SCIENTISTS IN SCHOOL
SCIENTIFIQUES À L'ÉCOLE

Teacher Resource Package

Let us help you piece together the science!

Background Information an overview of the topic and theoretical concepts.

Hands-on Activities

Activity 1 - pen/paper activity
Activity 2 - short, easy-to-do activity (30-60min)
Activity 3 - short, easy-to-do activity (30-60min)
Activity 4 - longer activity (greater than 1 hr)
Activity 5 - complex activity

Teacher Resources

Literary Resources
Website Resources
Interactive White Board Resources
Multi-media

Student Resources

Literary Resources
Interactive Websites

Please help us improve our teacher resource packages!

If you have any feedback about this package or suggestions for new resources to include, please don't hesitate to contact us at: inquiries@scientistsinschool.ca.

Air and Flight

It's a bird, it's a plane…what is that in the air and, more importantly, how did it get there? For thousands of years, humans have looked into the sky and wondered how the objects they saw flying in the sky stayed aloft. Flight takes many forms, from seeds drifting in the wind, birds soaring on warm air thermals, to rockets blasting through the atmosphere. Nature perfected flight and, for thousands of years, humans tried to copy it but the feat proved to be quite elusive and became almost magical. The Greeks created Icarus, who flew on wings of wax. Russian and Arabian folk tales told of flying carpets. Eventually however, humans found that the mechanics of flight came down to the relationship between gravity, lift, thrust and drag, and not long after, humans were flying to the moon.

Background Information

Humans have dreamed about flying for thousands of years. In the mid-15th century, an anonymous manuscript was found that depicted a design for a parachute. Around 1485, Leonardo da Vinci sketched plans for an ornithopter, an aircraft that flies by flapping wings. However his design was heavy and no one was strong enough to actually flap the wings. Hot air balloons are classified as "lighter-than-air" aircrafts, and were first introduced to the world in 1783. Almost 70 years later, Henri Giffard, a French engineer, created the first powered aircraft: a steam engine powered airship or dirigible (balloon filled with hydrogen). Airships were the first aircraft to enable controlled, powered flight, and were widely used before the 1940s.

Ornithopter *(Source: www.aviastar.org)*

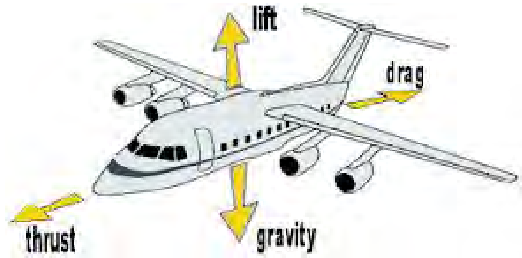
The first glider was invented in 1804 by English engineer, George Cayley. A few years later, American Samuel Langley invented the first steam powered model, but could not create a version that could be piloted by a human. Based on the work of these aviation pioneers, it was the Wright brothers, in 1903, who finally achieved powered, heavier-than-air, human flight. Their patented wing warping design allowed the pilot to control the plane. Since then, there have been many advances in flight, with the impetus of two world wars and the development of rockets and space exploration.

What is Flight?

Flight is the process by which an object moves through the atmosphere or beyond it, using lift, thrust, buoyancy or ballistics and with no direct support from a surface. There are many different forms of flight and all can be found in nature. The simplest form of flight is parachuting, which is when a fall is controlled using a large surface area to create drag. This is how dandelion or milkweed seeds are spread. A slightly more advanced form of flight is gliding. Gliding differs from parachuting in that descent is at an angle, takes advantage of an airfoil design (e.g. wings) to create lift and generally uses streamlining to reduce drag. Think of a hang-glider or imagine a flying squirrel. Many bird species use gliding, during flight, to save energy. Soaring is similar to gliding but is generally seen only in large birds and requires specific atmospheric conditions. It occurs when birds use rising air to carry them to higher altitudes and is useful because it conserves energy. The most sophisticated form of flight in nature is powered flight. This is when wings are flapped for power and move up and down to create lift so that the animal can ascend. Human powered flight could not have been achieved without an understanding of flight as it exists in nature.

How Flight Works

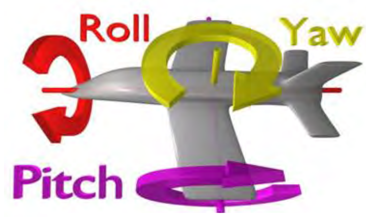
The four forces that are involved in flight are gravity, lift, thrust and drag. Gravity is a force that attracts bodies toward each other and which manifests itself as weight. It acts downward toward the centre of the Earth, and plays a large role in preventing things from getting off the ground. Lift is a force that pushes upward on the flying object – opposite to weight. For flight to occur, the force associated with lift must be greater than weight. Drag is also referred to as aerodynamic resistance and acts to slow down the flying object. It works in the opposite direction to the direction of flight. Thrust is the force that creates forward motion. It must overcome drag or there will be no forward flight movement.



Source: www.inventors.about.com

Lighter-than-air flight can be powered or unpowered. Lift in these types of aircraft is created using a gas that is less dense than the surrounding air. In a hot air balloon, the air inside the balloon is heated. As warm air rises, it pushes up against the inside of the balloon causing it to rise; the colder the surrounding air, the more the lift. This is why you tend to see hot air balloons in the sky in the morning when the air is still cool. Alternatives to warm air include hydrogen and helium gases that are less dense than air. Dirigibles, like Blimps and Zeppelins, rise because they use helium gas for lift. Hydrogen was originally used to fly airships; however, it is extremely flammable and is no longer used. The Hindenburg, a famous dirigible, was flown using hydrogen gas and it has been suggested that it was the ignition of this gas that caused the famous explosion. This 1937 disaster was the end of this type of passenger air travel.

A glider is an example of heavier-than-air flight that is not powered. Large gliders must be towed by an airplane to a high altitude before they can fly. Hang-gliders can be launched off the side of a cliff. The lift for flight is influenced by the shape of the wing. Some gliders can be manoeuvred like a conventional plane using ailerons, elevators and a rudder. Ailerons are flight control surfaces attached to the trailing edge of each wing whereas elevators are flight control surfaces attached to the rear of an aircraft. It is also necessary for the glider pilot to find warm air thermals and ridge lifts, where wind has hit an obstacle and it has been deflected upward, to help maintain altitude in the air. Powered heavier-than-air flight encompasses all airplanes, helicopters and rockets. Airplanes get their thrust from either a jet engine or a propeller. Lift is created by the shape of the wing.



Source: www.wikipedia.org

Flight occurs in three dimensions, so it must also be controlled in three dimensions. Pitch is determined by whether the plane is parallel to the ground or not. Yaw is the direction perpendicular to the wings (left or right, if driving). Roll is the side to side movement, usually noticed when one wing dips toward the ground as the other one rises. A pilot has special levers and buttons in the cockpit to control the pitch, yaw and roll of the plane and these controls ultimately determine how the plane will fly.

Helicopters use engines to power two rotors. The main rotor provides thrust and lift, while the tail rotor prevents the helicopter from rotating around the centre of the main rotor assembly. Both the pitch of the main rotor assembly and that of the individual rotor blades can be adjusted to control the helicopter.

Rockets are a little different than other aircraft. Thrust is created by the forceful ejection of burning fuel that powers the rocket forward. In most other aircraft, lift works in the direction opposite to weight and perpendicular to thrust to raise the object off the ground; in rockets, thrust and weight work in opposition to each other. In this case, wing-like fins near the bottom of the rocket are used to stabilize and steer the rocket.

Activity 1: A Wing for Every Purpose & How Does It Fly?

Time: 30 minutes

Other Applications: Biology

Key Terms: thrust, drag, lift, gravity

Group size: Individual

Materials (per student):

☐ “Flight Descriptions” information sheet

☐ “A Wing for Every Purpose” worksheet

☐ “How Does It Fly?” worksheet

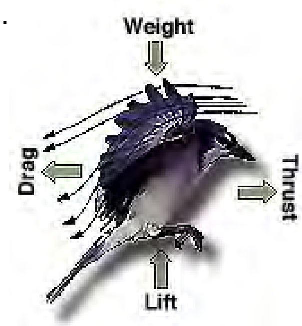
☐ pencil

Learning Goal: The students will learn about wing shapes and how things fly.

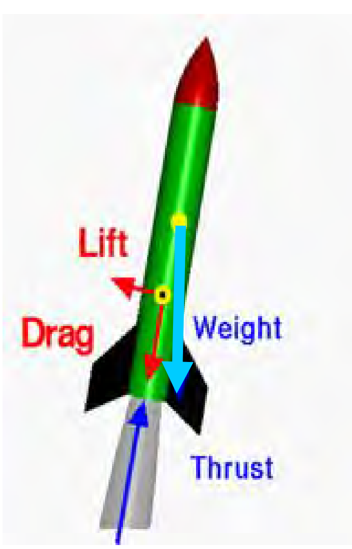
Procedure:

1. Hand out the “Flight Descriptions” information sheet and the “A Wing for Every Purpose” worksheet to each student.
2. Ask students to read through the “Flight Descriptions”. Instruct the students to identify and write the “Flight Description” number on the “A Wing for Every Purpose” worksheet so that it corresponds to the description in the box beside the bird or machine that uses that type of flight.
3. Next, ask students to draw a line to match the bird wing to the aircraft that has the most similar wing design.
4. Hand out a “How Does It Fly?” worksheet to each student. For each type of flying object, have students briefly describe the thrust, lift and drag acting on that object. Teacher answer sheets are provided for both worksheets.

Observations:
The size and shape of a wing depends on what it is being used for, regardless of whether the wing is found in nature or is manufactured. For example, large sea birds and hang-gliders both need long wings to attain a lot of lift and maintain long gliding periods. All things that fly need lift in order to get off the ground but that lift, as well as the thrust that causes flying things to move, comes in many forms.



Source: http://www.lcse.umn.edu/



Source: www.exploration.grc.nasa.gov

Discussion:
The definition for flight can vary greatly. It can encompass anything from time spent aloft to powered movement through the air. The students can discuss what they think flight is and how it can vary from slowed descent (e.g. parachutes and dandelion seeds) to powered transport (e.g. birds and airplanes).

The students may need some guidance filling out the “How Things Fly” worksheet for the rocket. Rockets differ from other powered aircraft. It may be helpful to draw a rocket on the board, showing all four forces – gravity (weight), lift, drag and thrust - and illustrate how they act on the rocket as it rises straight up in the air.

Flight Descriptions

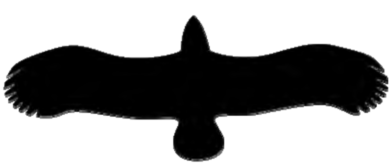
For use with the "A Wing for Every Purpose" worksheet

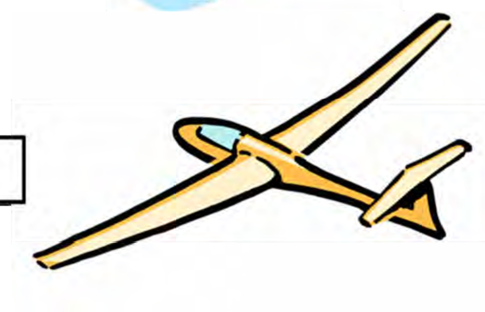
1	A glider has no engine and must access thermals or pockets of rising air in order to stay aloft.
2	A swallow has relatively small, narrow, tapering wings. These wings can be flapped rapidly to provide speed with very little drag. The fastest flyers in the bird world, such as falcons and swifts, have wings of this shape.
3	Hummingbirds can hover in one spot or quickly move forward, backward, sideways, and straight up or down. They can flap their wings up to 100 times per second.
4	Many seabirds like albatrosses have long, narrow, pointed wings for gliding long distances with the ocean winds. The length of their wings helps to generate a lot of lift.
5	Forest birds, like blue jays and crows, have short, rounded wings which allow rapid takeoffs, good manoeuvrability and short glides. They are adapted for quick sharp turns between trees.
6	Bush planes must be able to make short takeoff and landings and they often carry heavy loads.
7	Helicopters create their thrust upwards with their rotors. They are able to change the angle of their rotors to allow great manoeuvrability. Some airplanes, for example Harrier jets, can hover.
8	Fighter jets, with their delta-shaped wings, are able to manoeuver at very high speeds.
9	Long, broad eagle wings have a large surface area for soaring for long periods of time. They also have spaces between the feathers at the ends to help reduce drag and are used for fine control at slow speeds.
10	Commercial airliners have long thick wings in order to carry heavy loads for long distances. They have flaps that are adjusted for takeoffs and landings.

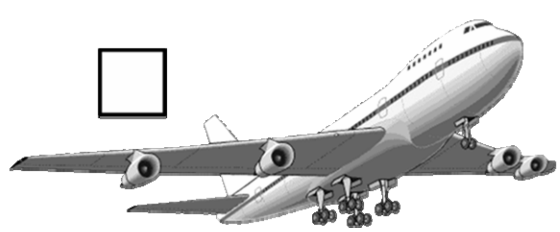
Name:___________________

A Wing for Every Purpose

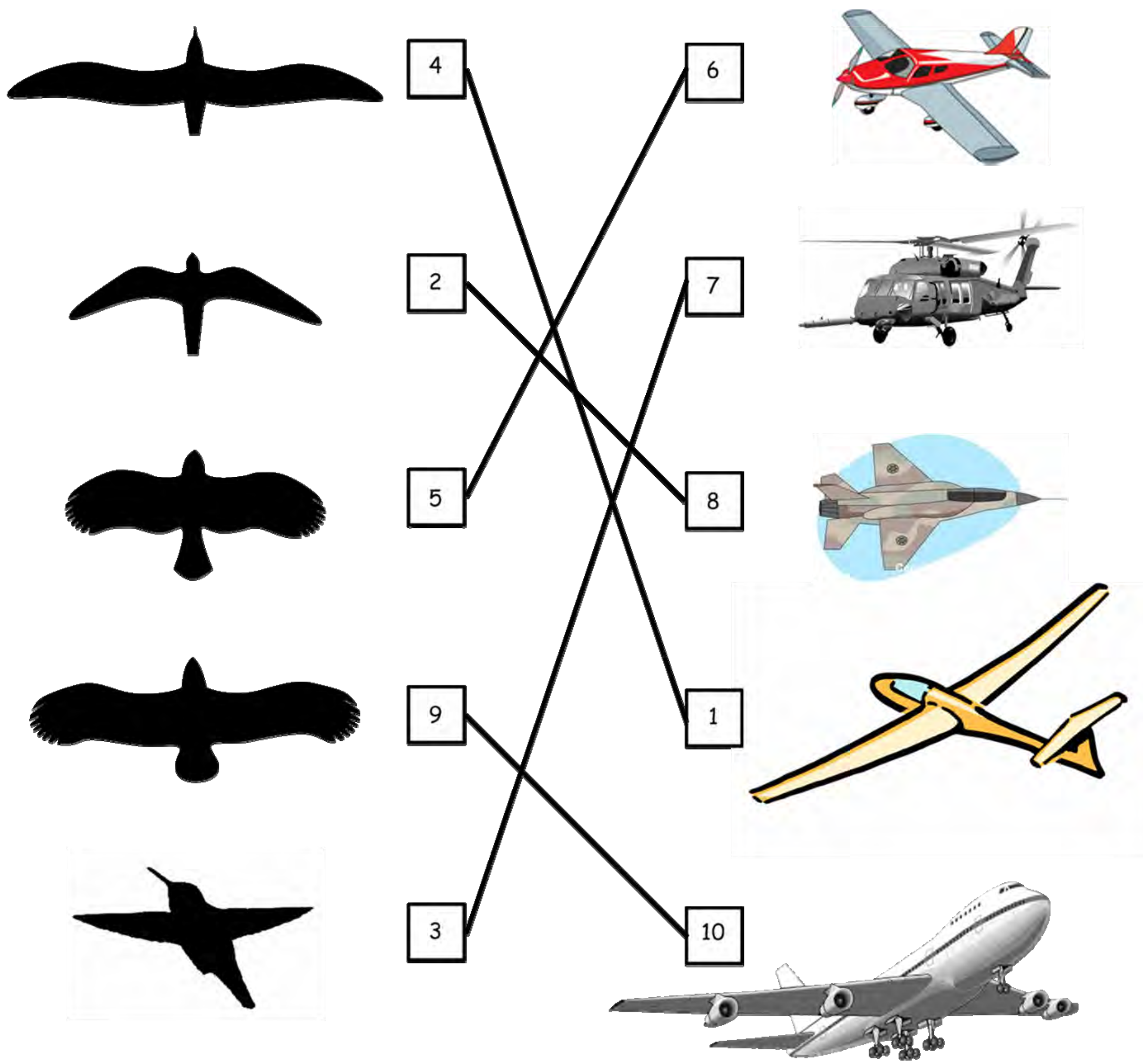
1. Enter the correct number from the "Flight Descriptions" information sheet in the appropriate box below.
2. Draw lines to match the naturally shaped bird wing on the left to the similarly shaped man-made wing on the right.







"A Wing for Every Purpose"
Teacher Answer Sheet



Name:___________________

How Does It Fly?

Flying Object	Thrust	Drag	Lift
Parachute			
Helicopter			
Hot air balloon			
Flying squirrel			
Rocket			
Bird			
Glider			
Non-rigid airship (e.g. blimp)			
Airplane			

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"How Does it Fly?" Teacher Answer Sheet

Type of Flight	Thrust	Drag	Lift
Parachute	None	Fabric of parachute	Double layer that can be shaped into an air foil
Helicopter	Tilting of the spinning rotor blades	Shape of the helicopter and friction of the blades against the air	Spinning of the rotor blades
Hot air balloon	None	Air pushing the balloon around	The air inside the balloon is hotter than the air outside. Hotter air is less dense and will rise
Flying squirrel	None	Skin and fur flaps between fore and rear legs	Changing the shape of the wing flap
Rocket	Expulsion of burning gas from bottom of rocket	Friction between the moving body of the rocket and the air	Works on the side of the rocket to stabilize flight*
Bird	Flapping of wings	Shape of the bird and friction of air at wing tips	Shape of the wing (air foil)
Glider	None; gravity can create thrust (e.g. flight downhill)	Shape of the glider and wings	Long wings with ailerons
Non-rigid airship (blimp)	Engines	Shape of the airship	Helium (lighter than air)
Airplane	Engines	Shape of the plane	Shape of the wing (air foil)

* Rocket - With most aircraft, the direction of flight (thrust) is perpendicular to the force of gravity, but rocket thrust is directed in the opposite direction than that of gravity. Hence lift provides vertical stability and can be used to steer the rocket and prevent it from spinning around the centre axis of the rocket.

Activity 2: Make and Fly a Take-tombo

Time: 60 minutes

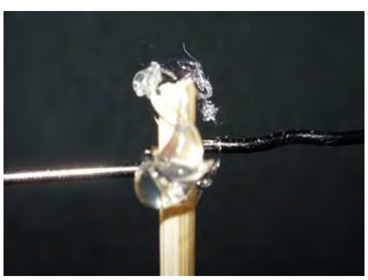
Key terms: pitch, leading edge, trailing edge

Other Applications: Math

Group size: Individual

Materials (per student):

- ☐ hot glue gun (for class use)
- ☐ thick bamboo skewer (~ 4 mm x 24 cm long)
- ☐ 2" metal paper clip (not plastic coated)
- ☐ Styrofoam tray (minimum of 14 cm x 20 cm)
- ☐ pen
- ☐ scissors
- ☐ craft knife
- ☐ ruler



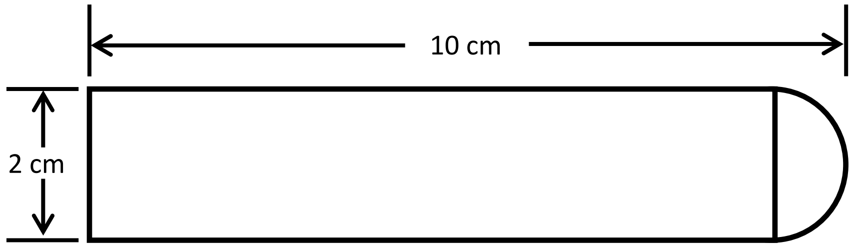
Paper clip wire and hot glue on skewer

Learning Goal: The students will learn how rotors and pitch work in flight.

A take-tombo is a toy helicopter rotor that originated in China around 400 BC. When made out of wood and shaped using power tools, it can rise several metres into the air.

Procedure:

1. Plug in the glue gun to heat up. Ensure the use of the glue gun is done with supervision.
2. Have the students cut the sharp tip off the bamboo skewer.
3. Open up the paper clip and straighten it as much as possible. Wrap the middle of the paper clip around the skewer about 5 mm from one end of the skewer. Make sure it is as tight as possible and that the two equally long ends are sticking out perpendicular to the skewer.
4. Apply a dab of hot glue to the paper clip wire wrapped around the skewer. Hold in place, at the ends, until the glue cools.
5. Cut the curved edges off the Styrofoam tray. Have the students use a ruler to measure and draw the rotor shape (included) on the tray and cut out two copies.
6. Hold the skewer so that the wire is at the bottom. Place a rotor blade under one of the wires and as close to the skewer as possible. Glue in place (this may need two pairs of hands). When the glue has cooled, repeat with the other rotor.
7. To tune the rotors, hold the take-tombo in front of you, with the rotors extending to the left and right. Bend the wire so that one rotor slants down toward you and the other slants up away from you, while remaining perpendicular to the skewer.
8. To launch the take-tombo, place it between your palms and rub your palms together to rotate the skewer. Let go when the fingertips of one hand extend past the heel of the other hand.
9. Experiment with what direction to rotate the skewer – one direction will work, the other won't. Ask the students to use their knowledge of air foils to figure out the correct direction of rotation. This YouTube video demonstrates this: http://www.youtube.com/watch?v=GBXT4fo-27c *(20/07/14)*.
10. Challenge students to see who can get their take-tombo to fly the longest.
11. Ask students to experiment with the pitch of their rotors. Have them adjust the pitch of the rotors to find the best angle for flight. Hint: each rotor should be slanted by the same amount.



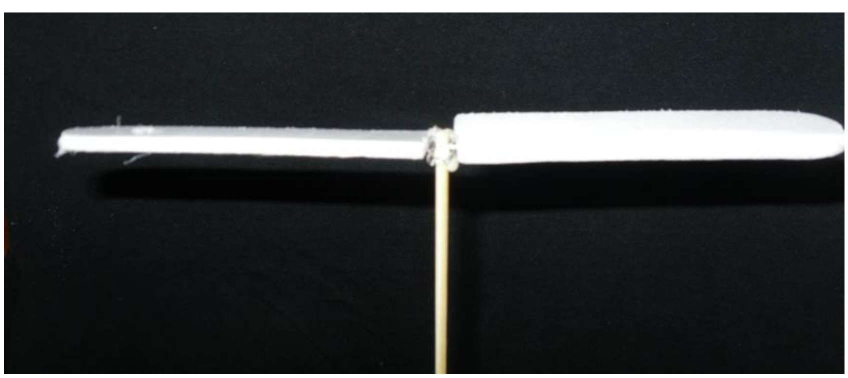
Use a ruler to draw this shape on the Styrofoam tray

Observations:
When the take-tombo is spun in the correct direction, the rotor will rise and spin for a few seconds before falling to the ground. If the take-tombo is spun in the wrong direction, it will just drop to the ground when released. The more the blades are angled (the larger the pitch), the more lift there will be, but the shaft (skewer) will need to be spun faster to overcome the additional drag.

Discussion:
The take-tombo is also known as a bamboo-copter, bamboo dragonfly or Chinese top. George Cayley, the inventor of modern aeronautics, based some of his early experiments on this toy. The principles at work that make the take-tombo fly are the same as the winged fruits (samaras) from maple trees.

Helicopters are also designed using this concept. The pitch of the rotors can be adjusted during take-off and flight to change the amount of lift generated. Airplane propellers are simply rotors tipped ninety degrees. Instead of generating lift, they create thrust. Can the students come up with any other examples either in nature or industry that use rotors?

Extension:
1. The take-tombo can be modified using a piece of sandpaper. Using a gentle touch, round the corners on the leading edges of the rotor blades and taper the trailing edge to a point. Try launching the take-tombo again. It should fly higher and longer due to the proper airfoil shape.



The finished take-tombo showing pitch of blades (for counter-clockwise rotation).

Activity 3: Rocket On!

Time: 30 minutes

Group size: desk groups (4 – 5 students)

Materials (per group):

- ☐ Presta valve inner tube (ask the local bike shop for extras)
- ☐ ¾ - 1” rubber stopper with hole in the centre (available at swimming or wine/beer supply stores)
- ☐ scissors or craft knife
- ☐ rag or glove
- ☐ ruler
- ☐ 2 L pop bottle
- ☐ drinking straw
- ☐ packing or duct tape
- ☐ bicycle pump (preferably an upright one)
- ☐ garden stake
- ☐ bamboo skewer
- ☐ water

Learning goal: The students will learn about the relationship between thrust and gravity in a rocket.

Caution: This activity must be done outside in an open area.

Procedure:

1. Cut the valve from the inner tube and discard the inner tube. Using scissors or a craft knife, remove as much rubber from the base of the valve as possible. Using the rag or glove to protect your fingers, push the valve into the hole in the rubber stopper. It should be in the stopper very snugly. Set aside.
2. Cut a 5 cm long piece of drinking straw. Tape it to the bottle near the bottom, in line with the vertical axis of the bottle. Cover the top end of the straw with duct tape to close the opening
3. To make the launching stand, go to an open area outside and push the garden stake into the ground as far as it will go. Securely tape one end of the bamboo skewer to the top of the garden stake, ensuring there is about 10 cm of skewer above the top of the stake.
4. Each group of students will run three different trials with different volumes of water in the bottle.
    - Trial 1 – 250 ml of water
    - Trial 2 – 500 ml of water
    - Trial 3 – 1000 ml of water
5. Fill the bottle with the desired amount of water. Push the stopper, with the valve inserted, securely in the opening of the bottle. Hang the bottle upside down on the launching stand by sliding the straw over the bamboo skewer. Some water may leak out of the valve, but this is not a problem. The taped end of the straw should prevent the skewer from going all the way through the straw.
6. Making sure the lock nut on the valve is open, attach it securely to the bicycle pump and lock in place. Some bicycle pumps may not have the lock feature.

   WARNING! This next step could result in the drenching of the person operating the pump!
7. While standing to the side of the rocket start pumping air into the bottle and continue pumping until the air pressure in the bottle forces the stopper out.
8. Repeat steps 5-7 for each trial amount of water. Which rocket travelled the furthest?

Observations:
When there is enough air pressure built-up in the bottle, the water is expelled out of the valve, and pushes against the ground, which should launch the bottle rocket up into the air. This is Newton's Third Law of Motion. Depending on how much water is in the bottle, and how much pressure has built-up in the bottle, some rockets will go higher than others. The rocket with 500 ml of water should go the highest compared to the other two. The rocket should travel one or more meters into the air.

Discussion:
The amount of water in the bottle directly affects how high the rocket will rise. A small amount of water will result in less thrust, but too much water will prevent the air pressure from overcoming the pull of gravity, and the rocket won't rise very high. The rocket with 250 ml will come off the launcher but not rise in the air. The rocket with 1000 ml of water may not even come off the launcher. The rocket with 500 ml should have the optimal amount of water to provide enough thrust to get off the launcher and rise into the air. However, if this rocket doesn't rise very high, the stopper may not have been pushed in as tightly as possible, and the rocket would be launched at a lower air pressure, resulting in a lower flight or rise.

Discuss with the students the different reasons why their rockets may or may not have performed as they would have liked and troubleshoot as a group to make an ideal rocket.

Extensions:
1. Have the students make and attach fins and a nose cone to the rocket. Does the flight pattern change with these modifications? (hint: it may go higher).
2. Have the students make a parachute out of string or thread and a plastic bag. Think about how it should be stored during flight and be deployed on the descent.
3. Have the students make a space shuttle out of a paper towel roll (body) and Bristol board (delta wings) to launch from the water bottle, demonstrating how the rocket drops away after it has launched the space shuttle. The shuttle can be hung on the rocket with a paper clip (on the shuttle) and a short piece of straw (on the rocket). See images below.



Bottle rocket assembly with the valve inserted and the space shuttle attached.

Activity 4: Full of Hot Air

Time: 1 hour

Group size: pairs or desk groups

Materials (per group):

- ☐ 4 pieces of tissue paper (20” x 26”); 2 different colours
- ☐ 4 pieces of another type of paper (e.g. newsprint, construction paper)
- ☐ pencil
- ☐ scissors
- ☐ glue pen, glue roller or glue sponge tip applicator
- ☐ 4 paper clips (all the same size)
- ☐ 2 elastic bands (same size)
- ☐ hair dryer

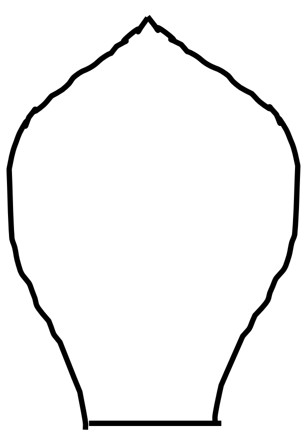


Illustration of the shape of each of the balloon sides. You will need four of these shapes.

Learning Goal: The students will learn how hot air can make a balloon stay in the air.

Procedure:

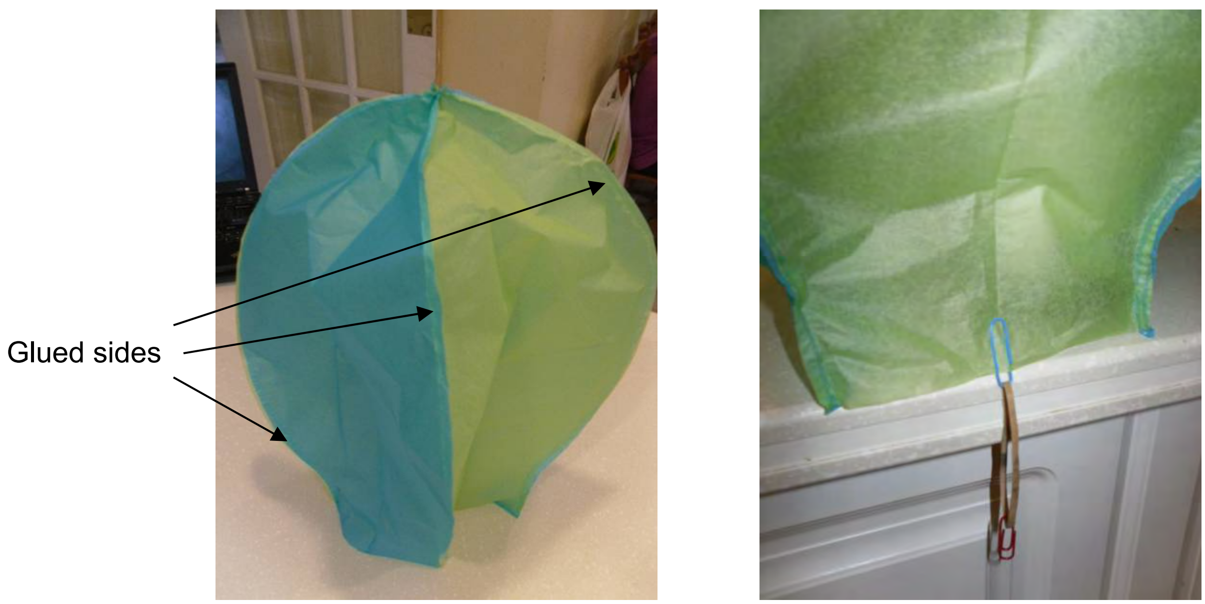
1. Lay out two sheets of the first colour of tissue paper and draw a leaf shape on it so that most of the paper is used. Cut out the shape. Do the same for the second colour using the first sheets as a template. You should now have four pieces of tissue paper cut in a leaf shape (see illustration). These will be the sides of your balloon.
2. Fold each tissue paper cut-out in half vertically and stack them in alternating colours. The folded edges should be lined up with the fold on the left.
3. Unfold the top sheet. Glue the right-hand curved edge of the top sheet, to the left-hand curved edge of the next sheet. Glue just the curved edges from the tip to the bottom. Leave the straight edge at the bottom unglued.
4. Unfold the second sheet and glue the right-hand curved edge of the second sheet to the left-hand curved edge of the third sheet.
5. Repeat until all the pieces are attached on their curved edges. You should now have a closed, balloon-shaped object (see photo on next page).
6. Dab some glue at the top of the balloon and twist together to close any holes. Ensure there are no places for air to escape.
7. Attach one paper clip to an open edge on one side of the balloon and another one on the open edge on the opposite side.
8. Loop elastic bands through the paper clips and hang another paper clip on the bottom of each elastic band. This will help to keep the balloon stable as it rises.
9. Have one student hold the hair dryer pointing up and another student hold the balloon by the tip with the opening over the air dryer, about 20-30 cm above it.
10. Have students experiment with what will work to get the balloon to stay in the air:
    - Turn hair dryer on low, wait 30 seconds, turn off hair drier and release balloon – does it stay aloft, rise or fall?
    - Turn hair dryer on high, wait 30 seconds, turn off hair drier and release balloon – does it stay aloft, rise or fall?
11. Which setting, low or high, worked the best to keep the balloon in the air and why?
12. Repeat the activity but have students build a balloon from a different type of paper (e.g. newsprint or construction paper). Ask them to compare the balloons’ abilities to float.

Observations:
When the hot air from the hair dryer, on the high setting, fills the balloon with warm air, it should stay in the air for a few seconds after the hair dryer is turned off before falling down. The low setting on the hair dryer will not provide enough heat to heat the air inside the balloon sufficiently and in that case, it will fall immediately after the hair dryer has been turned off.

There is also a certain size and shape the balloon needs to be in order for this experiment to work. If the balloon is too skinny, it will not be able to hold enough hot air to stay in the air. If the opening at the bottom of the balloon is too wide, the balloon won't be able to contain the hot air and it won't stay aloft either. If the balloon is too wide, there will be pockets inside the balloon that the hot air won't be able to reach and the weight of the tissue paper will be too heavy. If some balloons are not staying aloft, ask students to troubleshoot in their groups and give them the opportunity to remake their balloons.

Balloons made from heavier paper will not be able to rise like the tissue paper balloons. Ask students if there are any modifications they could make to their balloon to help it to rise.

Discussion:
The students could discuss other ways to heat the air in their balloons. Traditional designs use a small foil basket with candles in it to "sail" the balloon. Clearly, this is not safe in a classroom; however, knowing this can generate discussion about real hot air balloons. Balloon fires are relatively rare, partly because the balloon is partially filled with ambient air before turning on the propane burners.



Paper balloon with sides glued together and weights attached.

Activity 5: Go Fly a Kite!

Time: 1 hour

Key Terms: spine, spar, bridle

Other Application: Math

Group size: desk groups (4 - 5 students)

Materials (per group):

- ☐ 1 large garbage bag (preferably orange so it will show up against the sky)
- ☐ 6 bamboo skewers (~30 cm long)
- ☐ scissors
- ☐ scrap paper
- ☐ hot glue gun
- ☐ permanent marker
- ☐ metre stick
- ☐ tape
- ☐ duct tape
- ☐ plastic shopping bag
- ☐ dental floss

Learning Goal: The students will learn how size and shape affect the way a kite flies.

Procedure:

1. Group members should work together to decide on the size and shape of the kite they would like to build.
2. To make the spine and the spar: cut the pointed ends off all the skewers. Cut the skewers to the desired length. Two or more skewers may be needed to accomplish this. For each joint, cut two pieces of skewer 5 cm long. Place the skewers that need to be joined end to end on a scrap piece of paper. Place one 5 cm piece of skewer on either side of the joint. Hold in place and use hot glue to join them. Let cool. Turn the joined skewers over and add more glue to reinforce the joint.

3. Place the spar perpendicularly over the spine about a third of the way down from one end. Use the hot glue to secure it in place. Let cool.
4. Cut the bottom seam off a large garbage bag and cut up one side to make a piece that is one layer thick. Lay it flat on a desk or the floor.
5. Place the skewer assembly on the plastic bag. Tape in place at the end of each skewer.
6. Using a permanent marker and a metre stick, draw lines around the perimeter of the kite, joining the ends of the skewers.
7. Reinforce the edges of the kite by placing tape along the inside of each marker line, on the inside of the kite.
8. Cut the kite out following the marked lines.
9. To make the bridle, cut a piece of dental floss about 5 cm longer than the spar. Tie each end to an end of the spar, just inside the tape.
10. Tape over the entire length of the spar with the duct tape, trapping the bridle between the duct tape and the tape on the ends only. Tape the spine to the plastic using the tape.
11. To make the kite tail, cut off the handles and the bottom seam of the shopping bag. Cut three vertical strips from the bag, about 3 cm wide (and 30 cm long). Tie them together with square knots, leaving about 5 cm on either side of the knot. This will be used later.

12. Remove the dental floss from the container and slide the spool onto the pencil (this is your kite string). Tie the free end to the centre of the bridle. Secure with tape.
13. Try to fly the kite on a day that has a light to moderate breeze. It is easier to launch a kite if two people are involved. The flyer should stand with his/her back to the wind. The helper should hold the kite about 3 m away and as high up as possible. When the flyer feels the wind tug at the kite, he/she will tell the helper to let go. At this point, the flyer can experiment with letting line out and how to hold the spool to keep the kite aloft.
14. Tape the tail to the bottom of the spine and fly the kite again, noting any difference(s) in how the kite flies. If necessary, increase the length of the tail, or add a second one at the bottom of the spine. Flying the kite now is all about trial and error.

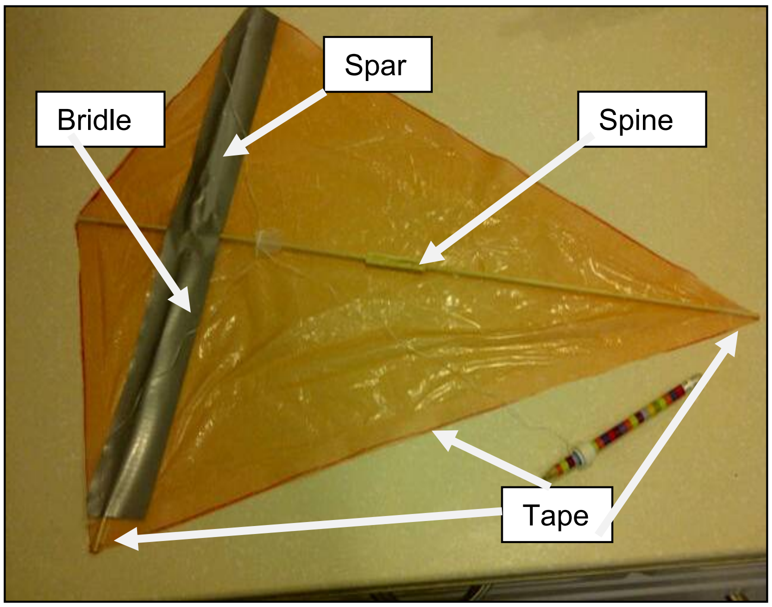


Image of completed kite with component parts labelled.

Observations:
The larger the kite, the stronger the wind required to get the kite aloft. A heavier wind will batter it about and cause it to come down head first or spin in the air. If the breeze is too light, the kite will simply not launch and drop tail first when released. The space used is also important. It needs to be a fairly large open space (most school fields are large enough) and away from obstacles such as power lines, trees and buildings. This is for safety, to keep the kite from getting tangled and also because obstacles affect how the wind moves and cause turbulence that makes it difficult to control the kite.

Discussion:
Which person/group had the most success flying their kite? Did it have to do with the way it was constructed or where they were standing? How did the addition of the tail affect the way the kite flew?

Compare how the different sizes and shapes of kites flew. Discuss the effect of the tail on the nature of the kites' flight. The shape of the kite will also affect how it flies. A skinnier kite will tend to spin and require a longer tail to stay in control. A wider kite will tend to be more stable. Adding a tail will increase the drag and reduce the spinning of the kite.

Kites fly using the principles that other flying objects do: gravity, lift, drag and thrust. The shape of the kite is like an airfoil and provides the lift needed to get the kite in the air. Thrust is generated by the person flying the kite applying tension to the line, as well as the force of the wind. Drag is created by the friction of air against the kite, hence the need for the tail and the reason that the knots were tied with long ends.

Extension:
The diamond shaped kite is the simplest to make, but there are many other types of kites, the most common being delta, slide and box. Challenge the students to research and make other types of kites using the materials and methods above and test them to see which ones fly best.

Fun Fact: Kite-flying World Record in Ontario!

The Guinness Book of World Records for the highest altitude flown by a single kite is 4,422 m. This world-breaking flight occurred on August 12, 2000 from a flying field near Kincardine, Ontario (Sauble Beach area)! The massive delta kite was designed and flown by Richard Synergy. The length of line at its highest altitude was over 7 km long and the flight was 8 h 35 min long!

Fun Fact: Flying Fish

The streamlined torpedo shape of flying fish helps them generate enough speed to break the water's surface. Once airborne, they can glide for hundreds of metres with the help of enlarged fins that act like wings.

Fun Fact: Alive & Flying

The only living things capable of powered flight are insects, birds and bats.

Teacher Resources

Literary Resources

Birds. Jackie Ball, Justine Ciovacco, Bill Doyle, Dan Franck, Uechi Ng. 2002. Gareth Stevens Publishing. ISBN 0-8368-3210-8. Gives a basic understanding of birds and flight.

175 Science Experiments to Amuse and Amaze Your Friends. Brenda Walpole. 1988. Random House, Inc. ISBN 0-394-89991-1. Good resource for household science experiments.

A Century of Triumph The History of Aviation. Christopher Chant. 2002. Free Press. ISBN 0743234790. A good overview of modern flight.

Wings A History of Aviation from Kites to the Space Age. Tom D. Crouch. 2003. Smithsonian National Air and Space Museum, in association with W.W. Norton. ISBN 0393057674

Website Resources

http://www.allstar.fiu.edu/aero/ *(05/11/15)*
Great lesson planning information.

http://airandspace.si.edu/ *(05/11/15)*
General information about air and space from the Smithsonian National Air and Space Museum.

http://www.ucmp.berkeley.edu/vertebrates/flight/enter.html *(05/11/15)*
Great information regarding vertebrate flight.

http://www.edu.gov.mb.ca/k12/cur/science/found/5to8/6c2.pdf *(05/11/15)*
Lesson plans for flight.

http://www.wra2.org/ *(05/11/15)*
Great resource for bottle rocket enthusiasts.

https://www.grantvillegazette.com/wp/article/publish-507/ *(05/11/15)*
The mechanics of airship propulsion.

Interactive White Board Resources

"Flight"
http://exchange.smarttech.com/details.html?id=342e99bc-078f-437c-9281-80097fc23010 *(05/11/15)*
Interactive presentation on the history and basics of flight.

"Flight Technology"
http://exchange.smarttech.com/details.html?id=da9d98c5-08e6-4ee3-b6cb-49b025ff3d11 *(05/11/15)*
Interactive lesson on the history and mechanics of flight.

"Air and Flight: Living Things"
http://exchange.smarttech.com/details.html?id=cb935d14-01fb-497f-b80f-480fba26efe5 *(05/11/15)*
Interactive lesson on how living things fly.

“Parts of an Aircraft”
http://exchange.smarttech.com/details.html?id=8c3c2043-3791-4515-8f52-230fcce16999 *(05/11/15)*
Interactive lesson on the parts of an airplane and their function.

Multi-media

http://www.fi.edu/wright/ Many short 1:00 min clips. *(05/11/15)*
Videos of the Wright brothers’ first flight.

http://www.youtube.com/watch?v=aLJzEI5st8s “The Forces on an Airplane” 8:15 min. *(05/11/15)*
A comprehensive video all about flight.

Student Resources

Literary Resources

Space and Flight Experiments. Louis V. Loesching. 2006. Sterling Publishing Co., Inc. ISBN 13: 978-4027-2334-6 and 10: 1-4027-2334-2. Great hands-on flight experiments.

Book of Flight. Judith E. Rindard. 2001. Firefly Books. ISBN 1-55209-619-X and 1-55209-599-X. A good history of flight and flying technology.

Make it Work! Flight. Andrew Haslam. 2001. Two-Can Publishing. ISBN 1-58728-371-9 and 1-587728-355-7. Great hands-on experiments for all types of flight.

Interactive Resources

http://www.grc.nasa.gov/WWW/k-12/UEET/StudentSite/index.html *(05/11/15)*
Everything to do with aeronautics, including history, vocabulary, lesson plans and games.

http://johnbenzies.com/flightsim/ (*05/11/15*)
A very fun computer game where you fly the plane!

http://www.ge.com/thegeshow/flight/#ch2 (*05/11/15*)
Design a plane to see if it will fly

http://howthingsfly.si.edu/ *(05/11/15)*
Interactive site to explain how things fly.

http://flightwebquest.blogspot.ca/ *(05/11/15)*
Self-directed learning and activities on flight.

http://hrsbstaff.ednet.ns.ca/klinek/Webquest%20Files/Flight/Flight.htm *(05/11/15)*
Self-directed learning on the history and mechanics of flight.

http://exploration.grc.nasa.gov/education/rocket/ *(05/11/15)*
Beginner’s guide to rockets.

References
In addition to the resources listed above, the following references have also been used to write this package:
http://www.factmonster.com/dk/science/encyclopedia/rockets.html (*01/29/14*); http://animals.nationalgeographic.com/animals/fish/flying-fish/ (*01/29/14*); http://www.sciencekids.co.nz/sciencefacts/flight.html (*01/29/14*); http://www.sciencekids.co.nz/sciencefacts/flight.htm (*03/31/2014*); http://www.guinnessworldrecords.com/records-1/highest-altitude-by-a-single-kite/ *(18/07/14;*
flight silhouettes: *http://commons.wikimedia.org/wiki/File:FlightSilhouettes.svg (L Shyamal) & http://naturemappingfoundation.org/natmap/facts/annas_hummingbird_k6.html.*

SCIENTISTS IN SCHOOL SCIENTIFIQUES À L'ÉCOLE | Get kids excited about science

Science Education Through Partnership

Scientists in School is a leading science education charity that reaches more Kindergarten to Grade 8 youth than any other science non-profit in Canada – more than 700,000 in the 2018-19 school year.

Through our hands-on, inquiry-based science, technology, engineering, math (STEM) and environmental classroom and community workshops, we strive to ignite scientific curiosity in children so that they question intelligently; learn through discovery; connect scientific knowledge to their world; get excited about science, technology, engineering and math; and have their interest in careers in those fields piqued.

By making science a verb - something you do - our workshops allow children's natural curiosity to reign, inspire kids to see themselves as scientists and engineers, and make connections between science and the world around them. This sets the stage for a scientifically-literate future generation who will fuel Canada's economic prosperity and think critically about the scientific challenges facing our society.

Scientists in School relies upon corporate, community, government and individual donors, as well as school board partners for support to develop new programs, continuously improve our existing programs, reach new geographic areas, provide complimentary workshops to less-privileged schools, and subsidize the cost of every one of our 24,872 annual classroom workshops.

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Natural Sciences and Engineering Research Council of Canada, TD Friends of the Environment Foundation

Innovation Level:

Amgen Canada, John and Deborah Harris Family Foundation, Nuclear Waste Management Organization, Ontario Power Generation, Toronto Pearson International Airport

Imagination Level:

ArcelorMittal Dofasco, General Motors Canada, McMillan LLP, Superior Glove Works Ltd., TELUS

Discovery Level:

Alectra Utilites, Aviva Community Fund, Cadillac Fairview, CAE, Cameco Corporation, Canadian Nuclear Safety Commission, Carolyn Sifton Foundation, Celestica, Hamilton Community Foundation, MilliporeSigma, Modern Niagara, Niagara Community Foundation, Pendle Fund at the Community Foundation of Mississauga, Purdue Pharma, S.M. Blair Family Foundation, Society of Petroleum Engineers Canadian Educational Foundation, Syngenta Canada Inc., Systematix Inc., The McLean Foundation

Exploration Level:

Ajax Community Fund at Durham Community Foundation, Brant Community Foundation, Cajole Inn Foundation City of Brantford, Community Foundation Grey Bruce, Dwight and Karen Brown Family Fund – Ottawa Community Foundation, Elexicon Energy, LabX Media Group Charity Fund at the Huronia Community Foundation, Siemens Milltronics Process Instruments, The Community Foundation of Orillia and Area, The County of Wellington, The Source, The Township of Tiny, Whitby Mayor's Community Development Fund