O	T	X	O
S	A	Z	Q	I	C	Z	P	Z	V	P	B	A	S	A	O	U	A	R
G	A	S	C	A	N	Z	J	E	O	I	D	A	R	N	A	R	L	P
A	V	Z	N	S	A	C	P	Z	U	A	W	X	I	C	S	A	Z	T
K	R	B	Y	F	I	S	H	N	A	D	T	K	F	V	A	B	A	A
A	C	O	L	S	N	A	V	P	U	K	T	A	I	A	M	N	A	O
M	U	W	A	K	E	S	U	O	H	T	H	G	I	L	A	A	O	B
B	O	A	X	P	F	L	A	S	H	L	I	G	H	T	V	A	M	E

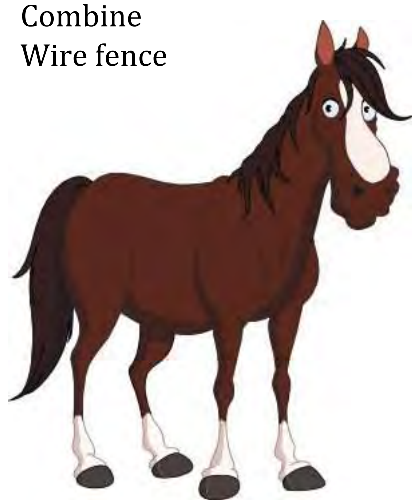
Life jacket	Buoy	Gas can
Floater suit	Fish	Dock
Pukta	Whistle	Fishing hut
Sail boat	First aid kit	Lighthouse
Power boat	Boat propeller	Canoe
Sea-doo	Radio	Beach
Fishing boat	Bucket	Blanket
Buoy	Flashlight	Rope
Sea gull	Compass	Oars
	Map	Chart

3 I Spy


CORNETS
CONES
MILK
LAIT
PIZZA
POGOS
POUTINE
FRIES
LIMONADE
LEMONADE
Canada

I spy...

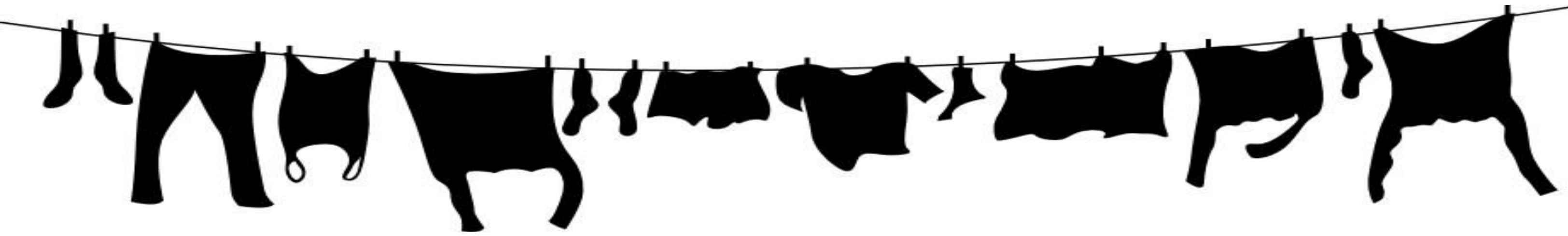
- Dairy cows
- Beef cattle
- Horses
- Sheep
- Goats
- Ducks
- Corn field
- Wheat field
- Canola field (yellow fields)
- Soybean fields
- Pasture
- Potato field
- Flax field
- _______ field (your choice)
- Weeds (purple loosestrife)
- Hay field
- Hay bales
- Vineyard
- Wetlands
- Apple orchard
- Peach orchard
- Vegetable plot
- Flower garden
- Fish pond
- Shelter belt (wind protection)
- Nursery
- Greenhouse
- Windmill
- Farmers' cooperative
- Tractor
- Combine
- Wire fence



- Wooden split –rail fence
- Barn
- Grain elevator/ bin Silo (crop storage)
- Corral
- Irrigation system (waters crops)
- Research station or lab
- Chip stand
- Hot dog/hamburger stand
- Composter
- Flower stand
- Fruit/ vegetable stand
- "Pick your own berries" sign
- Ice cream stand
- Lemonade stand
- Drink machine
- Recycle box or station
- Ice chest
- Grocery store
- Butcher shop
- Fresh produce store
- Farmers' market
- Food processing plant
- Bakery
- Convenience store
- Dairy
- Donut shop
- Produce truck
- Milk truck
- Refrigerated truck
- Canteen
- Grain railcar
- Family restaurant
- Billboard featuring food
- Billboard featuring vitamins
- Ethanol fuel station

4 Can you spell energy efficiency?

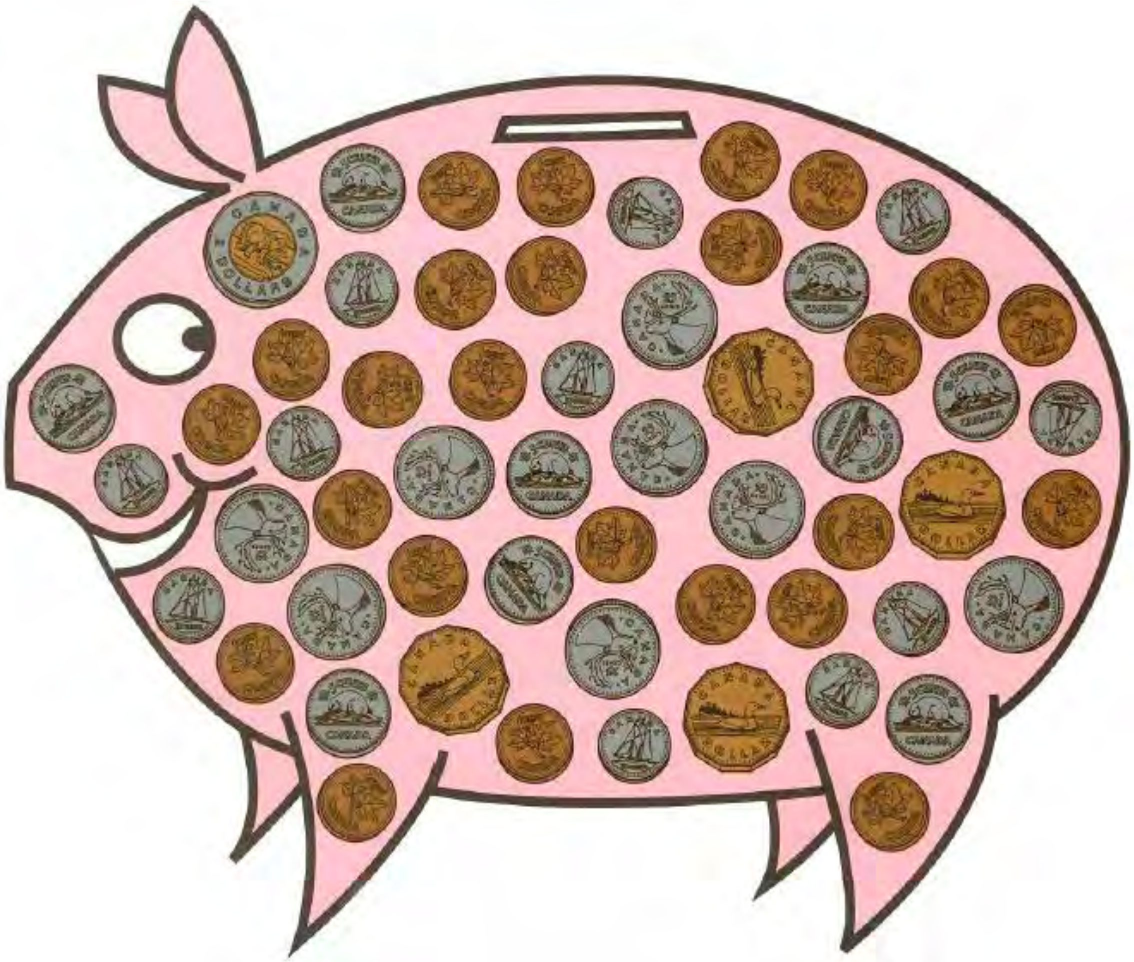
Read the text below and identify the spelling error in each sentence that relates to saving energy. Circle the words that are misspelled and then write them correctly in the space provided below.



1. Energy efficeincy means using less energy to get the results you want.
2. Put on a sweiter if you are cold instead of turning up the heat.
3. Use energy-saving compact floresent light bulbs at home.
4. Make use of soler energy by letting the Sun inside in winter and blocking it out in summer.
5. Take alternitive transportation to school - bus, bicycle, scooter, walk!
6. Play outdoors with a soccer ball rather than indoors on the computor.
7. Biofules are made from renewable plant sources like cereal crops or trees.
8. Use previosly owned stuff! It's good for the environment - and your piggy bank - to use and enjoy goods that are not brand new.
9. Recluse your use of energy by turning off lights when you leave the room.
10. Reuse and rescycle as much as you can.

5 Coins in the piggy bank

Let's count the money in the piggy bank! How many coins of each are there?



 Pennies ________

 Nickels ________

 Dimes ________

 Quarters ________

 Loonies ________

 Toonies ________

Total ________

6 Coinage Bingo

Roll both dice and add the two coin values that appear on the face of each die. If that sum is also on your bingo card, cross it off. The first player to have all of their squares completely crossed-off **wins!**

$1.25	$3.00	$0.10
$1.05	FREE	$2.10
$0.50	$0.26	$0.02

$2.00	$0.35	$2.25
$1.10	FREE	$0.30
$0.11	$4.00	$0.06

Note: You need to make your own dice for this game, see next page.

Cut out the dice on the dotted lines (- - -) and assemble them by folding on the solid lines (——).

Don't cut on the solid lines. Fold on them after you have cut on the dotted lines. Glue the shaded areas.

7 Litter can be deadly

Objective:

To investigate how harmful litter can be in a marine ecosystem and what we can do to prevent this harm.

Materials:

- litter collected from a marine ecosystem
- paper
- pencil
- material to make a litter collage
- glue

Activity:

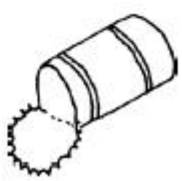
Collect litter on a rocky shore. Divide the litter into two piles, biodegradable and non-biodegradable. Make a litter collage of the non-biodegradable items. Discuss the negative effects of litter in a marine ecosystem and what we can do to prevent litter and the damage it causes.

Background:

Litter in a marine ecosystem can be deadly.

Imagine being a dolphin who has curiously stuck its nose into a plastic bag full of a half-eaten sandwich. While eating the sandwich you also eat the plastic bag. Or imagine being a turtle which innocently eats a plastic bag, thinking it's a jelly fish. Plastic is not a normal part of your diet. It can block your digestive system and remain in your stomach, giving you that 'full' feeling, so that you don't eat enough to survive. It can also cause excess buoyancy, preventing you from diving under water in search of food. The result - litter can be deadly.

Litter causes many problems for marine animals. They can get caught and entangled on wires and fishing line. They can swim into glass bottles and get stuck. They can get cut on the jagged edges of metal cans. Litter can be deadly.



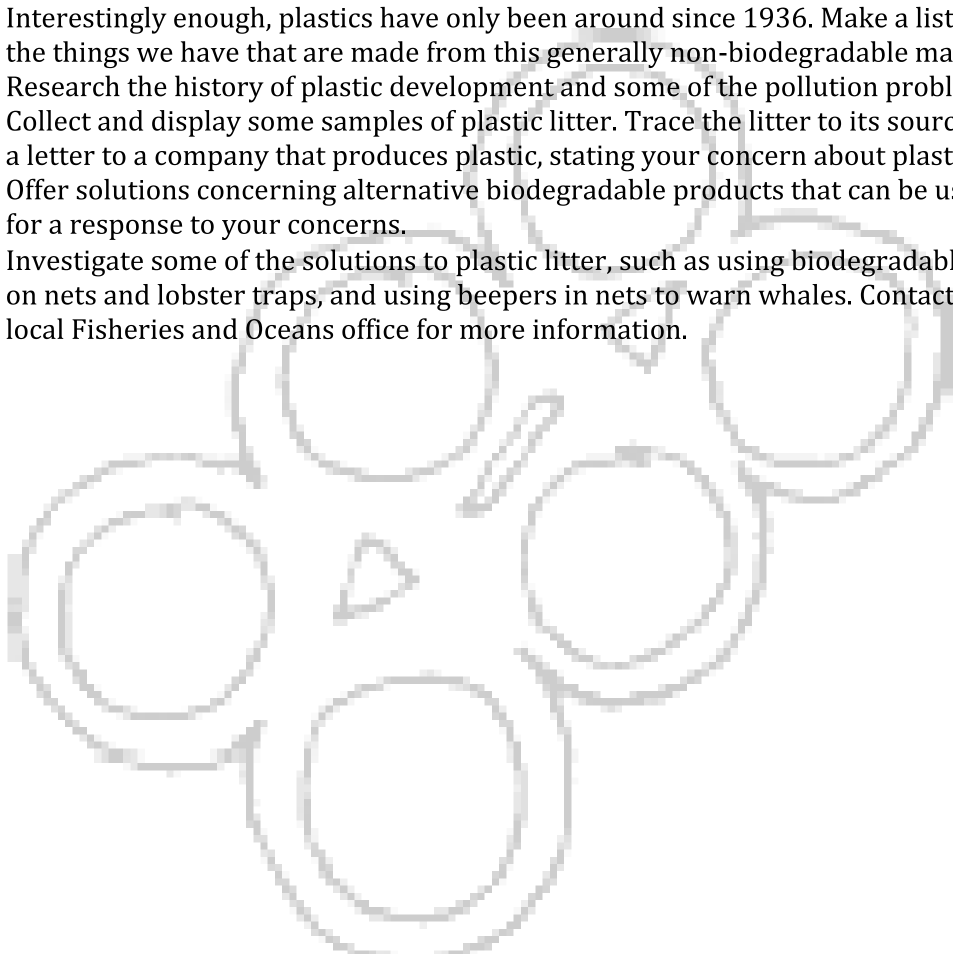
What can we do? We can start by recycling, reusing, and reducing waste. Considering alternatives to buying overly packaged goods. We can stop throwing our litter in the ocean or along the shore. And we can also inform others about the deadly effects of litter and how to prevent the damage it causes. Every little bit helps. We must all do our part to create a cleaner and safer marine environment.

Procedures:

1. Take a walk in a coastal ecosystem. Collect the litter that you find.
2. Divide the litter into two piles, biodegradable and non-biodegradable. What happens to non-biodegradable litter?
3. Of all the non-biodegradable products that you collected, are there any alternatives? Can these products be recycled, reduced, or reused? What other things would make a good substitute for these products? Think of ways to cut down on litter.
4. Make a litter collage of the things you found.
5. Create a list of ideas about how to prevent the creation of the litter that you found by reducing, recycling, and reusing.
6. Tell others the news that litter can be deadly in a marine ecosystem by sharing your litter collage and list of prevention ideas.

Extensions:

1. Interestingly enough, plastics have only been around since 1936. Make a list of all the things we have that are made from this generally non-biodegradable material. Research the history of plastic development and some of the pollution problems. Collect and display some samples of plastic litter. Trace the litter to its source. Write a letter to a company that produces plastic, stating your concern about plastic litter. Offer solutions concerning alternative biodegradable products that can be used. Ask for a response to your concerns.
2. Investigate some of the solutions to plastic litter, such as using biodegradable parts on nets and lobster traps, and using beepers in nets to warn whales. Contact your local Fisheries and Oceans office for more information.



8 Space Walk

What happens when you lose the use of one of your senses?

Materials:

- 2 copies of the Space Walk
- 4 different coloured pencils

What to Do:

- Choose a leader to give instructions to the group
- Read clearly and slowly and give your group members time to follow each step

1. Place your pencil on the large dot beside the astronaut.
2. Move up 6 spaces.
3. Turn right and move 5 spaces
4. Go up 3 spaces.
5. Turn left and move 4 spaces.
6. Go up 8 spaces.
7. Turn right and move 7 spaces.
8. Go down 5 spaces.
9. Turn right and move 3 spaces.

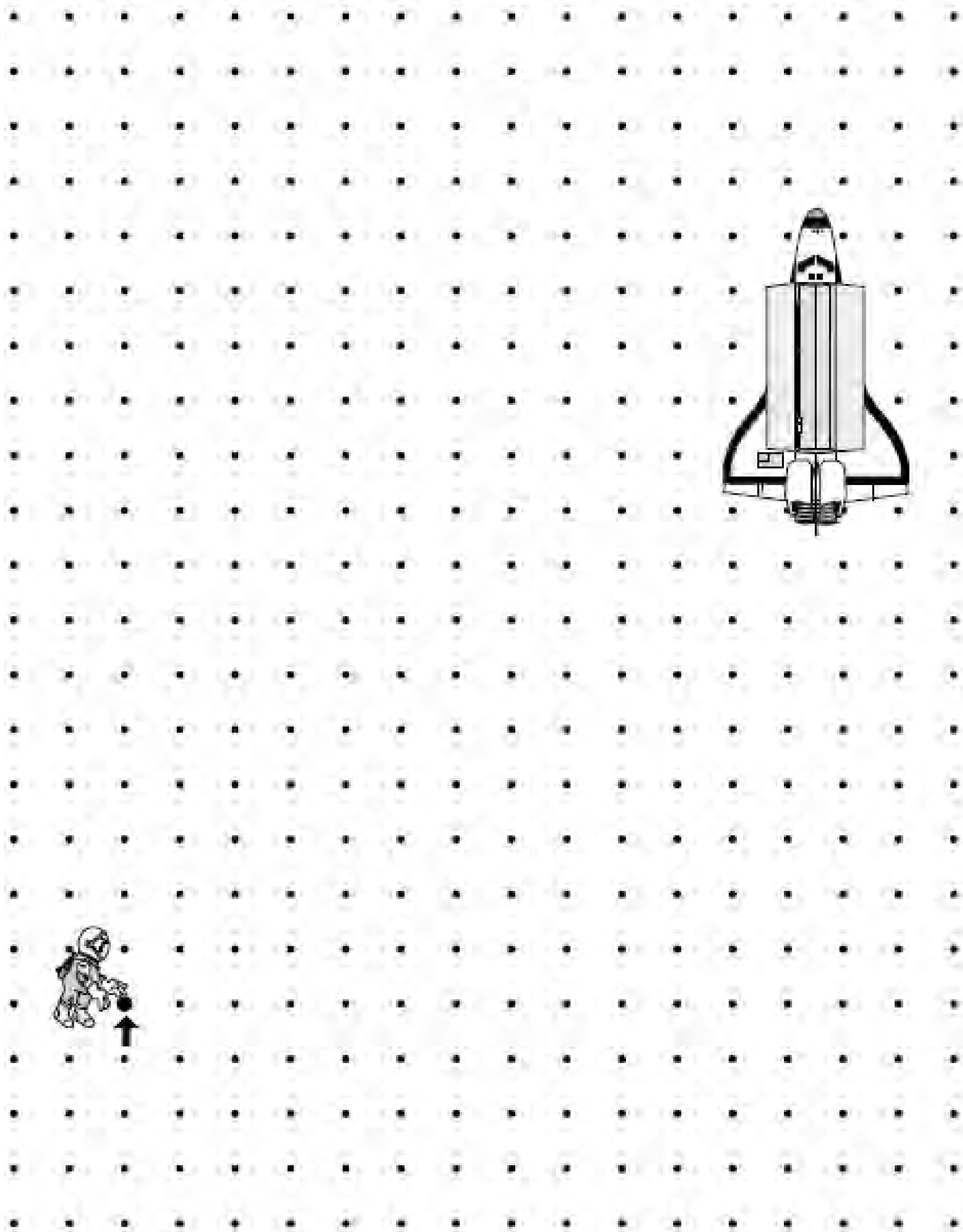
Mission Accomplished!

- Now have your team repeat this procedure with their eyes closed. They should use a different coloured pencil to mark their new path.
- Ask each team member to share how close he/she was to the target destination.

A hypothesis to test:

- If I try this four more times, would I be able to return to my starting point more accurately?

Using a different colored pencil each time, test the hypothesis. Was it correct? How did you adapt? Have each team member share his/her worksheet with the group.



9 Make a Model Comet

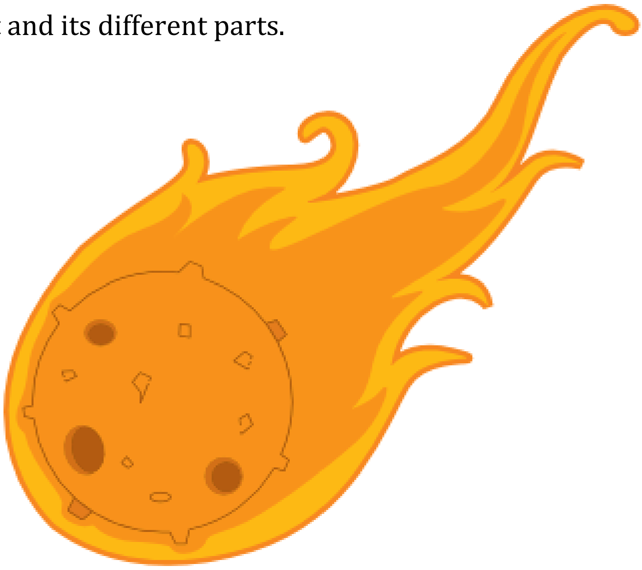
In this activity, you will make a model Comet Hale-Bopp to understand its immensity.

1 cm = 100,000 km

Remember that the main part of the comet, the nucleus, is still embedded inside the coma. The nucleus is not shown in our model because it is only 10 km or so across. This would make it smaller than the tiniest pinpoint!

Procedure:

1. Glue a cotton ball that is about 5 cm onto the middle of a sheet of paper. This represents the coma of the comet.
2. Cut 10-15 strips of crepe paper 4-5 metres long.
3. Tape the paper sheet with the coma on it at one end of a wall. Gather one end of all the crepe paper strips. Tape or glue them next to the coma so that they can easily be stretched along a wall.
4. Stretch the crepe paper along the wall and tape it so that the tail fans out slightly.
5. Add labels to identify the comet and its different parts.



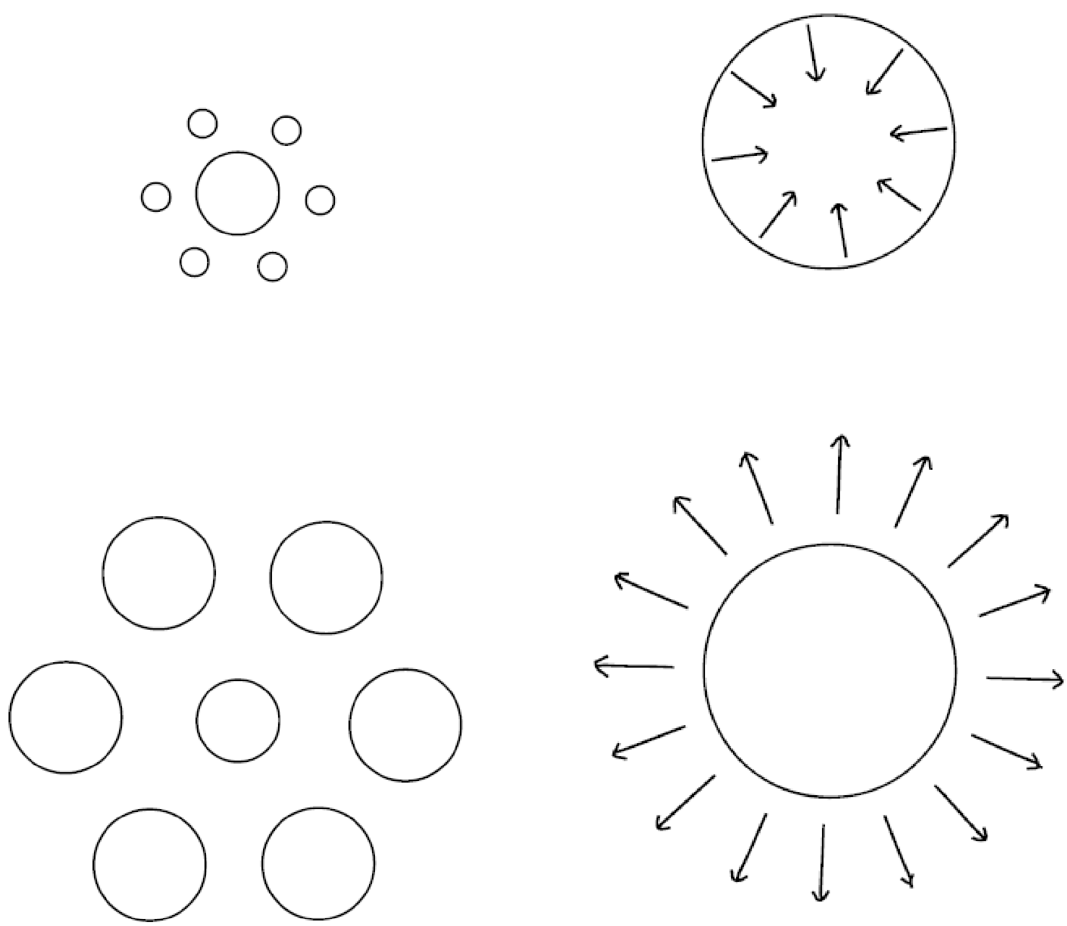
10 Seeing is not always believing

Usually, your eyes and your brain work together to tell you that what you are seeing is what is really there. But sometimes an object or shape you are used to looking at one way can appear totally different when its surroundings are changed. When this happens, your eyes see something that your brain tells you cannot be true. In other words, your eyes and your brain disagree about what is real!

Purpose:

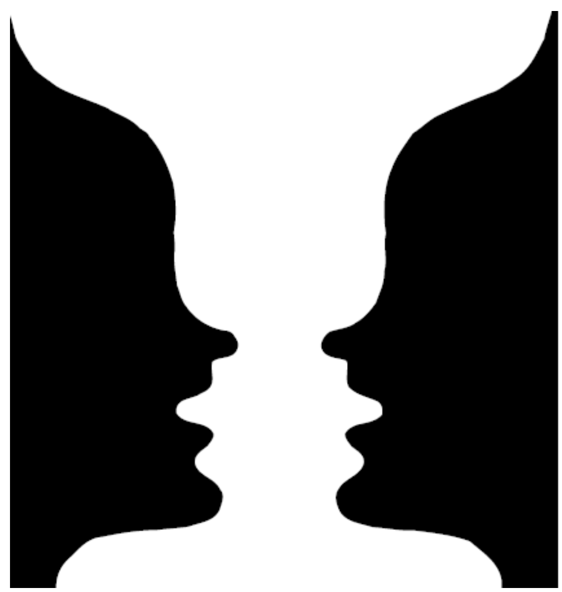
To demonstrate that your eyes can fool your brain - an optical. illusion.

Which inner circle is bigger?



Is this a beautiful young woman or an old woman?

What do you see?



We do not come across illusions as strong as these in daily life because there are usually many visual cues in our surroundings to help our brain interpret what it sees. The sample illusions are confusing because the images have been simplified - the brain does not receive the contextual cues that usually surround the objects, so it must guess as to what it "sees".

11 Build a spacesuit

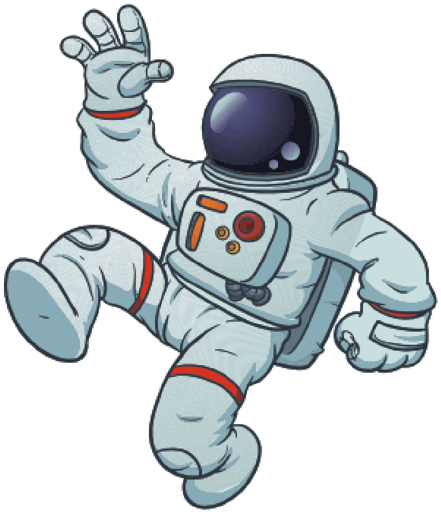
In this creative activity, your students will design and build their own, wearable space spacesuits.

Materials:

- A wearable paper suit from a paint store
- Photos of astronauts in their EVA suits
- Variety of duct tapes/hockey tapes (all colours)
- Dryer hose tubing
- Cereal or other flat boxes
- Odds and ends
- Glue/tape/scissors/felts

Procedures:

1. Obtain some kind of wearable "paper suit" from a local paint store or hardware store;
2. Obtain photos of astronauts wearing their Extra Vehicular Activity (EVA) Suits and note all the details;
3. Have students decorate their suits using various coloured tapes, dryer hose tubing, and other kinds of tubes and felts;
4. Using the cereal box, have students create a control box for their suit;
5. Add lots of pockets and tethers for your suit, so your space tools won't float away!
6. Through the Canadian Space Agency, you can obtain stickers of the various Canadian mission patches and logos for students to add to their spacesuits;
7. Divide students into "crews", and have them create their own mission patches to add to their suits;
8. Your spacesuits are now ready to wear; good luck on your mission!



12 Build a space helmet

In this creative activity, students will build an accompanying space helmet, to go with their Spacesuits.

Materials:

- A 16 inch balloon
- Paper maché
- Newspaper
- White paint
- White duct tape
- A knife
- A few pots

Procedures:

1. Have each student blow up one 16-inch balloon and tie it off;
2. The balloon needs to “sit” in something hard and stable in order for you to work on it. A bowl or pot works great for this.
3. Tear the newspaper into dozens of long, narrow strips.
4. Mix the papier maché and have it near you in another bowl.
5. Papier maché the entire balloon twice over. Let it stay in its bowl or pot to dry overnight.
6. Repeat step 2 to 5, and again, let the balloon dry overnight (the balloon has now been covered four times).
7. Using a sharp knife carefully cut out a generous hole at the bottom, big enough to be able to fit your head through comfortably. You may want to do this for your students.
8. Cut out an area for your face (called a visor) so you can see through. Put the cut-out piece aside;
9. Using white duct tape (easily obtainable at a hardware store) tape over all the edges to keep the papier maché from wearing away.
10. Paint the entire helmet white, and allow overnight drying.

NOTE: Allow at least 5 days for this activity.

13 My constellation

Now it's your turn to find a recognisable pattern of stars, and to create a myth around them. Look closely at the stars on this page. Can you form a picture of something or someone? Write the story behind your constellation in the area provided at the bottom of this page.

My constellation is called ____

Because ____

____

____

____

____

2 Intermediate level activities

Best suited for ages 11 to 15

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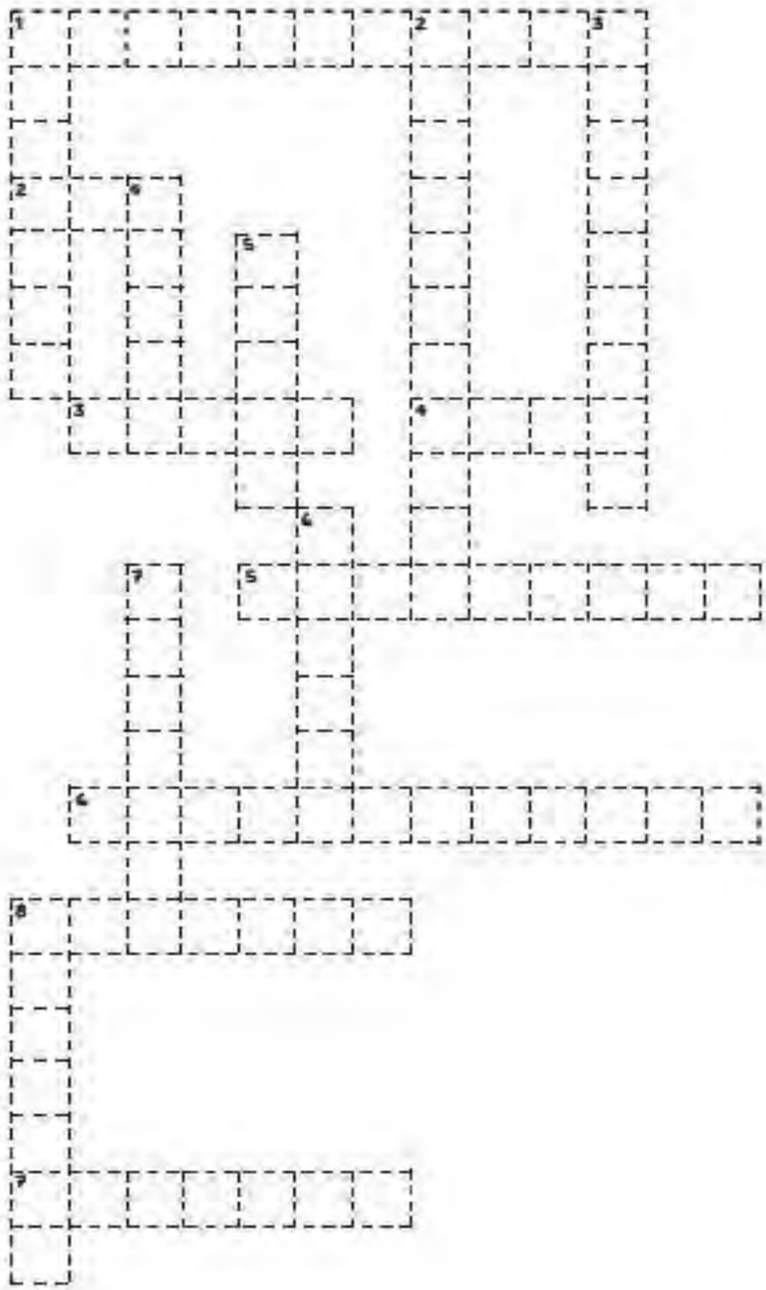
Intermediate level

1 All about energy crossword

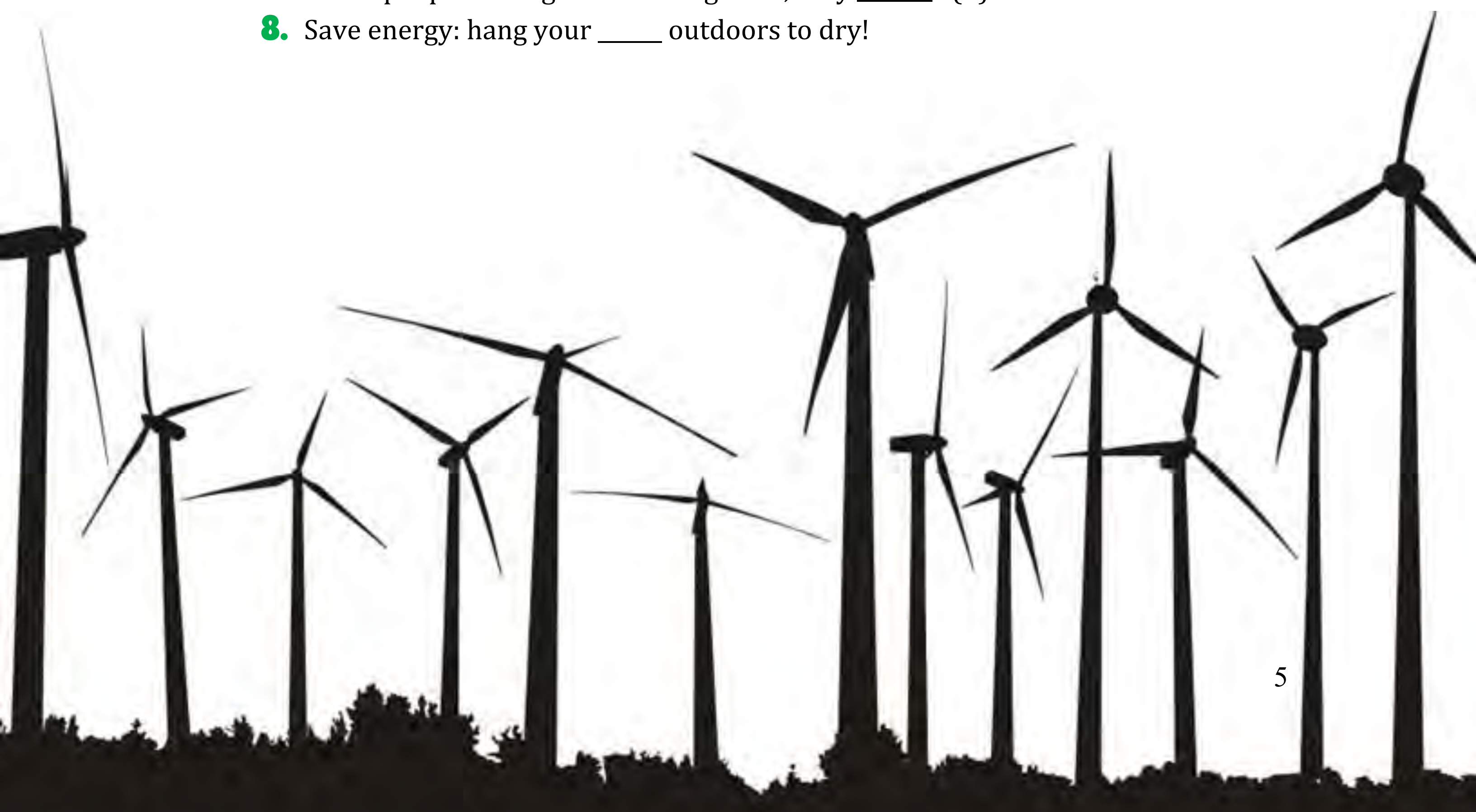


Across

1. This instrument measures temperature in degrees (11)
2. Take the (instead of a car) with your friends (3)
3. These familiar green giants absorb greenhouse gases. You can help by planting more. (5)
4. This fossil fuel is a black rock we burn to make electricity. (4)
5. By ______ instead of using the garbage, you help save energy and conserve our natural resources. (9)
6. It describes our efforts to use less energy. Think opposite of waste! (12)
7. This car fuel is made from plants. (7)
8. The temperature scale used in Canada. (7)

Down

1. A machine that turns flowing water or blowing wind into electricity. (7)
2. It powers the television, computer, refrigerator and much more! (11)
3. Name for energy sources that cannot be used up. (9)
4. Sunshine gives us this kind of energy. (5)
5. Colour associated with behaviours that protect the environment. (5)
6. Energy-saving motto: ______ , reuse, recycle! (6)
7. When people arrange to drive together, they ______ (7)
8. Save energy: hang your _____ outdoors to dry!



2 Crack the code

Use the decoder key to crack the code and reveal the mysteryanswer!

HOW CAN YOU HELP PROTECT YOURSELF AGAINST HARMFUL ENVIRONMENTAL NOISE?

WHAT HAPPENS IN A QUIETER ENVIRONMENT?

3 Health risk cruncher

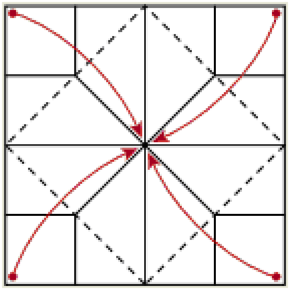
Look out for health-risks in your environment

Congratulations! Look out for health risks in your environment and you'll make your home and community a safe place for you and your friends.

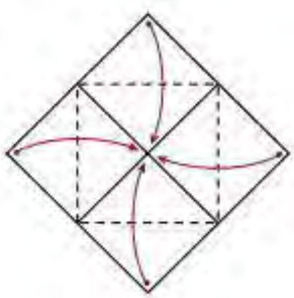
Instructions for folding a Cruncher:

1. Cut the Cruncher.

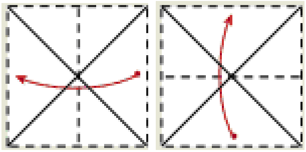
2. Illustrations facing down - Fold all four corners so they meet in the middle of the paper.



3. Flip over - Again fold all four corners together so they meet in the centre of the paper and leave them there.



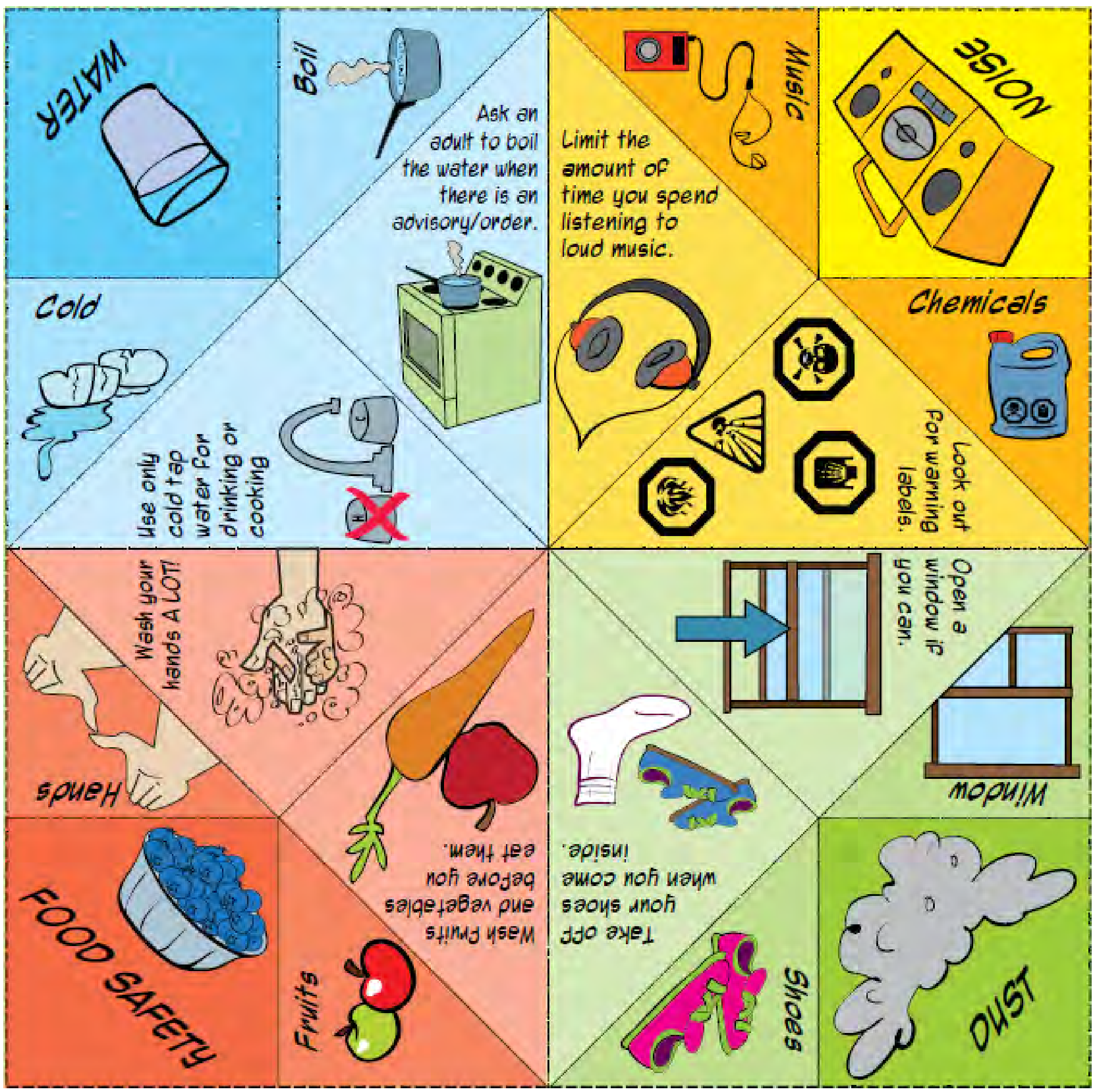
4. Fold in half in one direction, then in half in the other direction.



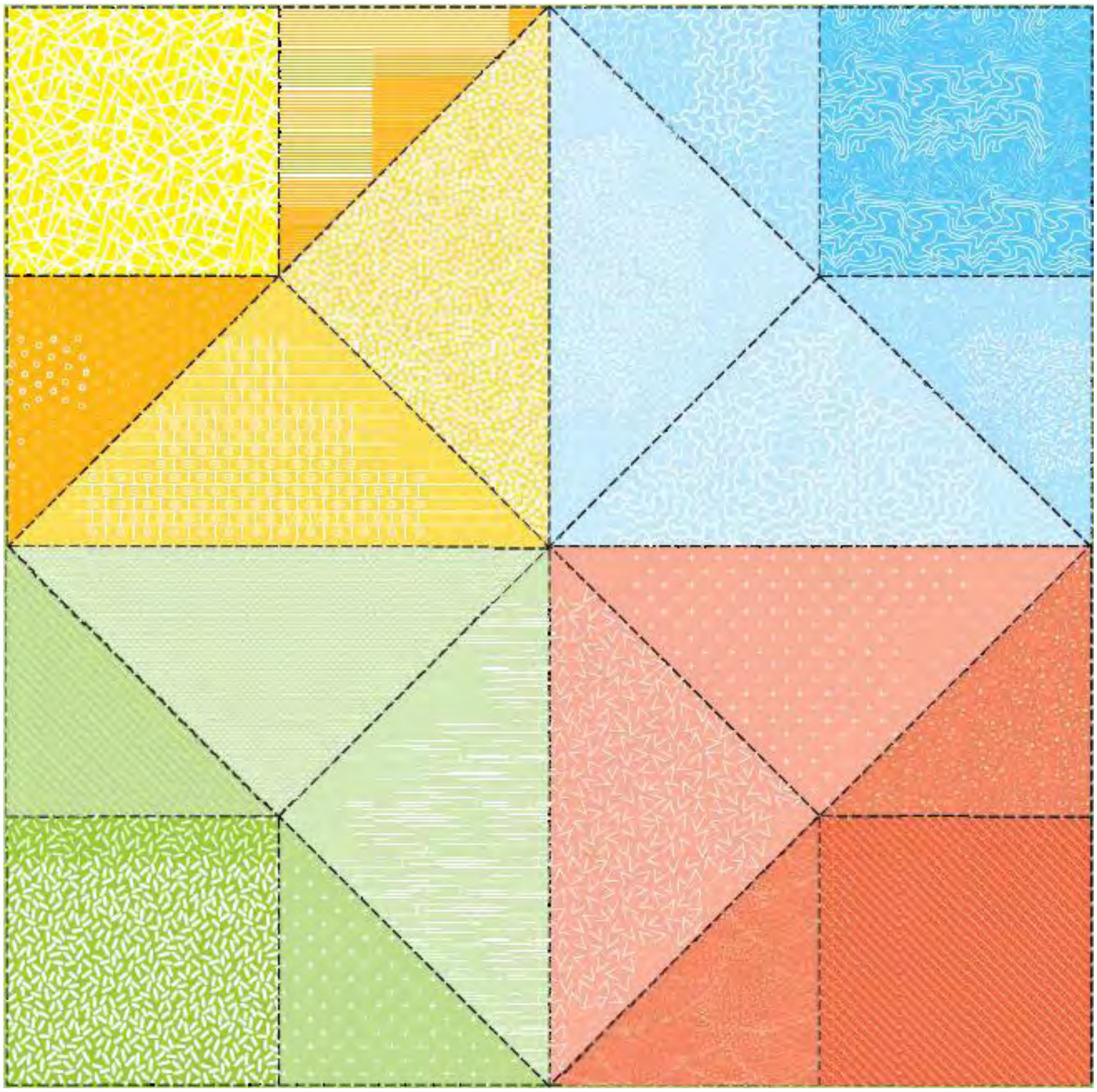
5. Finish - Stick your thumbs and first two fingers into the four pockets on the bottom of the cruncher and start crunching.

Play with a friend or on your own

1. Choose one of the top words
2. Spell out the word you open and close the cruncher
3. Then choose on of the words you can see
4. Spell out the word as you open your cruncher
5. Pick a word under the flap and read the Environmental Health tip
6. Go cruncher crazy and repeat the steps as many times as you want



4 Build your own cruncher



5 Building a thermometer

Materials:

- Glass jar (the smaller and narrower, the better)
- A small quantity of cooking oil
- Stopper or cork for the jar
- A sealant such as petroleum jelly, candle wax or modeling clay
- Several drops of food colouring
- Clear narrow drinking straw at least 15 centimetres long
- Eye dropper
- Water
- An index or recipe card about 8 cm by 13 cm (13 inches by 5 inches)
- Thermometer for reference

Method:

1. Fill the glass jar with water and add a few drops of food colouring to make the water visible.
2. Cut a hole in the stopper or cork, just large enough to slip the straw through.
3. Place the stopper in the jar and insert the straw through the hole.
4. Add more water but this time through the straw and until the water is about one quarter of the way up the straw.
5. Seal the straw into the stopper and the stopper onto the jar using either the petroleum jelly, modeling clay or candle wax.
6. Finally put a drop of the cooking oil into the straw so that the oil sits on top of the wafer. The oil prevents the wafer from evaporating.
7. Attach the index card to the straw. Allow the thermometer to settle for 2 or 3 hours.
8. Now use your reference thermometer to calibrate your home-made thermometer. To do this, note the level of water in the straw and mark a line on the card. Beside the line, record the temperature shown on your reference thermometer. Repeat this process over the next several days.

A final note:

The width of the straw and the amount of liquid in the jar will affect how quickly and accurately your thermometer will respond. With a narrow straw, a smaller volume of water is required to raise the level in the straw noticeably.

Points to discuss:

This thermometer is based on the principle that water, in fact most liquids, expand when heated and contract when cooled. Ask your students to predict where they think the hottest and coldest parts of room are located — then let them check out their predictions over the next 2 days using their thermometer. Remind them that this thermometer takes a long time to respond because the entire jar of water must adjust before it will register the new temperature. Ask your students if there are any drawbacks to using their home-made thermometer, and see if they can identify at least 3.

6 Conserving Grandma's catch

Objectives:

To show the role our coastal ecosystems play in providing productive fish habitat and the importance of not only protecting coastal areas, but also managing fish populations to ensure a continuous supply.

Materials:

- fish bowl
- two bags of 'goldfish' crackers

Background:

Our Atlantic coastal ecosystems are some of the most diversified and productive in the world. They provide essential habitat for a variety of fish species. Coastal ecosystems are necessary for their survival and must be protected. But protection is not the only thing we must consider if we want our grandchildren to be able to eat fish.

Fish are a renewable natural resource. Unlike coal and oil, renewable natural resources are always replenishing themselves. But if we are not careful and destroy the habitat and take too much, the fish will not survive. To make sure we always have a source of fish, we must carefully manage how many fish we take.

There are a variety of methods used to manage fisheries, such as setting regulations on how to fish, when to take the fish, and limits on how much to take.
Protecting coastal ecosystems and following fisheries regulations is practicing good conservation. Conservation means we use nature wisely without using it up, so that future generations can also benefit.

Procedures:

1. Discuss what fish need to survive: Good habitat in our coastal ecosystems where they find food, shelter, water, and space.
2. Tell the participants that in this activity they come from a community where fishing has been the major enterprise for the past 200 years. It supports the whole community. People not only work on the boats, but also in the cannery where the fish is processed. The local stores are kept busy by the customers who work in the fishing industry. The teachers and doctors are in the community to provide services to the employees of the fishery and their families. What would happen to the whole

community if the fishery was closed, due to a lack of fish? Inform the participants that each generation wants to make a living from fishing.

3. Assign each participant the following roles.
   First generation: grandma, grandpa
   Second generation: son #1, son #2, daughter #1, daughter #2
   Third generation: grandchild #1, grandchild #2, grandchild #3, grandchild #4, grandchild #5, grandchild #6, grandchild #7, grandchild #8.
4. Pour the contents of one bag of goldfish crackers into the bowl.
5. Let each grandparent fish from the bowl by scooping up a handful of fish. Let the grandparents decide if this is enough fish for them.
6. Let the second generation fish in the same manner as the grandparents.
7. Let the third generation fish in the same manner as the grandparents. (Chances are there will be no fish left.)
8. Ask the participants if there is anything about fish we have forgotten? Fish reproduce. Repeat steps 4 through 7, but add two handfuls of fish from the second bag of goldfish crackers for each generation. Repeat after the third generation. Do you still run out of goldfish? (Chances are there will be no fish left.)

Discussion:

Discuss with the participants who did not get enough fish? Why? How could the fish be conserved for future generations? Would you limit the number of people who could fish? Is there a way of changing the fishing method? (Try using only your thumb and forefinger.) Would you allow a shorter time to fish and would you set a limit for the number of fish caught? Discuss these questions with the participants and come up with a solution to solve the overfishing problem.

7 Interesting

You just opened a bank account!

1. Here are the transactions you completed this month:

- **a)** You deposited $100.
- **b)** You used your Interac card to buy a bouquet of flowers for your mother that cost $17
- **c)** You went to the movies last week. Since you didn't have any cash on you, you used your Interac card to pay for the ticket, which cost $7.50.
- **d)** You cashed a $20 cheque from your grandparents.
- **e)** You withdrew $20 from your account using an ATM at your bank.
- **f)** Three times you withdrew $20 from an ATM other than your bank's ATM. Therefore, each transaction cost you $1.50.

How much money is left in your bank account?

NET BALANCE ___________

2. From the list that follows, you buy all of the items that satisfy ONLY fundamental needs, and avoid buying those that are wants. If you started with $185, **how much would you have left?**

- a muffin and orange juice for breakfast: $3
- a tuque, or winter hat: $20
- the sport socks you've been wanting forever: $80
- a concert ticket to see your favourite singer or group: $20
- eye glasses: $90
- a hamburger and fries from the snack bar in your neighbourhood: $4
- school books: $36.99
- shoes: $21.75
- a cap with the logo of your favourite soccer team: $28.99
- a bag of potato chips: $1.99

I HAVE LEFT ___________

3. On your birthday, you deposit $20 into your bank account. Your financial advisor explains that the money you deposit earns interest every year. Interest is calculated on an amount either invested (like in a bank account) or borrowed.

For example, an investment of $10 in an account that earns annual interest of 5%, will give you $0.50 in interest after a year. If you invest $40 in an account that earns annual interest of 10%, you will receive $4 in interest after that same year.

a) Calculate how much interest your $20 deposit will earn in one year if the interest rate is 5%.

5% of $20 =

b) You have $30 in your pocket. If you add that money to the money you already have in the bank, how much money would you have at the end of the year if the interest rate went up to 10%?

$20 + $30 + 10% of $50 =

c) Two years have gone by since you first opened your bank account. The first year, you deposited $100 and the interest rate went up to 10%. The second year, you deposited $135, and the interest rate went down to 5%. How much money do you now have?

First year

$100 + 10% of $100 =

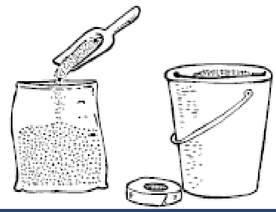
Second Year

First year + $135 + 5% of the previous amount =

8 Drawing circles

How to make a 2G simulator

- Fill a self-seal bag with 2-3 kg of damp sand
- Seal the bag removing as much air as possible
- Spread the sand equally throughout the bag



Materials:

- 3 blank papers
- 2 markers
- masking tape
- 2 g simulators

Procedures:

Conduct this experiment in 3 parts:

1. On the first paper, draw and trace a circle ten times with your eyes open and ten times with your eyes dosed.
2. Repeat part a) on the second paper with a 2 g Simulator taped to your forearm.
3. Remove the 2 g Simulator and immediately repeat the procedure on the third paper.

Findings:

Compare your drawings of the circles on your 3 papers.

- Compare your ability to retrace the circles in each of the drawings.
- Compare your ability to draw circles before using the 2 g Simulator and after you removed it.
- Were they the same?
- Why or why not?

Compare and discuss the results with other team members.

- Were each member's findings the same?
- What conclusions can you draw?

Discussion:

Together, discuss how you could relate this to what the astronauts experience. Do you think the shuttle astronauts would experience the same effects if they were asked to perform the tasks before, during and after their mission?

9 Influence of microgravity on balance and the sense of orientation

Objective:

To demonstrate the importance of the eyes in keeping your balance.

Materials:

- Plank (2” x 4” x 24”)
- Chronometer
- Blindfold

Method:

- Lay the plank flat on the ground. Have two students hold either end to keep it steady.
- Have a volunteer stand on the plank with the toe of one foot touching the heel of the other and arms crossed on his or her chest.
- Time how long he or she can balance on the 2x4 with eyes open.
- Repeat the experiment and time it again with the person blindfolded.
- Explain why the volunteer lost his or her balance more quickly the second time, when he or she no longer had any visual cues.

10 Luminous water

Astronauts are first and foremost scientists. Therefore, they perform several experiments while on mission, but also when they are on the ground. **Try the following experiment!**

Some obstacles, such as water and glass, cause light to deviate. This experiment is a good way to demonstrate what happens.

Making a Light Deviation Device

Materials:

- Scissors
- Clear plastic bottle
- Water
- Flat dish
- Small flashlight

Procedure:

1. Use the scissors to poke a small hole in the bottom third on the side of the bottle. With your finger on the hole, fill the bottle with water. Place the bottle on the dish and turn off the lights in the room.

2. Let the water trickle out of the hole onto the dish. Shine the beam of the flashlight around the bottle at level with the hole. If the beam is properly positioned, the water trickling from the bottle should become luminous. Even the water in the dish should emit light.

11 Sweet pee

Since water is a rare commodity in space, astronauts on the International Space Station will be recycling their water. This includes respiration, perspiration, shower and shaving water, and even urine. This wastewater will be purified and then recycled for drinking and other uses.

Biological treatments are used to purify water on Earth. The micro-organisms used in this process destroy contaminants in the water. The International Space Station will use physical and chemical processes to remove contaminants, along with filtration and temperature sterilisation to ensure the water is safe to drink.

Materials:

- Simulated Urine
  - yellow food colouring
  - clear carbonated soft drink
- Simulated Biological Active Agent
  - 8 raisins
- Simulated mixture of Citric and Carbonic Acid
  - clear carbonated soft drink
- stirring stick or spoon
- 500ml beaker or appropriate glass jar labelled "Sample Jar"
- Two 500 ml clear bottles with sealing top
- drinking glass (clear)
- knife
- coffee filter
- small plastic vial or closable plastic bag

Preparation:

1. Mix the following liquids in a 500 ml bottle, to simulate urine: approximately 100 ml of a clear or yellow soft drink (Example Ginger Ale, 7-Up) and 1-3 drops of yellow food colouring. Some experimentation with the correct size and number of drops may be required to give the correct appearance. Let this mixture go flat (can be accelerated by stirring).
2. Chop the raisins into very small pieces, and store in the plastic vial or bag. Label the vial with "Biologically Active Re-Processing Organism". On the label write an impressive looking number (e.g.AF-4366032-B2) and a recent past date. Place the top on the vial (a film canister works well as a plastic vial). This is the "biologically active agent".

3. Pour 450 ml of clear soft drink in the 500 ml clear bottle with a sealing top. Make sure to seal the top so that the carbonation is retained. Label this bottle "Citric and Carbonic Acid".

In Class Demonstration

Remember that this is a simulation, so that if the audience knows what the actual components the demonstration really are, the effect will be lost.

1. Prior to the presentation, place the plastic container with the "biologically active agent" and the Citric and Carbonic Acid Bottles on the desk or some other observable spot. Beside them place the empty 500 ml beaker (sample jar) and the stir stick or spoon. The container with the simulated urine should be hidden in a bag or left in a room away from the audience.
2. Just prior to the presentation, the presenter takes the sample jar and the unseen "urine" to a private room and pours the mixture from the bottle into the sample container. The empty "urine" container is then again hidden.
3. Introduce the need to conserve materials such as food and water when living in Earth orbit. Note that for short missions, all the water that is needed for the mission can be taken on the flight. Water can be transported from the Earth's surface to orbit, and all waste, including human waste, liquid and solid, can be brought back as needed. For extended missions, not all the water needed for "one time use" can be taken. Water will have to be recycled. This includes urine. At this point hold up the "urine" in the beaker and state that you will show them how this will be done. Be careful not to state what is in the beaker directly. Let the imagination of the audience carry the demonstration.
4. State that the process of "purifying" the water in the beaker to a drinkable state requires two distinct steps. The first is the dilution of "this" fluid in the "citric and carbonic acid" – this allows the second step to be more effective. Add the fluid in the citric and carbonic acid bottle to the mixture. If anyone is observant enough to comment that the fluid you are adding looks like 7-UP or Sprite, comment that a major portion of both 7-Up and Sprite are citric and carbonic acid and that they could be used.
5. Next, state that a biologically active agent that converts all the impurities in the "solution", except the colour, to harmless materials does the purification. It also removes any odour and any "bad taste". Open the biologically active agent container and dump the agent into the fluid. The combination of the agent to the fluid to be purified will result in active bubbling. You can make the statement that "things seem to be working". State that in normal water purification this process takes some time but that you can speed it up because of the small amount of solution and the large amount of reagent. State that stirring helps. Stir the container with the spoon.
6. State that the process will take about 30 minutes, and ask the students to remind you to stir the solution about every 5 minutes, to ensure that the appropriate reactions take place.
7. Over the next 30 minutes or so, stir the fluid and biological active agents. Comment that things seem to be progressing nicely.
8. When approximately 30 minutes are up, give the fluid one last stir to ensure that the fluid will be flat. State that you will now separate the fluid and the biologically active

agent by filtering it. Place the filter paper in the drinking glass and slowly pour the solution through the filter paper.

9. Once the filtering process is complete, you quickly make the statement that "this should be purified enough to drink" and quickly drink some.
10. State that on long haul missions in space, nothing can be wasted, so that even the biological agent needs to be recycled. Ask what the audience thinks they would do with it. Field some answers. Add "eat it" as one possible answer at the end, and quickly eat a portion of the agent.
11. Drink all of the purified drink and continue with the lesson or discussion.

13 Influence of microgravity on bone structure

Objective:

To demonstrate that a person grows taller in zero gravity

Materials:

- 3 large flexible sponges (to represent the spongy tissue)
- 4 large books (to represent vertebrae)
- 1 large rubber band
- 1 photo of the spine

Method:

- Stack the books and sponges alternately.
- Press down on the book and sponge assembly to compress it. Stretch the rubber band around the assembly to hold it in that position. The rubber band illustrates the force of gravity, which compresses the discs in the spinal column when the astronaut is on Earth.
- Have the students measure the height of the assembly.
- Remove the rubber band while keeping the stack upright.
- Have the students take another measurement. Explain to students that the difference in height results from the removal of the rubber band — or, in real life, the disappearance of the Earth's gravity once the astronaut is in space.

14 Build a Directly Controlled Robotic Camera

Robotically explore your neighbourhood from the sky!

Materials:

- 1 disposable camera
- 1 kitchen timer
- 1 Sheet of 2.5cm thick hard-foam insulating material (about 30cm x 30cm)
- elastic bands (lots)
- 2 swivel hooks or fishing-leaders
- 1 large sheet of cardboard or Bristol-board
- several large paper-clips
- tape
- pencil
- 1 doweling (about 70cm to 100cm long)
- 1 big kite and lots of string
- patience (lots)
- a windy day

Tools:

- a set of small screwdrivers
- coping saw
- set of drills
- small needle-nose pliers
- ruler

Here's How:

1. Remove the timer mechanism from its cover and open the packaging from the camera.
2. Place the camera and the timing mechanism on the foam sheet as shown.
3. Trace around the timer and the camera.
4. Mark out a rectangular outline of the payload shell.

5. Using the coping saw blade cut out the payload shell. The foam cuts so easily that you'll only need to hold the blade. The saw handle is entirely optional.

6. Using a drill bit make a hole in each corner of the camera slot and in the centre of the timer slot. Here again, the use of a drill is entirely optional. The foam drills so easily that the bits can be hand-held.

7. Using the saw blade cut out the slots for the camera and the timer. It is best to cut them so that the camera and the timer will fit a bit "snug" if possible.

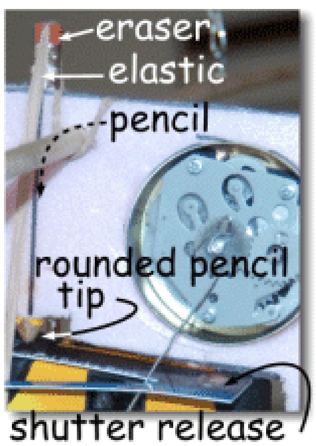
- What if the slots are a bit too big? No problem - small wedges of foam can be cut and fitted around the edges to snug things up.

8. Fit the camera and the timer into the payload shell. Cut out tiny bits or shim up the gaps as required.

- The camera fit does not have to be too tight. Elastic bands will be used to restrain the camera. The timer, however, should fit as tightly as possible.

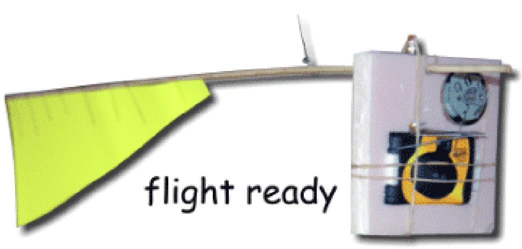
9. Using a large paperclip and pair of needle-nose pliers, create and fit the shutter lever.

10. Remove the camera from the payload shell. Drill a hole from the top of the payload shell down to where the camera's shutter button should be. Make the hole large enough to accommodate a pencil.
11. Cut the pencil so that it is about 1cm longer than is needed to reach the shutter button, and insert it (eraser end up) into the hole.
12. Install the camera.



13. Cut a small slot in the eraser end of the pencil (with the coping saw blade) to hold an elastic band.
14. Stretch an elastic band around the payload shell as shown. This will hold the pencil firmly down on the shutter button of the camera.
15. Install the shutter release plate and cut it to fit so that it is free to slide entirely out from under the pencil when the timer extracts it.

- **Hint**: Students participating in this project have discovered that the rounded graphite tip of a pencil has a very low coefficient of friction on a plastic surface (such as a credit card).



16. Attach the vertical stabilizer and locate the center of balance.
17. Install a small eye-screw at the balance point and attach the suspension string using a swivel or fishing leader.

This completes your robotic camera. It is now "flight-ready". Select a clear breezy day and send your robot exploring.

Extra notes on the "Build a Directly Controlled Robotic Camera" activity

Note to teachers

This design is extremely easy to build. It uses inexpensive and readily available materials.

This activity can be used as a focal point for much of the mechanics (kinematics and dynamics) in secondary school physics at both the introductory and advanced levels.

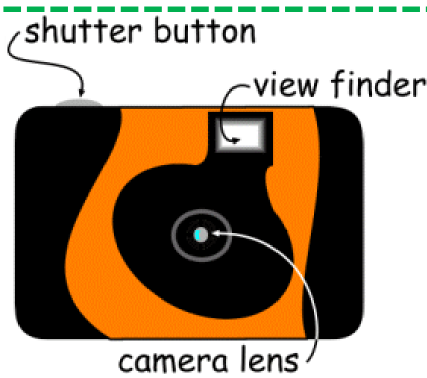
For teachers who wish to integrate this activity into a semester-long project in mechanics, relevant topics have been suggested with each stage of the construction process.

It is strongly recommended that students keep a construction journal. In their journal they should write detailed notes recording all their observations, results of any experiments, and any conclusion they may have drawn from building each component of their robot, as well as all other data related to their project.

The task of building a robotically controlled, remote sensing device, attached to a moving (and a sometimes unstable) platform shares a great deal in common with the design of similar devices for spaceflight applications. It will provide your class with plenty of opportunity for experimentation and design modifications. The primary objective of this activity is to build and operate a robotic camera, and in the process of building this device, explore the physics of its design.

The robotic camera platform is suspended from a home-made (or store-bought) kite. It is able to take aerial photographs at a time programmed into its "nanobrain" prior to launch.

The altitude and direction of the aerial photograph depends upon the length of the kite string and the orientation of the camera.



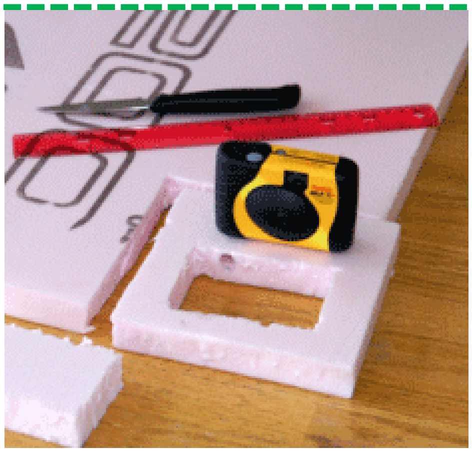
The heart of our robot device is a very small, lightweight disposable camera. (Actually our camera is called a recyclable camera since it is re-loaded with film at the factory and then re-sold to the next user).

There are several types of such cameras on the market. All of them work equally well for this project.

Try to avoid the slightly more expensive disposable cameras which have a built-in flash. The distance from the camera to the ground is too far to make the flash useful under low-light conditions. The flash only serves to make the camera heavier.

In any application that involves flight - whether it's kites, balloons, or spacecraft – mass is your biggest enemy! One of the great features of small disposable cameras is their truly remarkable low mass.

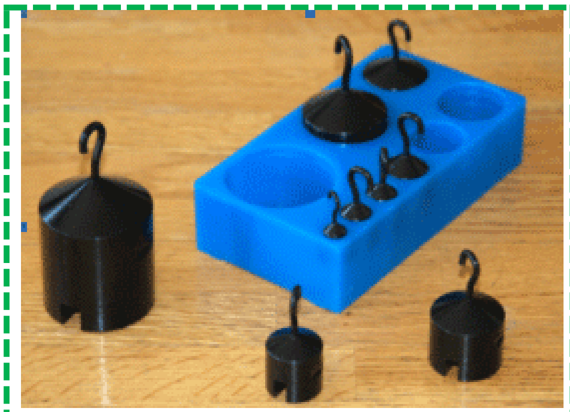
Our camera had a mass of only 67 grams.



To keep the total mass of our robotic camera as small as possible, and to simplify construction, the framework for our project uses 2.5cm thick foam insulation.

The foam insulation is pink (although other colours are available) and has a very hard smooth surface. The interior foam has a relatively small cell structure, which makes this product very strong and very light. Hard foam insulation is available in large sheets at low cost.

Do not use white styrofoam. White styrofoam has an interior cell structure that is too coarse (big) to give the material much strength. It breaks much too easily.



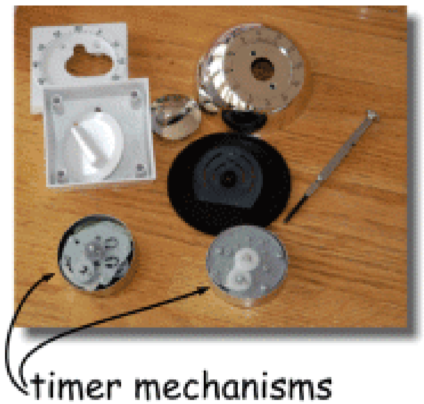
Information about the lifting capacity of your kite is worth knowing before you begin.

Using a set of standard masses you can test the lifting capacity of your kite. Experience has shown that kites lift payloads best when the payload is attached about 2 to 3 metres from the kite's attachment point to the kite string.

If your kite can lift a mass of 250 grams it will fly this robotic camera.

Kite designs vary greatly. While some designs have a lot of lift, others have better flying characteristics and greater stability.

Explore your kite's lifting capacity as a function of wind speed. Explore other kite designs.



Of course a robot wouldn't be a robot if it did not have some level of intelligence. Our robot is not very smart, it only "knows" that after a certain amount of time has elapsed that it is supposed to trip the shutter of the camera.

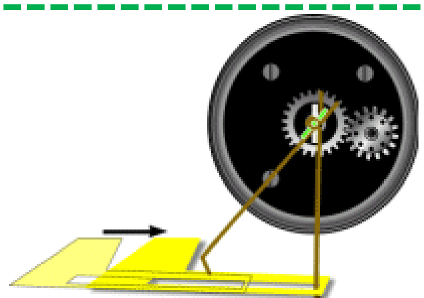
Our robot's brain (we'll call it a "nanobrain" since it's not very smart) is a small mechanical timer extracted from a cheap kitchen timer. It can be set for time delays up to 60 minutes.

A "smarter" robot could be equipped with an electronic timer or even contain a micro-computer with on-board sensing devices that would cue the robot to take pictures of specific objects or under certain conditions.

Our timers (two of them shown in the photo) cost exactly two dollars each (plus tax) from the kitchenware department of a discount store.

You will need to remove the fancy casing from the timer. Simply pull off the dial and remove the small screws from the back. The timer will simply fall out.

A set of small hobby screwdrivers is required because the screws that hold the timer in the case are quite small.



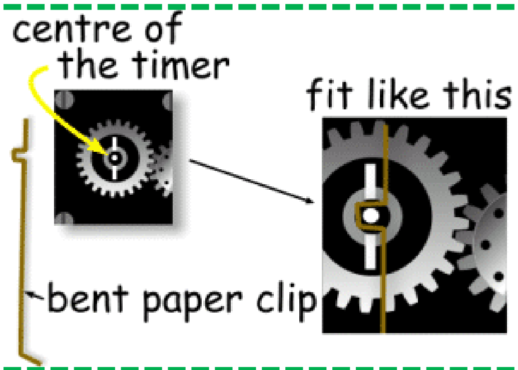
Once the timer has been extracted from its case it is ready to use.

The nanobrain (timer) needs to be set up so that it can release the camera's shutter at the appropriate time. This is accomplished by building a shutter-release mechanism as illustrated.

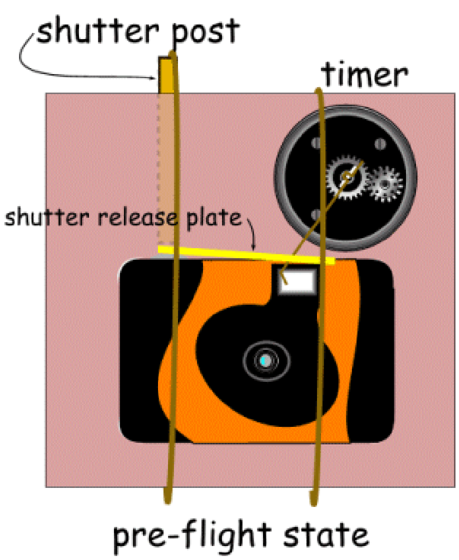
Details of how to install it are shown later, but the basic concept is illustrated here.

An old plastic credit card makes a very good shutter release plate. It is light, strong, and most importantly, it has a low coefficient of friction (it is very slippery).
It is useful to investigate the following topics that relate to this design:

1. Causes of friction;
2. Coefficients of static and kinetic friction;
3. Methods of reducing friction.



The centre of the timer looks similar to the diagram given here. A lever-arm can easily be attached using wire from a straightened paper clip. A pair of needle-nose pliers is helpful.



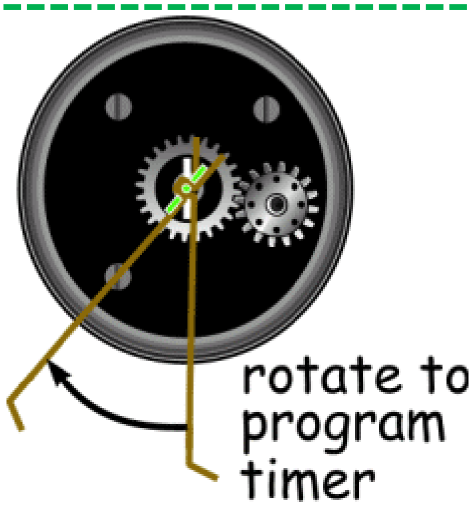
Setting up the mechanism to trip the shutter of the camera requires a bit of careful planning.

Examine the diagram carefully. Note the alignment of the various components.

Elastic bands are used extensively in this project. Have lots of them available.

The key idea is to use the shutter release plate to prevent the shutter post from pushing down on the shutter button of the camera. The diagram to the left illustrates this.

As the timer un-winds (in a counter-clockwise direction) the wire arm gradually extracts the shutter release plate from underneath the shutter post, which will then push down on the camera's shutter button.



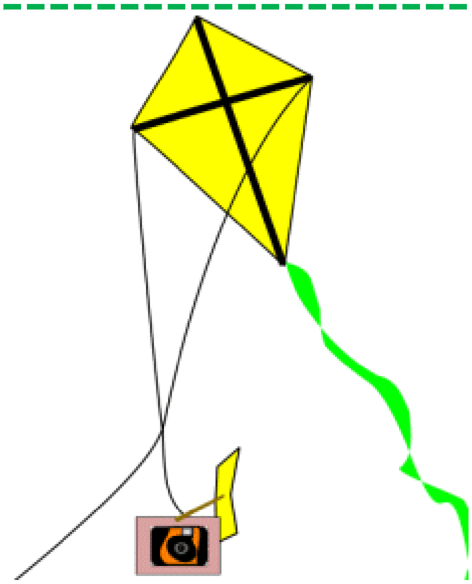
To set the timer delay, simply rotate the timer (centre). Use the original dial and then remove it once the timer is "set".

Test your design carefully to ensure that it functions as you predict. Make whatever adjustments are needed.

In understanding the function and operation of the timer, and how it extracts the shutter release, consider the following topics:

- Torque;
- Measuring torque;
- Increasing the force applied to the shutter release plate;

- Gears;
- Levers.



The flight payload is flown suspended from a kite.

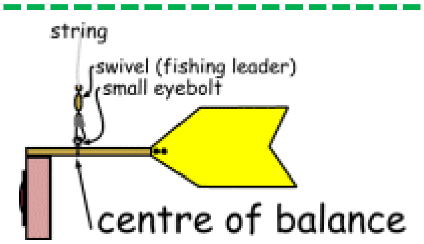
The payload package must be designed so that it is both aerodynamically stable and extremely light. (See below).

In order to minimize any interference with the flight characteristic of the kite, the payload should be flown at least two metres from the kite. Testing your kite with a simulated payload prior to an actual robotic flight is both helpful and instructive.

Swivel hooks (or fishing leaders) are required to prevent unwanted kinks and knots from forming in the kite and payload strings.

Most important

Remember: Never fly a kite where there is the slightest chance of it coming into contact with overhead wires or when there is any risk of lightning.



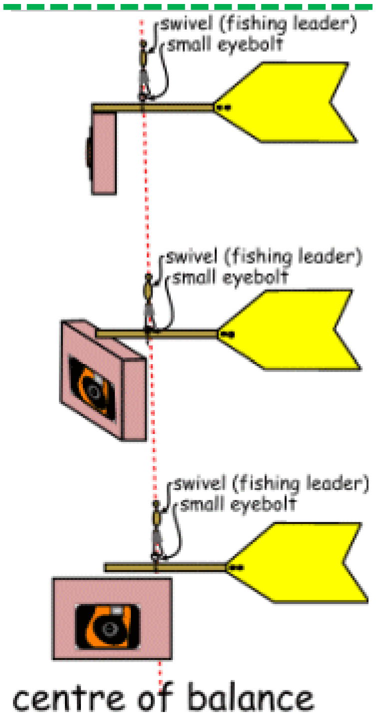
Aerodynamic Stability

The camera assembly is suspended on a long wooden (or plastic) dowel of about 1 metre in length (Not to scale in the diagram).

A large cardboard or Bristol-board fin (called a vertical stabilizer) is attached to the opposite end of the doweling so that it acts as a weather-vane, pointing the camera into to wind, as illustrated.

In order to minimize any interference with the flight characteristic of the kite, the payload should be flown at least two metres from the kite. Testing your kite with a simulated payload prior to an actual robotic flight is both helpful and instructive.

To fully appreciate the design, the following topics should be investigated:



- The moment of inertia for a long uniform solid rod;
- Centre of pressure (as related to air flow) over and around an airplane or fin;
- Centre of mass;
- The relationship between centre of mass and centre of pressure as related to aerodynamic stability.

The camera can be "aimed" to take photos in different directions relative to the direction of the wind.

Be careful about causing changes in the "centre of pressure" when the robotic camera is aligned to take photos at right angles to the wind direction. Be certain that the fin is big enough!

The centre of aerodynamic pressure (on the side of the payload) must always be behind the centre of balance.

If you fly your kite in extremely turbulent winds some additional stability can be produced by adding a horizontal stabilizer, but this will be at the expense of additional payload mass. Our payload did not require it.

3 Secondary level activities

Best suited for ages 16 +

Table of contents

Secondary level

1 Quiz on science and innovation in agriculture

Question 1

In the 1920s, a Canadian came up with a really COOL idea. What was it?

a) Ice cream
b) Refrigerator
c) Frozen foods

Question 2

Which of these products contain corn or corn by-products?

a) Ethanol and spark plugs
b) Toothpaste and shampoo
c) All of the above

Question 3

What do sheep and baseballs have in common?

a) It takes a herd of 140 sheep to eat or mow the grass before each baseball game
b) There is wool at the core of a baseball
c) The pitcher must wear a wool cardigan to keep his pitching arm warm

Question 4

How many times does the average cow burp in a day?

a) 2
b) 1,000
c) 123,000

Question 5

How many of the 10,000 products found in a supermarket come from corn?

a) 500
b) 2,500
c) 5,000

2 Tidal times

Objectives:

To study the daily movements of tides.

Materials:

- several coloured flags on poles
- watch
- graph paper
- pencil

Activities:

Measuring how fast the tide comes in and the height of the incoming tide during different hourly intervals of the day.

Background:

In most regions of Atlantic Canada there are two high and two low tides each day. Some places have only one tide.

These activities can be done as part of a field trip.

TIDAL RANGES -ATLANTIC COASTAL AREAS (in metres)

	LOW	HIGH
Nova Scotia		
Bay St. Lawrence	0.8	1.2
Margaree	0.7	1.1
Port Hood	0.9	1.3
Antigonish Harbour	1.0	1.6
Pictou	1.2	2.0
Cape Cliff	1.7	2.6
New Brunswick		
Cape Tormentine	1.3	2.0
Shediac Bay	0.8	1.6
Pt. Sapin	0.9	1.4
Portage Island	1.1	1.6

Lower Neguac	1.0	1.6
Shippagan	1.5	2.1
Bathurst	1.6	2.3
Dalhousie	2.0	3.0
Prince Edward Island		
Souris	1.1	1.7
Charlottetown	1.8	2.9
Borden	1.6	2.5
Summerside	1.5	2.2
Miminegash	0.8	1.2
Malpeque	0.8	1.1
North Lake	0.7	1.1

Spring Tide Figures for certain regions:

South shore of Nova Scotia	
Halifax Harbour	2.2
St. Margarets Bay	2.1
Shelburne	2.4
Cape Sable	3.3
Yarmouth	4.3
Bay of Fundy	
Brier Island	5.8
St. John	9.0
Cobequid Bay	15.3
Cumberland Basin	14.0

Procedures:

Obtain tidal charts from your local newspaper. Tide tables can also be purchased from your local Fisheries and Oceans office, bookstores, your provincial Geographic Information Centre, or the Canadian Hydrographic Service in Dartmouth, Nova Scotia.

Familiarize yourself with the charts. Try to pick a day for your trip when you arrive at a high tide or at least at ebb tide.

Experiment I

1. When you arrive on site, put a flag at the water's edge. Record the time.
2. Every hour, mark the position of the water with a flag of a different colour and record the time the flag was placed.
3. Measure the distance between each flag. At the end of the field trip you will be able to determine how fast the tide was moving at different times of the day.
4. When you get home you can graph the results.

Distance graph:

Experiment II

Check the tidal range chart above and mark a stick in intervals for measuring the height of the incoming tide.

1. Label these intervals on the stick clearly so they can be seen from far away.
2. Drive the stick down into a crevice in the rock or in the sand close to the water line.

Height graph:

3 Do you have big feet?

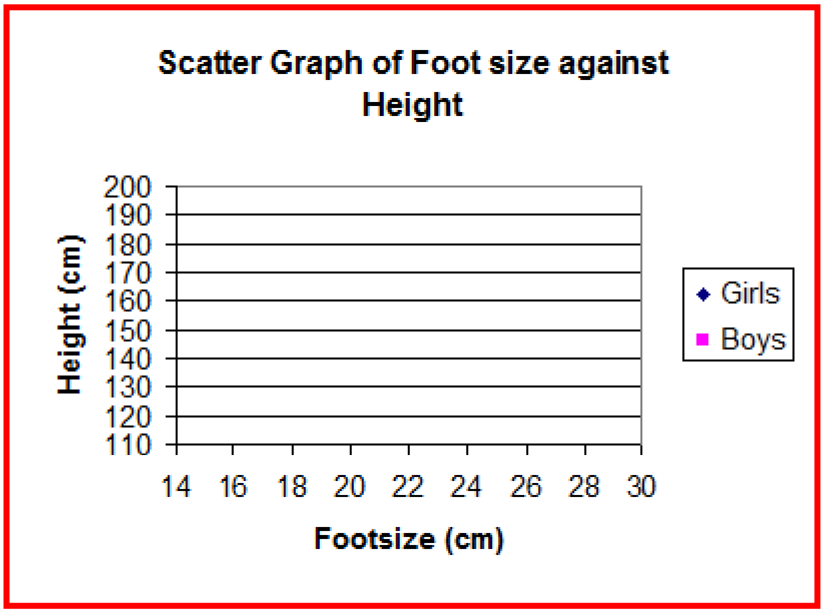
Let's ask this in a nicer way:

Does foot size increase with height and
do boys have bigger feet than girls?

Let's use some data from Census at School to find out. On page 2, there is a table using data on height, foot size and gender. These data were taken from 60 randomly selected student records in the UK database.

- Draw a scatter graph with the X axis representing foot length and the Y axis showing height. (X scale from 14 to 30 , Y scale from 110 to 190)
- Mark boys and girls with different symbols or in different colours on your graph.
- Don't forget to give a title to the graph and label the axes and add a key.

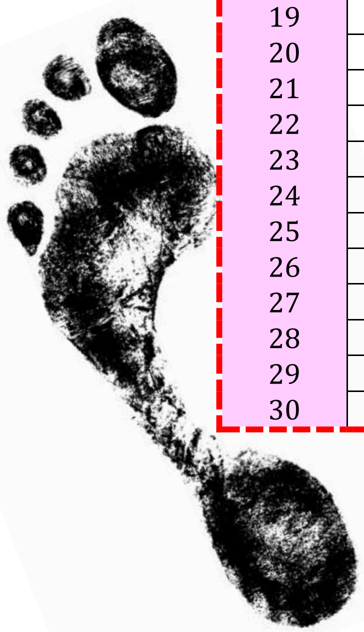
Example:



After admiring your handiwork try looking carefully at your graph and write a few conclusions.

- Can you identify any students who have particularly big or small feet for their height?
- Are there differences between boys and girls? What are they?
- Do the taller students have bigger feet?
- Is there positive, negative or no correlation?
- Can you draw in a line of best fit
- Think of some questions of your own to ask as well.

Pupil no.	Gender	Height (cm)	Foot (cm)	Pupil no.	Gender	Height (cm)	Foot (cm)
1	F	160	25	31	M	126	20
2	M	111	15	32	M	150	24
3	F	160	23	33	M	170	26
4	F	152	23.5	34	F	141	21
5	F	146	24	35	F	123	20
6	F	157	24	36	F	122	19
7	M	136	21	37	M	125	20
8	F	143	23	38	F	133	20
9	M	147	20	39	M	165	25
10	M	133	20	40	F	131	20
11	F	153	25	41	F	134	17
12	M	148	23	42	M	158	25
13	M	125	20	43	F	170	25
14	F	150	20	44	F	125	15
15	M	183	28	45	F	135	21
16	M	184	25	46	F	138	19
17	M	125	18	47	M	134	20.5
18	F	140	20	48	M	145	22
19	M	170	27.5	49	F	171	25
20	F	168	25.5	50	F	181	24
21	M	131	23	51	F	139	19.5
22	M	149	23	52	M	147	25
23	F	156	21	53	M	134	19
24	F	130	19.5	54	F	164	24
25	F	142	22	55	M	127	19.5
26	F	159	24	56	F	138	23
27	F	145	21.5	57	M	180	24
28	F	162	25	58	M	159	26
29	M	149	22	59	F	151	23.5
30	F	169	24.5	60	M	165	29



How does this data compare with your own class data?

4 Where does the time go?

At the end of the day, we often wonder where the time went. Time flies by quickly… especially when we're on vacation!

Examine the data on time use for various activities that were collected in the Census at School survey of 2006/2007 (question #17 of the Grade 9 to 12 questionnaire.)

Using Canadian results of the survey, retrieve a large ***random sample*** *of responses. First, go to www.censusatschool.ca and select* ***Data and results*** *from the left sidebar. Under the heading* ***International results and random data selector****, click on* ***random data selector****. At the bottom of the next screen, click on* ***Choose data,*** *select* ***Canada*** *and then* ***Phase Four Secondary (06/07)****.*

Work in teams to:

a) determine the activity on which Canadian students spend the most time in a week. How can you justify your answer and defend it to your 'fellow statisticians'?

b) determine which activity is the most popular, that is, the one the most students participate in. Is this the same activity as the one on which Canadian students spend the most time in a week, identified in a)?

c) determine the activity on which Canadian students spend the least amount of time in a week. How did you arrive at this answer? Can you justify it and convince your team-mates?

d) determine which activity is the least popular. Is this also the one on which Canadian students spend the least amount of time in a week?

Compare your conclusions with those of the other teams in your class. If you don't agree with their findings, explain why. Try to arrive at some common conclusions.

Is there still time to watch TV?

With everything else that takes up time during the week, how much is left to watch television? How would you go about evaluating how much time Canadian students spend, on average, in front of the television? What steps would you take to do this? Why?

Using your approach, on average, how much time a week would you say Canadian students spend watching TV? What percentage of total leisure time does this represent? Can you be sure? Explain your reasoning. Then, compare your analysis with that of the other teams.

How do working students spend their time?

People often say that students with jobs are so busy that they don't have the time to study or to help out around the house. Are these statements really justified?

Analyse the activities of the group of students who work seven hours or more a week by answering the following questions:

1) What percentage of the Canadian total does this group of students represent?

2) If you compare their use of time with that of the rest of the Canadian students, what activities have they apparently given up?

3) What proportion of students who work seven hours or more plan on continuing their education? Is this the same percentage as for those who work less than seven hours?

4) Do you notice a difference in the answers to questions 2) and 3) depending on the kind of work involved (paid or volunteer)?

5) Summarize your findings on the effects of working on students.

Whiz quiz: Can you answer these questions?

In a given week:

- How many hours did at least 50% of students spend with their friends?

  ______ hours or more.

- How many hours did fewer than 25% of students spend reading?

  At least _____ hours.

- How many hours did more than 75% of students spend doing their homework? Fewer than_____ hours.

- What proportion of the students spent more than three hours on housework? _____%.

Note: This activity uses a random sample of Canadian results from the 2006/2007 *Census at School* survey. The question on time use was not included in more recent questionnaires, so you cannot use your class data for this activity.

5 Math = games?

Are math lovers more likely to be fond of games?

Math lovers often say that solving a math problem is a lot like a game: you're faced with a challenge and you have to think up a strategy to deal with it . . . and it's as much fun looking for the answer as finding it!

To answer this question, we can analyze *Census at School* data pertaining to the time students spend playing video or computer games and board or card games. (See question #17 of the 2006/2007 Grade 9 to 12 questionnaire at www.censusatschool.ca under "Survey Questions")

We will compare the time spent during one week playing such games:

- by respondents who report that math is their favourite subject
- by those with another favourite subject

Procedure:

Using Canadian data from the 2006/2007 *Census at School* survey, draw up a large random sample of 200 students. Visit www.censusatschool.ca, click on Data and results and under "International results and random data selector", click on "random data selector". At the bottom of the next screen, click on "Choose data", select "Canada" and then "Phase Four Secondary (06/07)".

Then sort the dataset by age to select a sample of students of the same age. Split the sample into two groups: students who declare that math is their favourite subject and students who prefer another subject.

For each group:

- Begin by calculating the mean time spent playing games. (Include video or computer games and board or card games.)
- Then examine the distribution of time spent playing games by creating a histogram.
    - How do you decide on the size of the histogram's classes or groups?
    - What extra information about the mean time does the histogram provide?
- Determine the different quartiles.
- Calculate the standard deviation of time spent playing games.

What relationships can you establish:

- Between the histogram and the quartiles?
- Between the histogram and the standard deviation?

Further questions

- Do you observe a significant difference between the two groups? Can the differences between the groups (for mean time, quartiles, standard deviation and histogram) solely be attributed to randomness?
- Does the difference appear to be greater for one of the two game categories (video and computer games or board and card games)?

Can you conclude that:

- Those who like math play games more often?
- Those who like math may be more likely to play games than those who don't?
- Playing games can lead to liking math?

Explain your reasoning for each of these hypotheses.

Note: This activity uses a random sample of Canadian results from the 2006/2007 *Census at School* survey. The question on time use was not included in more recent questionnaires, so you cannot use your class data for this activity.

Definitions

Random sample: Probability (or random) sampling involves the selection of a sample from a population, based on the principle of randomization or chance. See also:
http://www.statcan.gc.ca/edu/power-pouvoir/ch13/prob/5214899-eng.htm

Mean time: Sum of all time values observed, divided by the number of observations.

Histogram: The histogram is used to summarize discrete or continuous data that are measured on an interval scale. A histogram divides the range of possible values in a data set into classes or groups. For each group, a rectangle is constructed with a base length equal to the range of values in that specific group, and a height proportional to the number of observations falling into that group. A histogram has an appearance similar to a vertical bar graph, but when the variables are continuous, there are no gaps between the bars. When the variables are discrete, however, gaps should be left between the bars. See also:
http://www.statcan.gc.ca/edu/power-pouvoir/ch9/histo/5214822-eng.htm

Quartiles: The median divides the data into two equal sets.

- The lower quartile (given the notation Q_1) is the value of the middle of the first set, where 25% of the values are smaller than Q_1 and 75% are larger.
- The upper quartile (given the notation Q_3) is the value of the middle of the second set, where 75% of the values are smaller than Q_3 and 25% are larger..

The median (given the notation $Q_{2)}$ is the second quartile.
See also: http://www.statcan.gc.ca/edu/power-pouvoir/ch12/5214890-eng.htm

Standard deviation: The variance (symbolized by $\mathbf{S^2}$) and standard deviation (the square root of the variance, symbolized by **S**) are the most commonly used measures of spread. The variance for a discrete variable made up of **n** observations is defined as:

$$s^2 = \frac{\Sigma (x - \overline{x})^2}{n}$$

The standard deviation for a discrete variable made up of **n** observations is the positive square root of the variance and is defined as:

$$s = \sqrt{\frac{\Sigma (x - \overline{x})^2}{n}}$$

See also: http://www.statcan.gc.ca/edu/power-pouvoir/ch12/5214891-eng.htm

6 Human reaction time

During a space flight, astronauts are required to be able to respond quickly to any given situation. Unexpected problems may arise that require a rapid response to the problem. The faster the reaction time of an astronaut and the crew, the better chance they will have in dealing with a given situation.

Purpose:

- To measure and record reaction time to a variety of activities
- To demonstrate the importance of physical fitness for space explorers

Materials and Equipment:

- Stopwatch or watch with second hand
- Pencil, paper, ruler

Method:

1. Work with a partner for the activity. Each person needs to make a recording sheet.
2. On a sheet of paper, draw a square 12 cm by 12 cm. Draw 12 boxes inside the square. Mark these boxes in the middle with the numbers from 1 - 12 but do not put them in order!
3. Get ready to start timing your partner. Don't let your partner see the sheet before you start the experiment.
4. Your partner places index finger on square marked #1 and touches each square in numerical order.
5. Record the time. Then do the activity again but this time, have your partner touch the squares in reverse order. Record the time again. Do this several times and see what happens to your time.
6. Reverse the roles and record the results.
7. Do the activity or 2 or 3 days in a row to see if your reaction time improves.
8. Make up your own activity and challenge your partner. Compare the results using non-standard symbols or the letters of the alphabet. Devise a different system which is faster than numbers.
9. Create a series of graphs and charts to show the improvements by class members over time.

Observations/Results:

Record your results in your Scientific Journal.

Scale:

10 seconds = slow
9 seconds = average
7 seconds = very good
5 seconds = excellent

Questions:

1. How do these activities relate to living and working in space?
2. Why would it be important to be quick and steady for space experiments?
3. What happens to your time after you have done the exercise several times? Why?

7 Gaining height

It is possible to record changes in our height due to the lack of gravity without ever leaving Earth! When we lie down to sleep, our spine does not have to support the weight of our body. This allows the soft tissue between and around our vertebrae to expand. This actually means that people are taller in the morning than in the evening! These changes can be seen more in people under 20 years old because the tissue around the spine is more flexible than in older people.

One of the effects of working in a microgravity environment is the fact that because there is no gravity pulling them down, astronauts tend to "grow" several centimetres while in space. This effect is lost when they return to Earth.

Purpose:

- To demonstrate the effect of gravity on your body

Materials and Equipment:

- tape measure
- pencil

Note: some parts to be completed at home

Method:

1. First thing in the morning (as soon as you get up!!), take your measurements: height, neck span, waist, around calf, around ankle, etc. Ask someone at home to help you with this.
2. Record the results in your Scientific Journal.
3. Take the same measurements at noon, at 18:00 hr and before going to bed and record the measurements.

Observations/Results:

- 7:00 hr measurements:
12:00 hr measurements:
18:00 hr measurements:
21:00 hr measurements
- Record your measurements and create a chart or graph to indicate the differences.
- Compare results with other class members.
- Record your conclusions in your Scientific Journal.

Questions:

1. What does this demonstrate?
2. What differences are there for people of different heights?
3. What kind of research could scientists conduct on the Space Station using this information?

8 Microgravity on earth

Everywhere in our universe, we feel the pull of gravity. When astronauts go into space, they experience "weightlessness" and everything falls freely at the same rate. People appear to have no weight because there is nothing in the way to stop their fall.
The zero-gravity that astronauts experience inside the Space Shuttle is not really zero-gravity at all. Zero-gravity implies that the gravitational pull in space is zero. This is not the case.

Astronauts "float" in space because they are in a state of free fall produced by their orbital motions around Earth. Astronauts and their spacecraft are falling together. This condition is sometimes called "weightlessness" because a bathroom scale inside the Shuttle would not record any weight for an astronaut standing on it. The scale would be falling as well. The more accurate term is microgravity, since astronauts and the spacecraft do make a small gravitational attraction for each other.

Purpose:

- To simulate "weightlessness" by performing a freefall demonstration

Materials and Equipment:

- Styrofoam cup
- pencil or other pointed object
- water
- bucket or other object to catch the water

Method:

1. Punch a small hole in the side of a Styrofoam cup near its bottom.
2. Hold your thumb over the hole as you fill the cup with water. Predict what will happen to the water if you remove your thumb.
3. Place the bucket on the floor under where you are working. Remove your thumb and let the water stream out from the cup into the bucket on the floor.
4. Again, put your thumb back over the hole and refill the cup with water.
5. This time, drop the filled cup into the bucket. Try and drop the cup from the highest possible point.

Repeat the experiment several times and compare results.

Observations/Results:

Record your observations in your Scientific Journal.

Questions:

1. How does this demonstration show microgravity for a brief moment?
2. Why is the water held inside the cup? What force is keeping it there?

9 Make your own solar array

Here on Earth, we use the energy from the Sun for many things. Spacecraft rely on the Sun's energy as a form of power for motors. Spacecraft that travel great distances away from the Sun can not make this form of energy its only source. The missions to Mars are able to use limited solar energy in the form of rechargeable batteries but they also need alternate energy sources.

The International Space Station will capitalize on the Sun's energy. This is evident by the size of the solar arrays. These panels will focus the rays of the Sun and harness the energy into a usable form.

Purpose:

- To construct a solar motor

Materials and Equipment:

- Three tin cans (large soup cans)
- Can opener
- Pencil and paper
- Masking tape
- Straight pins with heads
- Sheet of white paper or aluminum foil 15 cm square
- Scissors
- Wire
- Wooden blocks, bricks, or stacks of books

Method:

1. Remove both ends from the three large cans. Tape the cans together to form a column.
2. Position the tin can column on top of two supports (such as the bricks) in direct sunlight. Make sure there is a space between the ground and the tin can column (provided by the bricks.)
3. Tape a straight pin (head down) to one end of a piece of wire. Bend the wire and tape it to the top of the tin can in the column so that the pin points upward in the centre of the column.
4. Make a pinwheel. Cut a 15 cm sheet of paper or aluminum foil diagonally from each corner to within 1 centimetre of the centre. Bend every other point back to the centre of the square. Tape the points together at the centre.
5. Balance the pinwheel on the pin in the middle of the tin can column. Record your findings.

6. Draw a diagram of the solar motor and label all parts.

Observations/Results:

- Record your observations.
- Post your results in your Team Blog.

Questions:

1. What caused the pinwheel to turn?
2. How could you make it turn faster?
3. How could this information be used in the design of the habitat on Mars?

Other Activities:

- Experiment with other materials to find out how you can make the pinwheel turn faster. What happens if you change the colour on the inside or outside of the tin can column? If the outside is painted black, what happens to the temperature of the air? What happens if you raise the column higher off the ground? Experiment with different materials for the pinwheel.
- Research the types of materials being used for the solar arrays on the International Space Station and compare your findings. Consider using solar energy as one form of energy on Mars

10 Monitoring your heart rate

Astronauts need to be physically fit before they go into space. One way to measure this is how fast their heart rate returns to normal after exercise. Astronauts who are in very good physical condition will have a heart rate that returns to normal very quickly. That is important because if people get nervous or excited and their heart rate gets higher, they might not be able to perform some tasks properly. Astronauts train to get their heart rate lowered quickly.

Purpose:

- To monitor heart rate before, during and after exercise
- To demonstrate the importance of physical fitness for space explorers

Materials and Equipment:

- Stopwatch or watch with second hand
- Pencil and recording sheet

Method:

Work with a partner for the activities. Divide jobs into Timer and Performer. Make a record sheet for these activities. Create a chart to show the heart rate for your partner.

Timer

Resting Heart Rate:

1. Take your partner's resting heart rate. Use your index finger and middle finger to find the pulse on neck below the chin (easiest to locate) or inside of wrist.
2. Count the number of beats in 15 seconds and multiply by 4 to get heart rate for 1 minute.
3. Record resting heart rate.

Performer

Working Heart Rate:

1. Jog on the spot for 2 minutes
2. Quickly sit down while timer takes pulse again for 15 seconds
3. Record the working heart rate

Performer

Recovery Heart Rate:

1. Rest quietly for 1 minute in a sitting position.
2. Timer will take your pulse rate for 15 seconds, multiply by 4 to get recovery heart rate.
3. Record recovery heart rate.

Performer and Timer

1. Compare resting heart rate and recovery heart rate.
2. Switch roles and repeat activities.
3. Do this experiment several times over the program and see how it improves. Remember, the better physical condition you are in, the faster your heart rate will return to normal!! Chart your progress.

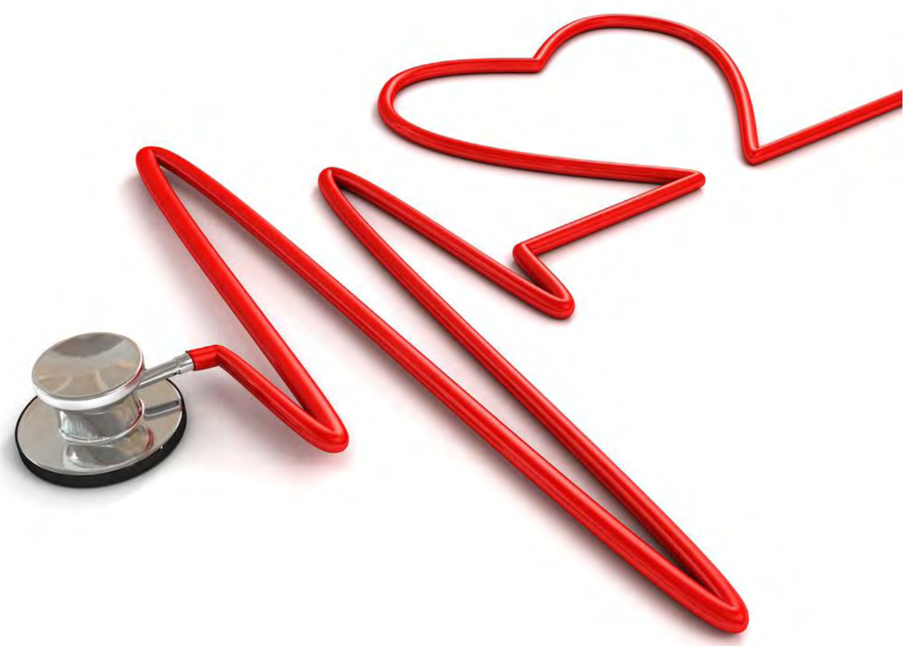
Observations/Results:

- Session # Date:

  Name
  Resting Heart Rate _ x 4 =
  Working Heart Rate _ x 4 =
  Recovery Heart Rate _ x 4 =
- Post your results in your Team Blog.

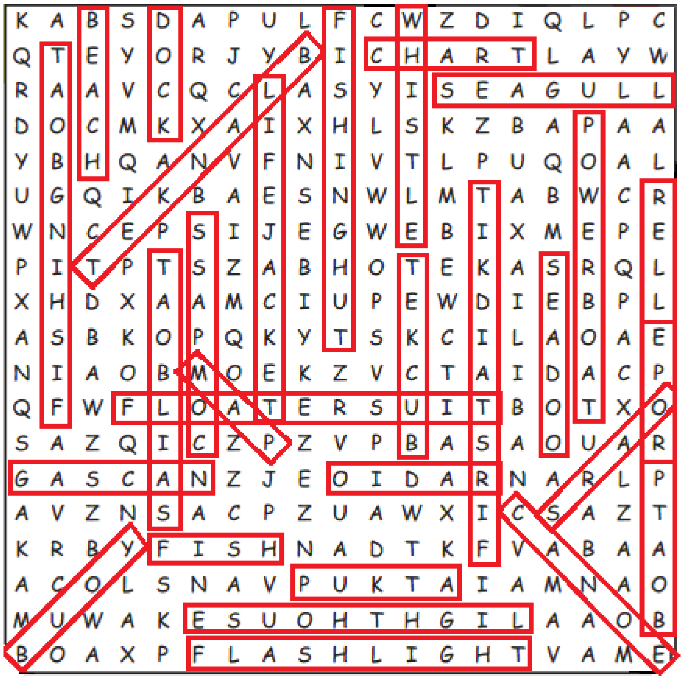
Questions:

1. Why is it important for space explorers to be in good physical condition?
2. How will you make sure that you get enough physical activity on the Space Station?
3. What difference does less gravity make on the physical condition of space explorers?



Activities answer key

Word Search



Can you spell Energy efficiency?

1. Efficiency
2. Sweater
3. Fluorescent
4. Solar
5. Alternative
6. Computer
7. Biofuels
8. Previously
9. Reduce
10. Recycle

Coins in the piggy bank

Pennies: 25
Nickels: 9
Dimes : 11
Quarters : 8
Loonies : 4
Toonies : 1

Total: $8.80

All about Energy

Across

1. Thermometer
2. Bus
3. Trees
4. Coal
5. Recycling
6. Conservation
7. Celsius
8. Ethanol

Down

1. Turbine
2. Electricity
3. Renewable
4. Solar
5. Green
6. Reduce
7. Carpool
8. Clothes

Crack the Code

Turn the volume down on your headphones or ear buds
It becomes healthier and relaxed

Interesting

1. $13.25
2. $13.26

3. a. $1.00
   b. $55
   c. First year : $110
      Second year: $257.25

Quiz on science and innovation in agriculture

1. *c) Frozen foods*

Frozen foods were an instant success when a Canadian decided to freeze fresh strawberries and raspberries and sell them at Christmas. Before frozen foods, fresh food would have to be purchased almost every day. Today, thanks to microwave ovens, the frozen food sector in Canada is a multi-million dollar industry.

2. *c) All of the above*

All these products contain corn or corn by-products. Scientists are always looking for new ways to use crops to help farmers diversify their activities and increase their profits.

3. *b) There is wool at the core of a baseball*

Baseballs have about 50 meters of wool in their core.

4. *b) 1,000*

About 1,000 times, more or less. Any cow that burps 123,000 times a day is probably going to explode. Methane is a big component of cow burps and is one of the greenhouse gasses that contribute to global warming. Scientists are testing different diets to reduce the methane emissions from animals.

5. *b) 2,500*

Corn is used in the production of about 2,500, or 25 per cent, of the products found in supermarkets. It is found in tacos and corn chips as well as in non-food items like glue, toothpaste, cosmetics, paper and diapers.