Anglophone School District - North

Grade 6 Science - Unit Lesson Guide

Flight

Table of Contents

The Aim of Science Education - Scientific Literacy

The aim of science education in the Atlantic Provinces is to develop scientific literacy.

Scientific Literacy is an evolving combination of the science-related attitudes, skills, and knowledge students need to develop inquiry, problem-solving, and decision-making abilities; to become lifelong learners; and to maintain a sense of wonder about the world around them. To develop scientific literacy, students require diverse learning experiences that provide opportunities to explore, analyze, evaluate, synthesize, appreciate, and understand the interrelationships among science, technology, society, and the environment.

The Three Processes of Scientific Literacy

An individual can be considered Scientifically Literate when he/she is familiar with, and able to engage in, three processes: Inquiry, problem solving, and decision making.

Inquiry

Scientific inquiry involves posing questions and developing explanation for phenomena. While there is a general agreement that there is no such sing as the scientific method, students require certain skills to participate in the activities of science. Skills such as questioning, observing, inferring, predicting, measuring, hypothesizing, classifying, designing experiments, collecting data, analysing data, and interpreting data are fundamental to engaging science. These activities provide students with opportunities to understand and practise the process of theory development in science and the nature of science.

Problem Solving

The process of problem solving involves seeking solutions to human problems. It consists of proposing, creating, and testing prototypes, products, and techniques to determine the best solution to a given problem.

Decision Making

The process of decision making involves determining what we, as citizens, should do in a particular context or in response to a given situation. Decision-making situations are important to their own right, and they also provide a relevant context for engaging in scientific inquiry and/or problem solving.

Science Assessment Overview

Science is a hybrid term that houses different disciplines such as: Physics, Chemistry, Biology, Environmental Studies, Engineering, Math, etc. Given this broad spectrum, it is not realistic that we can paint science assessment with a single brush in terms of probes that work for every science activity. However, regardless of school subject, let alone science, the frequency of assessment should be unbalanced with formative assessment occupying 80% of practise and summative with the remaining 20%.

80% Formative - 20% Summative

Formative Assessment
Formative assessment is a range of formal and informal assessment procedures employed by teachers during their learning process in order to modify teaching and learning activities to improve student attainment. It typically involves qualitative feedback (rather than scores) for both students and teacher that focuses on the detail of content and performance. Feedback is the central function of formative assessment. It typically involves a focus on the detailed content of what is being learnt.

Science Formative Assessment falls into 2 distinct categories, and they are divided about how feedback is given. Please be aware that an activity could be informal or formal, it is the purpose of the task that determines purpose.

Informal Formative
Informal Formative Science Assessment acts as a monitoring probe and is distinct because it is not graded.

Formal Formative
Formal Formative Science Assessment provides specific feedback to students, the teachers corresponds via anecdotal feedback, rubrics, and written responses to offer progress to student attainment.

Summative Assessment
Summative assessment seeks to monitor educational outcomes, often for the purposes of external accountability. Usually occurring at the end of a learning unit and determines if the content being taught was retained.

Flight

Focus and Context

The emphasis in this unit is on how things fly or stay afloat in the air, and variables that affect flight. This focus of this unit is, for the most part, problem solving. Students should be immersed in rich experiences with many aspects of air/aerodynamics and flight. Activities related to solving problems, like “How can I get the airplane to stay in the air longer?”, require that the students design, test, and then modify their designs and retest their models. Students should use their imagination, creativity, and research skills in designing model planes, various wing shapes, and in devising methods to test their designs. After much classroom experimentation, design and testing, teams of students should have the opportunity to investigate an aspect of flight that interest them most, and present their findings. By providing opportunities to reexamine and retest, research and rebuild, and share, students will grow in the four broad areas of skills: initiating and planning, performing and recording, analyzing and interpreting, and communications and teamwork.

Unit Instructional Overview

Drag	Lift and Wing Shape	Lift and Bernoulli's Principle	Thrust and Propulsion
Testing Parachute Designs for Drag	How Does It Stay in The Air?	Prior Knowledge Activity	Propelling Objects - Pulling Air
Research and Design to Reduce Drag	Building an Airplane Wing	Paper Strip Activity	Propelling Objects - Moving Gas
Making a Better Parachute		Moving Air Activity	Propulsion of Different Aircrafts
The Best Parachute to Maximize Drag		Another Moving Air Activity	Building A Bottle Rocket
		Activities	

* - EECD Grade 6 Inquiry package - available at https://portal.nbed.nb.ca/tr/lr/k-8Science/Pages/default.aspx

Flight - Curriculum Outcomes

<table>
<tr><th>Drag</th><th>Lift and Wing Shape</th><th>Lift and Bernoulli's Principle</th><th>Thrust and Propulsion</th></tr>
<tr><td rowspan="3">204-2 Rephrase questions about drag in a testable form...
205-5 and then carry out procedures...
207-2 make and record observations, to test the performance of a flying device</td><td>303-32 Describe the role of lift in overcoming gravity and enabling devices...to fly</td><td rowspan="2">303-33 identify situation which involve Bernoulli's principle</td><td>303-34 Describe and demonstrate the means of propulsion for flying devices</td></tr>
<tr><td rowspan="3">204-7, 205-1, 205-2 plan and carry out a set of steps to investigate the effects of wing shape on lift, and select and use tools in building models of various wing shapes</td><td rowspan="3">300-22 describe and justify the differences in design between aircraft and spacecraft</td></tr>
<tr><td rowspan="2">106-3 describe how aerodynamic research using wind tunnels and/ or computers can contribute to new airplane designs</td></tr>
<tr><td rowspan="2">301-18 Describe and demonstrate methods for altering drag in flying devices</td></tr>
<tr><td>301-17 Demonstrate and describe how lift is affected by the shape of a surface</td><td rowspan="2">104-3 Explain why using computer simulations and/or wind tunnels are appropriate processes for investigating wing and airplane designs</td><td>105-3 compare current and past air and space craft</td></tr>
<tr><td rowspan="2">104-5 Describe how the results of testing drag in similar (and repeated) investigations may vary, suggest possible explanations for variations</td><td>300-21 identify characteristics and adaptations that enable birds and insects to fly</td><td>107-9 describe some ways that flying devices have changed the way people work and live</td></tr>
<tr><td>106-4 Describe how knowledge of wing shape, and ability to change wing shape in flight, can affect lift</td><td>205-8 Identify and use a variety of sources to investigate the use of wind tunnels in testing aircraft shapes</td><td>107-12 provide examples of Canadians who have contributed to the science and technology of aircraft</td></tr>
<tr><td>206-6 Suggest improvements to the design of a flying device to improve its performance</td><td></td><td></td><td></td></tr>
<tr><td>107-6 Provide examples of how technological research and design has resulted in many product designs that have reduced the amount of drag experienced</td><td></td><td></td><td></td></tr>
</table>

Flight
Strand - Drag

General Curriculum Outcomes	Specific Curriculum Outcomes
204-2 Rephrase questions in a testable form	204-2, 205-5, 207-2 rephrase questions about drag in a testable form and then carry out procedures, make and record observations, to test the performance of a flying device
205-5 Make observations and collect information that is relevant to a given question or problem	
207-2 Communicate procedures and results, using lists, notes in point form, sentences, charts, graphs, drawings, and oral language	
301-18 describe and demonstrate methods for altering drag in flying devices	301-18 describe and demonstrate methods for altering drag in flying devices
104-5 describe how results of similar and repeated investigations may vary and suggest possible explanations for variations	104-5 describe how the results of testing drag in similar (and repeated) investigations may vary, suggest possible explanations for variations
206-6 suggest improvements to a design or constructed object	206-6 suggest improvements to the design of a flying device to improve its performance
107-6 provide examples of how science and technology have been used to solve problems around the world	107-6 provide examples of how technological research and design has resulted in many product design that have reduced the amount of drag experienced

Testing Parachute Designs for Drag

Outcomes:
301-18 Describe and demonstrate methods for altering drag in flying devices
PP1, PP5, AE1 rephrase questions about drag in a testable form and then carry out procedures, make and record observations, to test the performance of a flying device
104-5 describe how the results of testing drag in similar and repeated investigations may vary, suggest possible explanations for variations

Lesson Activity Overview
The focus of this lesson is Drag, the force that slows things down. Students should have prior knowledge of this force, from times in which they have activated the force (e.g., if they have stuck their arm out the window of a moving car, walked with bristol board, etc)

The unit could start with a Know-Want to Learn-Learned (K-W-L) activity that focuses on flight and aerodynamics. Students could brainstorm what they know and have experienced with respect to wind, air resistance, flying, bird and insect flight and leaves falling. They could also raise questions that they have and would like to investigate. This activity will help the teacher gauge students' conceptions, and help focus the investigations in the unit.
There are four forces acting on flying objects: drag is the force that slows the flying device, gravity is the force that pulls it towards earth, thrust is the force that propels, and lift is the force that keeps it up in the air.

Students should save all of their parachute prototypes throughout this section to understand how the design process changes based on what is learned. Parachutes will be used and modified in each of the 4 lessons in this section.

Activity - Testing Parachute Design
Using three different pieces of paper (size and type of paper should be the same), have students create a different shape parachute with each piece of paper. Students will have to choose one object to hang from the parachute.

1. Have students design a testable question related to altering drag, they may choose to have an efficient parachute that has more drag or they could choose one that less drag, their intent (independent variable or variable to test) and the means in which they will measure it (dependent variable or variable to measure) should be evident in the question. PP1
2. Next, students should make a prediction of how each parachute will act in a free fall. Make sure their is justification to support why each parachute will rank based on what they already know about drag.
3. All students will drop their parachutes from an agreed upon height based on the dynamics of the school. Also, ensure that their measurements are recorded based on the dependent variable in the question
4. Students will record their observations and measurements (quantitative and qualitative) during each of the trials. Each parachute will have 5 trials. PP5
5. Students will analyze data and determine a list of how each design performed compared to their question. AE1

Discussion -
Each student will share their question, prediction and analyzed results with an explanation of why.
Discuss how each trial had a different result, give an explanation for how these results may vary and why 104-5

Journal - Entry/Exit card
Based on classroom discussion, what are the common factors that lead a parachute to be slower to fall or have a greater drag? 301-18

Assessment:Informal Formative
Ensure that students have written a testable question related to drag PP1

Ensure that students have recorded observations and data about each of the their trials PP5

Ensure that students have analyzed results of their trials and have communicated a list of their findings AE1

Ensure that students have been exposed to a discussion about how results multiple trials of the same experiment can vary 104-5

Assessment:Formal Formative
Ensure that students have written a journal entry to details the common factors that lead to a parachute having greater drag 301-18

Testing Parachute Design

Testable Question:

Prediction:

	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5
Parachute 1 - Time					
Notes					
Parachute 2 - Time					
Notes					
Parachute 3 - Time					
Notes					

Results:

Research and Design to Reduce Drag

Outcomes:
301-18 Describe and demonstrate methods for altering drag in flying devices
107-6 provide examples of how technological research and design has resulted in many product design that have reduced the amount of drag experienced

Lesson Activity Overview
The focus of this lesson is understanding how to reduce drag. The previous cycle most likely tried to have a greater drag on the parachute, based on the free fall from the sky. Now we switch the focus to aerodynamics and why different devices would like to have less drag experienced.

Activity 1
Ask each student to bring an image of their "favorite" car to class with them. Put students in cooperative groups. Give students the following scenario:
"Assuming that all these automobiles are using the same sources of fuel and that each has the same amount of horse power, arrange the images in order from slowest to fastest"

Questions
1. Why did you arrange your automobiles in that order?
2. What factors about each automobile will affect its overall speed?
3. Describe how car design has changed over time?

Journal
Using the concept of drag, assume that the fuel and amount of horse power are the same, which will go faster, a 2014 Lamborghini or a 1968 Mustang? 107-6

Activity 2
Using the images, on page 14, of an Olympic Alpine Ski Racer and an Olympic Ski Jumper, Discuss in groups how each athlete manipulates drag.

Questions
1. Identify the aspects of each athlete that are similar (e.g. snow, temperature, suit, etc)
2. Identify what evidence we have of different drag
3. Explain why each a ski jumper and an alpine skier require different amount of drag to be successful in their sport? What does each athlete have to do to manipulate that drag?

Journal
Using what you know about reducing drag to create more speed, explain what Olympic Swimmers should do be successful. 301-18, 107-6

Assessment:Informal Formative
Ensure that students have participated in a discussion and have responded to questions about the aerodynamics of automobiles 107-6

Ensure that students have participated in a discussion and have responded to questions about the need for athletes to alter drag to be successful in their sport 301-18, 107-6

Assessment:Formal Formative
Ensure that students have written a journal entry that explains why the aerodynamics of a modern car will allow it to go faster then a vintage car, given similar conditions 107-6

Ensure that students have written a journal entry that details how Swimmers reduce drag to be successful 301-18, 107-6


ENERGIE
ZAUCHENSEE


U.S. OLYMPIC
TEAM TRIALS
7
FISCHER
FISCHER

Making a Better Parachute

Outcomes:
301-18 Describe and demonstrate methods for altering drag in flying devices
PP1, PP5, AE1 rephrase questions about drag in a testable form and then carry out procedures, make and record observations, to test the performance of a flying device
AE4 suggest improvements to the design of a flying device to improve its performance

Lesson Activity Overview
The focus of this lesson is to suggest improvements to the design of the original parachute. In the first cycle (Testing Parachute Designs for Drag) students were restricted to using paper as the only material for their parachute. This lesson allows for different materials to be used.

Activity - Making a Better Parachute
Using the resulting parachute design and the same object that was used in the previous Testing Parachute Designs for Drag activity. Students will now be given the opportunity to select different materials to test the best material for a parachute.

1. Students can rephrase or rewrite a question that deals with increasing drag. Make sure that the question states materials that will be manipulated as the independent variable. PP1
2. Based on the materials selected and the parameters of the question, have students make predictions about which parachute will perform best.
3. All students will drop their parachutes from an agreed upon height based on the dynamics of the school. Also, ensure that their measurements are recorded based on the dependent variable in the question
4. Students will record their observations and measurements (quantitative and qualitative) during each of the trials. Each parachute will have 5 trials. PP5
5. Students will analyze data and determine a list of how each design performed compared to their question. AE1

Journal
Discuss the improvements that you have made from the previous activity in which you designed the parachute. Suggest further improvements to either design and/or materials that could yield better results. Remember performance of a parachute could be measured with both slower speed and accuracy of the drop. AE4

Assessment:Informal Formative
Ensure that students have written a testable question related to drag PP1

Ensure that students have recorded observations and data about each of the their trials PP5

Ensure that students have analyzed results of their trials and have communicated a list of their findings AE1

Assessment:Formal Formative

Ensure that students have responded to the journal in which they have suggested improvements to the performance of their parachute. The focus should be on improvements to their next design. AE4

Making a Better Parachute

Testable Question:

Prediction:

	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5
Parachute 1 - Time					
Notes					

Results:

The Best Parachute to Maximize Drag

Outcomes:
301-18 Describe and demonstrate methods for altering drag in flying devices
PP1, PP5, AE1 rephrase questions about drag in a testable form and then carry out procedures, make and record observations, to test the performance of a flying device
104-5 describe how the results of testing drag in similar and repeated investigations may vary, suggest possible explanations for variations

Lesson Activity Overview
The focus of this lesson is to use what students have learned through trial and error to design the best parachute possible. In the first cycle (Testing Parachute Designs for Drag) students were restricted to using paper as the only material for their parachute. The third lesson allows for different materials to be used. This lesson is the culmination of their learning

Activity - Making a Better Parachute
Using the suggestions for design modification in the previous Making a Better Parachute activity. Students will now be given the opportunity to select different materials to test the best material for a parachute.

1. Students can rephrase or rewrite a question that deals with increasing drag. Make sure that students advance to write a testable question that includes an independent variable and a dependent variable that will be measured. PP1
2. Based on the materials selected and the parameters of the question, have students make predictions about which parachute will perform best.
3. All students will drop their parachutes from an agreed upon height based on the dynamics of the school. Also, ensure that their measurements are recorded based on the dependent variable in the question
4. Students will record their observations and measurements (quantitative and qualitative) during each of the trials. Each parachute will have 5 trials. PP5
5. Students will analyze data and determine a list of how each design performed compared to their question. AE1

Journal
Discuss how results of testing drag in similar and repeated investigation varied, suggest possible explanations for variations 104-5

Explain drag as related to the parachute that you modified 301-18

Assessment:Informal Formative
Ensure that students have written a testable question related to drag PP1

Ensure that students have recorded observations and data about each of the their trials PP5

Ensure that students have analyzed results of their trials and have communicated a list of their findings AE1

Assessment:Formal Formative

Ensure that students have responded to the journal in which they have suggested how repeated trials vary 104-5

Ensure that students have explained drag as related to the final parachute design 301-18

The Best Parachute to Maximize Drag

Testable Question:

Prediction:

	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5
Parachute 1 - Time					
Notes					

Results:

Flight

Strand - Lift and Wing Shape

General Curriculum Outcomes	Specific Curriculum Outcomes
303-32 describe the role of lift in overcoming gravity and enabling devices, or living things, to fly	303-32 describe the role of lift in overcoming gravity and enabling devices, or living things, to fly
204-7 plan a set of steps to solve a practical problem and to carry out a fair test of a science-related idea	204-7, 205-1, 205-2 plan and carry out a set of steps to investigate the effect of wing shape on lift, and select and use tools in building models of various wing shapes
205-1 carry out procedures to explore a given problem and to ensure a fair test of a proposed idea, controlling major variables	
205-2 select and use tools in manipulating materials and in building models	
301-17 demonstrate and describe how lift is affected by the shape of a surface	301-17 demonstrate and describe how lift is affected by the shape of a surface
~~300-21 identify characteristics and adaptations that enable birds and insects to fly~~	~~300-21 identify characteristics and adaptations that enable birds and insects to fly~~
106-4 describe instances where scientific ideas and discoveries have led to new inventions and applications	106-4 describe how knowledge of wing shape, and ability to change wing shape in flight, can affect lift

How Does it Stay in the Air?

Outcomes:
301-17 demonstrate and describe how lift is affected by the shape of a surface
PP4 plan and carry out a set of steps to investigate the effect of wing shape on lift, and select and use tools in building models of various wing shapes

Lesson Activity Overview
The focus of this lesson is to introduce students to the concept of lift. Specifically, understanding how the airfoil design and the movement of air around the wing creates lift. Students will be given inquiry time to explore how lift works with various objects.

Question
How do heavy flying devices, like commercial planes, life off the ground and fly?

Investigate Lift Activity
Materials
sheet of paper ruler masking tape hair dryer

1. Fold the piece of paper in half. Tape one edge about 1.5 cm in from the other edge, as shown.
2. Place the ruler through the paper at the fold
3. Turn the hair dryer on to the low setting and aim it at the paper. Observe what happens as the air blows over the folded paper PP5
4. Hold the hair dryer at varying angles and observe the effect. PP5
5. Change the shape variable by increasing the top curve (move the tape edge farther back rom the free edge) or decreasing it (move the taped edge closer to the free edge). Repeat steps 3 and 4.
6. Repeat again, changing other variables - shapes, size, and types of paper, for example.

Journal
Explain the difference between aiming the hair dryer directly at the paper and what happened when you altered the angle. How would this affect a commercial airplane remaining in flight? 301-17

Assessment:Informal Formative
Ensure that students have recorded observations from step 3 and 4 (question 1 & 2) PP5

Ensure that students have conducted the experiment PP4

Assessment:Formal Formative
Ensure that students have responded to the journal in which they correlated the difference of the angle of air flow to the ability to remain in flight 301-17

Investigate Lift Activity

1. When the hair dryer is turned to the low setting and the aimed at the paper, what did you observe? Why do you think this happens

2. When the hair drying is moved to varying angles, what did you observe? Why?

3. What are the effects of changed the curve of the top half of the sheet?

4. What are the effects of using different shapes, sizes, and materials?

5. Draw a labelled diagram to show the effects of moving air on the sheet of paper in step 1 through 3.

Building an Airplane Wing

Outcomes:
303-32 describe the role of lift in overcoming gravity and enabling devices, or living things, to fly
301-17 demonstrate and describe how lift is affected by the shape of a surface
PP4 plan and carry out a set of steps to investigate the effect of wing shape on lift, and select and use tools in building models of various wing shapes
106-4 describe how knowledge of wing shape, and ability to change wing shape in flight, can affect lift

Lesson Activity Overview
The focus of this lesson is to expand students understanding of the concept of lift. Students should conceptually understand the movement of air creating a pressure change resulting in lift from the previous lesson. The shift in the learning should be from the shape of the airfoil creating a lift to how it eventually overcomes gravity to “lift off”. Since a commercial airplane is much heavier then a piece of paper, students need to focus on their conceptual understanding of lift and apply it to larger and heavier real world examples.

Design an airplane wing challenge

Students should be engaged in an engineering challenge to design a replica of a commercial airplane wing that would create lift.

During the challenge, students should be challenged to understand and explain how shape of the wing are changed during flight. (106-4)

After groups have created their wings, designs should be shared with the class. Conversations should take place regarding possible improvements that could be made in light of discussions. (301-17)

Journal
Based on the design process and the improvements that have been suggested. Highlight the key features and give a detailed explanation in order for a wing to create lift. 301-17

Explain how the shape of the wing must be altered during take off, in flight, to turn, and during descent. 106-4

Lift Resources
https://howthingsfly.si.edu/aerodynamics/factors-affecting-lift

What Factors Affect Lift?
The size and shape of the wing, the angle at which it meets the oncoming air, the speed at which it moves through the air, even the density of the air, all affect the amount of lift a wing creates.

Assessment:Informal Formative
Ensure that students have designed a wing PP4

Assessment:Formal Formative
Ensure that students have responded to the journal in which they highlight the key features and give a detailed explanation of wing shape creating lift 301-17

Ensure that students have responded to the journal in which explain how wing shape is altered during different parts of flight. 106-4

Flight
Strand - Lift and Bernoulli's Principle

General Curriculum Outcomes	Specific Curriculum Outcomes
303-33 identify situations which involve Bernoulli's principle	303-33 identify situations which involve Bernoulli's principle
106-3 describe examples of improvements to the tools and techniques of scientific investigation that have led to new discoveries	106-3 describe how aerodynamic research using wind tunnels and/or computers can contribute to new airplane designs
104-3 demonstrate and explain the importance of selecting appropriate processes for investigating scientific questions and solving technological problems	104-3 explain why using computer simulations and/or wind tunnels are appropriate processes for investigating wing and airplane designs
205-8 identify and use a variety of sources and technologies to gather pertinent information	205-8 identify and use a variety of sources to investigate the sue of wind tunnels in testing aircraft shapes

Science Resource Package: Grade 6

Flight:

Bernoulli's Principle

New Brunswick Department of Education

September 2009

Acknowledgements

The Department of Education of New Brunswick gratefully acknowledges the contributions of the following groups and individuals toward the development of the New Brunswick Science Resource Package for Grade 6 *Flight: Bernoulli's Principle*:

- The Science Resource Package Development Team:
  - ¥ Les Crossman, School District 14
  - ¥ Monique Hitchcock, School District 17
  - ¥ Julie LeGresley, School District 18
- Science East:
  - ¥ Michael Edwards, Director of Programming
  - ¥ Karen Matheson, Director of Education
- Kathy Hildebrand, Learning Specialist, Science and Mathematics, NB Department of Education
- Science Learning Specialists and science teachers of New Brunswick who provided invaluable input and feedback throughout the development and implementation of this document.

Note that at the time of posting, all URLs in this document link to the desired science content. If you observe that changes have been made to site content, please contact Kathy Hildebrand katherine.hildebrand@gnb.ca, Science Learning Specialist, at the Department of Education.

2009
Department of Education
Educational Programs and Services

Table of Contents

Rationale

This resource package models current research in **effective science instruction** and provides an **instructional plan** for one topic selected from the Grade 6 Atlantic Canada Science Curriculum. This curriculum includes STSE (Science, Technology, Society and Environment) outcomes, Skills outcomes, and Knowledge outcomes – all of which are important for building a deep understanding of science and its place in our world.

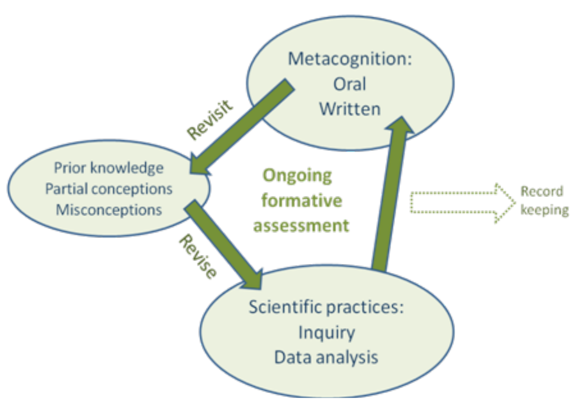
As has been true of our ancestors, we all develop “explanations” about what we observe which may or may not be valid. Once ideas are established, they are **remarkably tenacious** and an alternate explanation rarely causes a shift in thinking. To address these **misconceptions** or alternate conceptions, students must be challenged with carefully selected experiences and discussion.

A key part of this instructional plan is accessing **prior knowledge.** It is recorded in a way that it can and **will be revisited** throughout the topic. The intent is to revise, extend, and/or replace students’ initial ideas with evidence-based knowledge.

Science is not a static body of facts. The process of exploring, revising, extending, and sometimes replacing ideas is central to **the nature of science**. Think of science as an **ongoing evidence-based discussion** that began before our time and that will continue after it. Science is often collaborative, and discussion plays a key role. Students’ learning of science should reflect this as much as possible.

The intent of this instructional plan is to encourage a **constructivist** approach to learning. Students explore an activity, then share, discuss and reflect. The telling of content by the teacher tends to come after, as an extension of the investigation (or experience) explored by the students.

The learning is **organized into cycles**. The partial conceptions and misconceptions are revisited in each cycle so that students’ ideas will be revised. Each cycle will result in deeper and/or extended learning.



Hands-on activities are part of the instructional plan. Inquiry activities tend to be most structured in the first cycle. The teacher provides the question to investigate and gives a procedure to follow. In subsequent cycles, less structure tends to be given. For example, students may be given a question and asked to develop an experimental plan which they then implement. The goal is to **move towards open inquiry** in which students generate a testable question, develop an experimental plan using available materials, implement the plan, record relevant observations, and make reasonable conclusions. The included activities are meant to start this journey.

Discussion and **written reflections** are key parts of the lessons. Discussion (both oral and written) is a vehicle that moves science forward. For example, when scientists publish their evidence and conclusions, other scientists may try to replicate results or investigate the range of conditions for which the conclusion applies. If new evidence contradicts the previous conclusions, adjustments will be required. Similarly, in this instructional plan students first **do**, then **talk**, then **write** about the concept. A section on supporting discussion is included in this resource package.

Assessment tasks are also included in the instructional plan and assess three types of science curricular outcomes: STSE, Skills, and Knowledge. These tasks are meant to be used as tools for letting the teacher and the students know **where they are** in their learning and what the **next steps** might be. For example: Has the outcome been met or is more learning required? Should more practice be provided? Is a different activity needed?

When assessment indicates that outcomes have been met, it will provide **evidence of achievement**. This evidence may be sufficient and further formal testing (paper-pencil tests) may not be required to demonstrate that outcomes have been met.

Background Information

Prior Knowledge:

- Air: takes up space, has pressure, has mass, rises when temperature increases
- Gravity is a force working against flight

Common Misconceptions:

MISCONCEPTION
FACT
"The engine is what keeps planes in the air (provides lift)"
Wing shape and angle of attack provide lift.

"Fast moving air has high air pressure, slow moving air has low pressure"

Moving air exerts lower air pressure than still air.

Did You Know?

Be aware that lift (with respect to airplane wings) is a complex phenomenon with various explanations of how it works. This is a good example of the nature of science – there is ongoing discussion among experts on how lift is produced. Some experts indicate it has little to do with Bernoulli's principle. You might be most comfortable indicating that there is more to learn about lift and all the whys have not been answered. Bernoulli's principle is one way of thinking about lift.

"Fast moving air has more pressure" is something most people believe. In fact, when air moves faster the pressure it exerts is less. This is known as the Bernoulli effect or Bernoulli's principle. It applies to gases and liquids, both considered fluids because they can flow.

Examples of the Bernoulli Principle:

- A piece of paper flying off a table when someone walks by
  When someone is walking past, they make the air move faster. Faster moving air has less pressure, so the still air on the table has more pressure and moves across and off the table to where there is less air pressure (where you are walking) taking the paper with it.
- Subways/trains/trucks moving through tunnels or stations at a high speed
  People, cars/objects next to the train/truck are pushed towards the train/truck since the faster moving air has less pressure than the air away from the truck/train. This air then moves towards the truck/train. If you are riding a bicycle and a large truck goes by, you may feel drawn toward the truck. The air at the truck is moving quickly and has less air pressure than the air around your bicycle, the air around the bicycle moves to the low pressure area (fast moving air) created by the truck.

Instructional Plan

Access Prior Knowledge

Activity

1. In small groups, have students brainstorm and record a list of things that fly. You could have students print ideas on index cards or on pieces of paper with markers. These can be tacked to a bulletin board as they are shared.

2. Then as a whole class, share one item from each group (round robin style) and record on the board or on chart paper. As each item is named, those items that no other group has can earn that group a point.

Ask: *What keeps these things up in the air?*

Have students discuss this in pairs or small groups before sharing ideas with the whole class. Accept all ideas and record in a way that these ideas can be revisited in later lessons. Do not indicate whether the suggestions are correct or incorrect at this time. If students disagree with each other, allow them to express their thinking and reasons to each other. The discussion tips on pages 15-16 may be helpful. You may wish to have students sort the list of flying things by the how they think the objects stay in the air.

> ✓ **Assessment:**
> Note the concepts and misconceptions students are expressing. You will need to know these to plan effective questions for subsequent activities and discussions so that students will examine and adjust their alternate conceptions.

Post student versions of curricular outcomes on chart paper (see page 18). Inform students that these outcomes will be addressed over the next portion of the unit. Point out to students which outcomes are being addressed in each activity.

1^{st} Cycle

✪ **Curriculum Outcomes**

104-5 Describe how results of similar and repeated investigations may vary and suggest possible explanations for variations.
205-1 Carry out procedures to explore a given problem and to ensure a fair test of proposed idea, controlling major variables.
205-5 Make observations and collect information that is relevant to a given question or problem.
207-2 Communicate procedures and results, using lists, notes in point form, sentences, charts, graphs, drawings, and oral language.

Paper strip activity

(*The Sky's the Limit* resource on p.17, paragraph with bullet)

Materials:

Strip of paper (about 2 or 3 cm wide and the length of a sheet of paper)

Part 1:
Hold one end of a strip of paper against your bottom lip with the paper drooping down. Predict what will happen when you blow straight forward. Try it. What do you notice? Have each person in your group try this at least once. Record what happens during each trial.

Part 2:
Using air, how many different ways can you make the paper lift up? Record what you tried and what happened. Note negative results also as they also give important information.

✓ **Assessment:**
During the student activity, make notes on outcomes (or parts of outcomes) you observe being addressed. Process skill outcomes are part of the curriculum and should be assessed. Using the observation chart or the checklist (see pages 22-24) on a clipboard may be helpful to you. Develop your own code for quick notes.

A suggested code:
√ for observed and appropriate,
WD - with difficulty,
RTT - refused to try,
A -absent.

This chart may be used on multiple days, using a different coloured pen or pencil each day and putting the date in the corner. You may not have a symbol or note for every child every day. Some teachers like to focus on a group or two each time. However you choose to make note of your observations, you will always have a sense of who you need to take more notice of and who might need extra support. The information will also help you when it is reporting time.

Reflection: Class Discussion

- Have students share their observations and thoughts (conclusions). See teacher's note about encouraging classroom talk on pages 15-16.

- Emphasize that scientific knowledge is based on evidence and that it gets revised or changed whenever contradictory evidence is confirmed. Look back at ideas on "What keeps things up in the air?" from Accessing Prior Knowledge activity. *Do we need to revise, add to, or change any of these? Is there other information we could add?*

- **Skill Development:** After other discussions, draw attention to the different ways students have recorded their observations and information. Which are easiest for others to understand? Which are easiest to create and record in? Which sort might you want to try using another time?

2nd Cycle

✪ Curriculum Outcomes

104-5 Describe how results of similar and repeated investigations may vary and suggest possible explanations for variations.
205-1 Carry out procedures to explore a given problem and to ensure a fair test of proposed idea, controlling major variables.
205-5 Make observations and collect information that is relevant to a given question or problem.
207-2 Communicate procedures and results, using lists, notes in point form, sentences, charts, graphs, drawings, and oral language.
303-33 Identify situations which involve Bernoulli's principle.

Moving Air Activities

- In small groups:
  Each group is given a different activity to explore (Directions for students are given on pages 19-20)

Activity	Materials	Anticipated Results (For Teachers only)
Suspended Balloons	2 Balloons 2 pieces of string	The balloons should move together as the air moves between them
2 Pop Cans	2 empty pop cans 2 pieces of string	The cans should move together as the air moves between them
Paper Tunnel	1 sheet of paper	the paper tunnel should collapse as the air moves through it
Ping Ping Ball & Funnel	1 ping pong ball 1 funnel	it should be very difficult to blow the ball out of the funnel
Ping Ping Ball & Dixie Cup	1ping pong ball 1 dixie cup	Blowing down into the cup should not remove the ball. Blower over the top of the cup should cal the ball to be ejected from the cup
Pinwheel	1 pinwheel (see sheet)	The pinwheel should spin fastest when the air blows from the front
Pop Can & Straws	2 pop cans 20 drinking straws	The cans should roll together when air is blown between them and roll apart when air is blow on the outside edge

Students will select and use their choice of method of recording their results (refer to the skill development piece in the reflection discussion at end of 1st cycle on page 6). Following the exploring time, the groups will be responsible for explaining their activity and their observations/results to the whole class.

> ✓ **Assessment:**
> On observation chart (or other record), note how students are performing on the skill outcomes. Note that you may observe students controlling variables such as how close? How far? How fast? How slow? From which direction?

- Have each group briefly describe their activity and explain their results to the class. Highlight references to airspeed and air pressure and any connections made between them.
- After all groups have shared, ask questions to get discussion and build connections between activities. "Which other experiment was yours most like? Which is it least like?"
- Again revisit ideas on "What keeps things up in the air?" from Accessing Prior Knowledge activity. Again do we need to revise, add to, or change any of these?

Reflection: Journaling

- Have students write a quick entry (5-7 minutes) in their science journal or notebook stating which activity they completed and answering the following. Which other experiment was yours most like? Which is it least like? Explain.

> ✓ **Assessment:**
> Journal entries should not receive a score or mark. A positive comment followed by a question to refocus attention or suggest the next step in learning is very effective.
>
> When reading the journal entries, note which students are getting the idea that moving air has lower air pressure than still air (Bernoulli's principle).

Moving Air Activities

Suspended Balloons

Equipment: 2 balloons, 2 pieces of string

Instructions: Inflate the balloons and attach short lengths of string (approx. 30 cm). Hold one string in each hand and suspend balloons at mouth level – balloons should be 3 or 4 cm apart. Blow between the balloons and record what happens.

2 Pop Cans

Equipment: 2 empty pop cans, 2 pieces of string

Instructions: Tie short lengths of string (approx. 30 cm) to ring pulls on empty pop cans. Hold one string in each hand and suspend pop cans at mouth level – cans should be 3 or 4 cm apart. Blow between cans and record what happens.

Paper Tunnel

Equipment: 1 sheet of paper

Instructions: Fold paper to make a tunnel (as shown in diagram). Place tunnel on table and blow through the tunnel and record what happens.

Ping Pong Ball & Funnel

Equipment: 1 ping pong ball, 1 funnel

Instructions: Place ping pong ball into funnel. Holding funnel upright, attempt to blow ball out of funnel by blowing through the bottom of the funnel. Record what happens.

Ping Pong Ball & Dixie Cup

Equipment: 1 ping pong ball, 1 Dixie cup

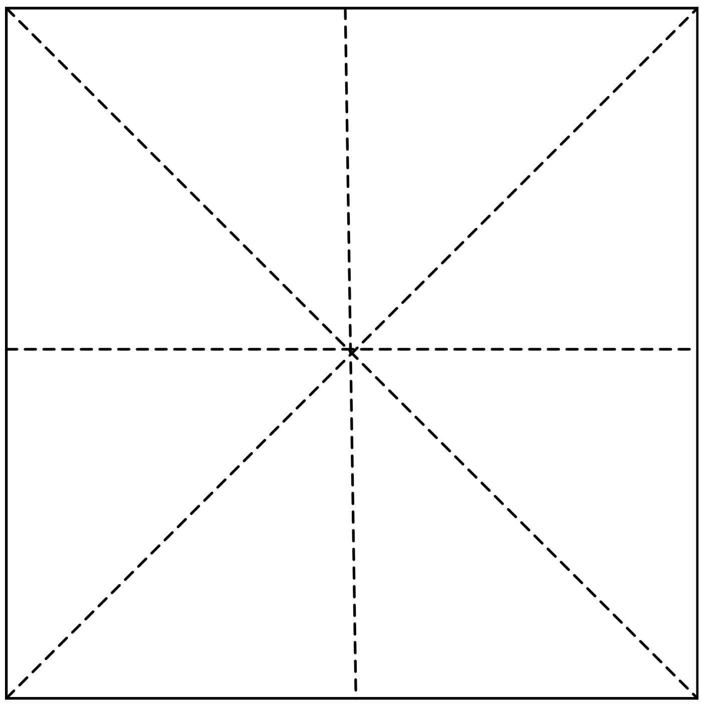
Instructions: Place ping pong ball into Dixie cup. Try to blow ball out of cup using various methods. Record which methods work and which ones don’t.

Pinwheel

Equipment: 1 pinwheel

Instructions: Try to make the pinwheel spin as quickly as possible by blowing from different directions. Record which direction works most successfully.

Cut out the following shape. Cut each dotted line almost to the center. Fold/twist each triangle the same way to make angled fan blades. Mount the pinwheel to a popsicle stick using a thumb tack so that it is free to spin.



Pop cans & Straws

Equipment: 2 pop cans, 20 drinking straws

Instructions: Place straws on table-top to act as rollers, and place the pop cans on top of the straws. Pop cans should be approximately 5 cm apart. Blow between cans and record what happens. Get two people to blow on past the outside edges of the cans and record what happens.

3rd Cycle

✪ Curriculum Outcomes

207-2 Communicate procedures and results, using lists, notes in point form, sentences, charts, graphs, drawings, and oral language.

303-33 Identify situations which involve Bernoulli's principle.

Journal Discussion

Comment on journal entries and how students are noticing a difference in air pressure between moving air and still air. Ask if any students want to elaborate or comment on this. Today, students will have another experience with this and do a write up of an experimental procedure.

Another Moving Air Activity

In small groups, have students explore a different activity from the 2nd cycle. This will give them further experience with air pressure of moving air.

Skill Development:
Note that if the rubric is to be used for assessing student work, it should be given to students and discussed **before** the investigation. Examples of previous experimental write ups should be displayed. If this is new to students, the process should be modeled by the teacher several times before expecting students to complete one independently.

Each student should write instructions for the activity so that other students could carry it out and see the same result(s).
Students should be aware that the directions need to be detailed enough for others to follow and that any variables are controlled. (For example: blowing direction, speed/force of blowing)
The rubric on the next page may be helpful.

Have students self-assess their write up before handing it in to you. Give students the guidelines (see "got it" column) and ask them to comment on how well their work meets each criteria. The third column will be for you to give feedback (see sheet on page 20).

✓ Assessment:
Note if students are able to write up a lab report or if mini-lessons on specific parts of the report are needed.

✓ **Assessment:**
Note if instructions are clear, organized and if variables are controlled.

Got it	Nearly There	Not Yet
Written steps are detailed and in sequential order. Steps are detailed enough that variables are controlled. Procedure could be replicated	Some steps are unclear or missing and/or steps are out of order. Missing some details that would controlled one or more variables during the replication	Steps are not accurate or there is not enough detail to be replicated
Spelling and grammar errors are absent or rare	Some spelling and grammar errors	Spelling and grammar errors common

Reflection: Class Discussion

- Revisit ideas on “What keeps things up in the air?” from Accessing Prior Knowledge activity. *Do we need to revise, add to, or change any of these? Is there other information we could add?*
- Talk with a partner about what you know now that you didn’t know before.
- Make a list of these in your journal.

4th Cycle

✪ Curriculum Outcomes

106-4 Describe instances where scientific ideas and discoveries have led to new inventions and applications.
303-32 Describe the role of lift in overcoming gravity and enabling devices or living things to fly.
303-33 Identify situations which involve Bernoulli's principle.

Activities

- Have students read about Daniel Bernoulli (see biography on pages 25-27) and answer the following questions.

  What questions might he have been asking himself about fluids?

  What useful idea did he describe?

  How does Bernoulli's principle apply to the activities you have experienced?

- Have students view the Bill Nye video on flight (or other similar video) which will confirm many of the conclusions arrived at through the inquiry cycles. The Bill Nye flight video can be found at http://learning.aliant.net/. Type flight into the search box and choose the Bill Nye video called Flight. Note that a table of contents opens beside the video so that you may select only certain sections for viewing if you wish. There is also an option to watch the video full screen. (You need to register to use the videos on the Aliant site. Registration is free. If you try to watch the video without logging in, you are prompted to do so.)

Reflection

- After watching the video, have students discuss and/or write about where Bernoulli's principle can be seen in the real world.

- You may wish to revisit and extend the discussion of how Bernoulli's principle applies to the activities the students experienced.

- Also revisit ideas on "What keeps things up in the air?" from Accessing Prior Knowledge activity (on page 4). *Do we need to revise, add to, or change any of these? Is there other information we could add?*

  Examples of other applications of Bernoulli's principle:

  Vacuum cleaner, paint sprayer, plant mister, perfume atomizer, aspirator

✓ Assessment:
Compare two (or more) of the moving air activities, highlighting their similarities and differences. Explain how Bernoulli's principle describes the role of air pressure to make things rise.

Think like a scientist

Asking good questions is an important skill in science. Good questions are clear and testable. Initially students will need support. Model the skill with the whole class and students will begin to have the confidence to contribute. After some practice, students will be able to generate questions successfully individually.

Present students with a situation and ask them to generate questions that could be investigated scientifically.

Situation:

> Formula One race cars travel at speeds up to 360 km/hr. At high speeds there is a danger of the car becoming airborne. These cars are designed to keep them on the ground. Instead of using lift to fly, cars are applying lift in the opposite direction - to stay on the ground and maintain traction.
>
> What is one question relating car aerodynamics to the car's contact with the ground, that could be investigated scientifically?

Possible extension

- ✶ Go to the "Learn Alberta" site (follow URL address below) to access "The Thrill of Flight", which contains a section on Bernoulli's principle.

http://www.learnalberta.ca/content/setf/html/StudentResource/source/Welcome.html

Building/Topic 2 has information on the Bernoulli's principle. It includes a simulation measuring lift on 2 shapes of wings.

- ✶ The video at http://www.wimp.com/aircrafttakeoff/ is an interesting one to discuss. What is allowing this unusual airplane to fly?

Other possible ideas for flight unit

301-17 Describe and demonstrate how lift is afftected by the shape of a surface
303-32 Describe the role of lift in overcoming gravity and enabling devices or living things to fly

Activity idea: Outline an airfoil on the floor or ground. Have students make a line standing in twos. The line of students divides apart as students walk, so that one line travels under (to the right) of the airfoil and one line travels over (to the left) of the airfoil. Students must reach the end of the airfoil at the same time as their partner. What is happening?

The following interactive site clearly shows the interactions of lift, drag, and angle of attack. Choose "Airfoil Design" http://www.pbs.org/wgbh/nova/space/lift-drag.html

205-8 Identify and use a variety of sources to investigate the use of wind tunnels in testing aircraft shapes

Students will review the concept and purpose of wind tunnels.

Students will select a shape to observe and note the movement of, when placed into a wind tunnel. The teacher will provide a choice of shapes for the students to select.

The following sites give directions for how to build a wind tunnel. http://wings.avkids.com/Curriculums/Aerodynamics/windtunnel_summary.html
http://www.ehow.com/how_4443958_build-wind-tunnel.html

Also see curriculum document page 63 for suggestions on how to suspend the shape within the wind tunnel. The shape must fit within the wind tunnel. Students will create a format for recording observations. (Curriculum outcome 207-2 communicate procedures and results, using lists, notes in point form, sentences, charts, graphs, drawings, and oral language)
Based on students' observations, discuss similarities in the movement of the shapes. Revisit Bernoulli's principle, discuss how this theory applies to the movements of the shapes in the wind tunnel. (Guide students toward aerodynamics and wing shape.)

Pose a challenge to the students: (to work in small groups) Create a wing (airfoil) that demonstrates one movement when placed in the wind tunnel, which is to rise (demonstrate lift). Provide a model wing which will demonstrate the desired movement. Ask students to point out the characteristics of the model wing (aerodynamic: one rounded edge and one tapered edge) and its effectiveness on creating a rising movement-lift.

Have students compare the movement and the characteristics of the model wing to their own wing.

Students should be able to discuss and demonstrate their results and conclude that aerodynamics and Bernouli's principle are related to the shape which creates the rising movement.

Other resources

http://www.mansfieldct.org/Schools/MMS/staff/hand/flight4forcesoverview.htm explains about the four forces acting on flight

http://www.iit.edu/~smile/phma2000.htm describes how to make a simple atomizer and other experiments on Bernoulli effect

Flight
Strand - Thrust and Propulsion

General Curriculum Outcomes	Specific Curriculum Outcomes
303-34 describe and demonstrate the means of propulsion for flying devices	303-34 describe and demonstrate the means of propulsion for flying devices
300-22 describe and justify the differences in design between aircraft and spacecraft	300-22 describe and justify the differences in design between aircraft and spacecraft
105-3 describe examples of scientific questions and technological problems that have been addressed differently at different times	105-3 compare current and past air and space craft
107-9 compare past and current needs, and describe some ways in which science and technology have changed the way people work, live, and interact with the environment	107-9 describe some ways that flying devices have changed the way people work and live
107-12 provide examples of Canadians who have contributed to science and technology	107-12 provide examples of Canadians who have contributed to the science and technology of aircraft

Propelling Objects - Pulling Air

Outcomes:
303-34 describe and demonstrate the means of propulsion for flying devices
300-22 describe and justify the differences in design between aircraft and spacecraft

Lesson Activity Overview
This lesson should focus on showing the two types of propulsion: propulsion based on gases being projected away from a plane (pushing the plane through the air), and propulsion pulling the plane through the air. In the previous lesson students created a model

Propellers turn in a way that pulls the air in front to the back, similar to a screw being twisted into wood.

Activity
Make a propeller

Materials

2l plastic pop bottle	sharpened pencil	nail
dry-erase marker	ruler	scissors

1. use a dry-erase marker to draw a strip about 2cm by 10 cm on the side of the empty plastic bottle. Using scissors, cut the strip from the bottle.
2. Use a ruler to draw two straight lines from opposite corners of the strip. Draw a dot where the two lines intersect. This is the centre.
3. Make a small hole at the centre of the strip, using a nail. The hole should be smaller than the pencil. Poke the pencil through it.
4. Hold each end of the strip between your thumb and forefinger. Gently twist the ends, rotating your hands in opposite directions.
5. Hold the pencil between your two hands and spin it round. Release it when it is spinning quickly. What happens?

Analysis
- What happened when you spun the propeller? Why? What forces did you observe?

Journal
- Use what you have observed to explain how a propeller moves a plane forward. 300-22

- Compare the driving force for a propeller aircraft to that of a jet craft 303-34

Assessment:Informal Formative
Ensure that students have completed the task of creating a simulated propeller wing

Assessment:Formal Formative
Ensure that students have journaled about their observations leading to an understanding of a propeller 300-22

Ensure that student have journaled about the propulsion of a jet craft 303-34

Propelling Objects - Moving Gas

Outcomes:
303-34 describe and demonstrate the means of propulsion for flying devices
300-22 describe and justify the difference in design between aircraft and spacecraft

Lesson Activity Overview
This lesson should focus on modelling to students. the force of Thrust. Thrust is what propels, or drives forward. A jet engine's thrust has to move an airplane upward and forward faster then gravity and drag can pull it down or push it back.
Space craft cannot use propellers, since there is very little air in space for it to catch on its blades. They must make their own gas to shoot out to propel the plane forward

Activity
Investigate propulsion

Materials

balloons of various shapes and sizes	clothespins	plastic straws	fishing line
tape	various weights: washers, sinkers, etc	stopwatch	

6. Inflate a balloon. Use a clothespin to stop the air from escaping.
7. Tape the straw onto one side of the balloon. Thread fishing line through the straw.
8. Secure the fishing line vertical from the floor to the ceiling of the classroom
9. Predict what will happen if you remove the clothespin.
10. Release the clothes pin and record what happens
11. Repeat 3 times

Analysis
- Describe and explain what happened with you remove the clothespin
- Compile the data from your investigation and produce a chart or graph that explains your results. Compare your results with those of your classmates

Extension
1. Experiment with different shapes and sizes of balloons and time to see which flies fastest. Record your results
2. Attach washers, sinkers, or other weights to the balloon. How many weights can it carry to the ceiling? Experiment with different balloons to see which transports the heaviest payload.

Journal
From what you have observed from the balloon, describe the means of propulsion in this simulation. 303-34

Explain how the movement of air (gas) created the trusting force forward. 300-22

As the balloons acquired more mass in the extension activities, describe the change in the interaction between thrust, drag, and gravity. 303-34

Assessment:Informal Formative
Ensure that students have completed the worksheet (Propelling Objects)

Assessment:Formal Formative
Ensure that students have journaled about their observations leading to an understanding of trust 303-34

Ensure that students have journaled about how the movement of gas created the trusting force 300-22

Ensure that students have journaled about the interaction of trust, drag and gravity when mass is added to a similar shaped device. 303-34

Propelling Objects

1. Describe the shape of your balloon - (make approximate measurements and sketch the design)

2. Predict what will happen when you release the clothespin

3.

Trail 1	Trial 2	Trial 3

4. Describe and explain what happened with you remove the clothespin

5. Compile the data from your investigation and produce a chart or graph that explains your results. Compare your results with those of your classmates

Propulsion of Different Aircrafts

Outcomes:
105-3 describe examples of scientific questions and technological problems that have been addressed differently at different times (compare current and past air and space craft)
107-9 compare past and current needs, and describe some ways in which science and technology have changed the way people work, live, and interact with the environment (describe some ways that flying devices have changed the way people work and live)
107-12 provide examples of Canadians who have contributed to science and technology (of aircraft)

Lesson Activity Overview
This lesson is designed to give real life application to what students have been learning about thrust and propulsion. In previous lessons students have created simulations build the understanding that items can be trusted by the moving of gas like in a space craft or the pulling of air in a propeller of a air plane or the jet turbine of a a jet plane.

Students should examine designs for spacecraft and airplanes, and note features that rely on an atmosphere (large wings, engines, propellers) and those that indicate the craft will be flying in space (small wings or rudders, large booster containers for rules as these are needed).
In the past, there were large differences between air and space craft, but increasingly, more flying devices (like space shuttles) are being developed that have the ability to fly both in space and in air, and those have features of both. 105-3

Its important for students to draw a connection between how flying devices, especially air planes, have changed the way people work and live. The focus here is not necessarily the technology of the plane, rather its how the demand of society on the need for air travel has lead to these advancements. 107-9

Its is always essential for students to understand how Canadians have impacted these advancements. Examples of Canadians who have contributed to flight are Wallace R. Turnbull from New Brunswick, who invented the variable pitch propeller, and Robert Noorduyn for Québec who designed the bush plane. J.D. McCurdy who built and flew aircraft in British Commonwealth. Other Canadians achievements in flight like Bombardier and Canadian Space Agency can be researched. 107-12

Task
Create a timeline display that illustrates a variety of aircraft showing developments from past to present day. Be sure to include Canadian contributions and make the connection to society's demand on air travel. (105-3, 107-9, 107-12)

Assessment:Informal Formative
Ensure that students have completed their requirements in the construction of a timeline
105-3, 107-9, 107-12

Building a Bottle Rocket

Outcomes:
303-34 describe and demonstrate the means of propulsion for flying devices

Lesson Activity Overview
This lesson is designed to give real life application to what students have been learning about thrust buy building their own bottle rocket. This lesson is not designed to be a generic lesson with a single design. Rather, students will need to alter an element of design in order to test the differences in design leading to a measured variable.

Please note that a Bottle Rocket Launcher will be required to properly do this task. Launchers can be purchased or hand built based on the comfort level of the school.

Bottle Rocket Launcher Kit
https://store.sciencebuddies.org/SBD-3000-KIT/bottle-rockets-kit.aspx

Bottle Rocket Launcher Plans
http://www.instructables.com/id/Bottle-Rocket-Launcher-The-Cheap-Doesnt-Get-You/

Materials

2 liter pop bottle	construction paper	heavy paper	modelling clay
garbage bags	rulers	string	duct tape
scissors	rulers	card stock	

Design Concepts to Consider

Fins	Nose Cone	Parachute (optional)
Fins should be firm	Card stock builds a firm secure nose cone	A garbage bag parachute will work
Fins should be secure: duct tape works well	The nose code should be a higher mass to surface area ratio	Cut open the bag so that it can lay flat
The size of the fins matters	Modelling clay can be used to allow students to add mass to the nose cone	Attach strings ot the end of the bag
Use the string to measure the diameter of the bottle and divide the length of the string by three. Make marks on the string dividing it into three equal parts and use those marks to mark the bottle for accurate placement of fins	The nose cone must go through the air easier then the body of the rocket	Place bag inside the nose cone and attach the loose end of the string to the inside of the sleeve on the body of the rocket
	If students choose to add a parachute…the nose cone needs to be able to separate from the rocket body	Use a “Z” fold to insert the parachute, do not wrap the strings around the parachute

*After applying the nose cone and fins, a string should be tied around the middle of the rocket to see if the rocket hangs evenly. If it doesn't then it has too much weight on one end or the other and should be balanced. You can also fly it overhead on the string to see if it is balanced in flight.

1. Design a testable question related to the expected outcome for the rocket based on an independent variable the is manipulated in size, shape, quantity, etc. and the dependent variable the is measure.
2. Formulate a hypothesis about how the dependent variable you are measuring is related to the independent variable you manipulated in the design
3. Record the data related to your dependent variable
4. Analyze and graph your data in a useable format appropriate to the task
5. Make simple conclusions. Students are able make a statement based upon logic and the evidence available. Whether the prediction/hypothesis is supported or refuted is not a measure of success or failure since scientific knowledge is advanced by either result.
6. Where possible students should compare the results of their investigation to those of others, recognize that results may vary and explain why. Comparison of findings to those of similar investigations can add weight to the conclusion.