Science Resource Package: Grade 6

Flight:

Bernoulli's Principle

New Brunswick Department of Education

September 2009

Acknowledgements

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- The Science Resource Package Development Team:
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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, kathy.hildebrand@gnb.ca, Science Learning Specialist, at the Department of Education.

2009

Department of Education

Educational Programs and Services

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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.

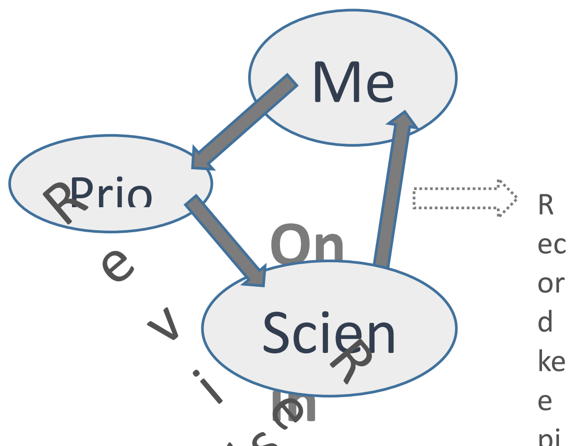
As has been true of our ancestors, we all develop "explanations" about what we observe which may or may not be valid. Once ideas are established, they are **remarkably tenacious** and an alternate explanation rarely causes a shift in thinking. To address these **misconceptions** or alternate conceptions, 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:

- <u>A piece of paper flying off a table when someone walks by</u>
  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.
- <u>Subways/trains/trucks moving through tunnels or stations at a high speed</u>
  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.

1st 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 teacher 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 Pong Ball & Funnel	1 ping pong ball 1 funnel	It should be very difficult to blow the ball out of the funnel.
Ping Pong Ball & Dixie Cup	1 ping pong ball 1 Dixie cup	Blowing down into the cup should not remove the ball. Blowing over the top of the cup should cause the ball to be ejected from the cup.
Pinwheel	1 pinwheel (page 16)	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 blown 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).

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 **control one or more variables** during the replication.	Steps are **not accurate** or there is **not enough detail** to replicate procedure.
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?*

✓ 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.

Examples of other applications of Bernoulli's principle:

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

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

Supporting Class Discussion

No one person is as smart as all of us together.

Page Keeley, in the book "Science Formative Assessment" (2008), uses the analogy of ping-pong and volleyball to describe discussion interaction. Ping-pong represents the back and forth question-answer pattern: the teacher asks a question, a student answers, the teacher asks another question, a student answers, and so on. Volleyball represents **a different discussion pattern**: the teacher asks a question, a student answers, and other students respond in succession; each building upon the previous student's response. Discussion continues until the teacher "serves" another question.

A "volleyball" discussion encourages **deeper student engagement** with scientific ideas. Students state and **give reasons** for their ideas. Through the interaction, ideas may be challenged and clarified. Extensions and applications of ideas may arise as well. Discussions should **avoid the personal** and always revolve around **ideas, explanations and reasons.** The goal is for students to achieve better understanding.

Share the ping-pong and volleyball analogies with your students. Good discussion **takes practice**. You and your students will improve. Many teachers find discussion works best if all students can see each other, such as in a circle, at least until they become accustomed to listening and responding to each other.

As the teacher, you will need to:
- establish and maintain a respectful and supportive environment;
- provide clear expectations;
- keep the talk focused on the science;
- carefully orchestrate talk to provide for equitable participation.

It is important to **establish discussion norms** with your class. Your expectations may include:

- Everyone has a right to participate and be heard.
- Everyone has an obligation to listen and try to understand.
- Everyone is obliged to ask questions when they do not understand.
- The speaker has an obligation to attempt to be clear.

At first, discussions are apt to seem somewhat artificial. Initially, a bulletin board featuring cartoon talk bubbles with suggested sentence starters may be helpful.

I respectfully disagree . . .
I had a different result . . .
Could you show how you got that information?
When I was doing ___, I found that . . .
Even though you said ___, I think . . .
The data I have recorded in my notebook is different from what you shared. I found . . .

It is helpful if **teacher questions refer to a big idea** rather than specifics. (Could humans and chickens move their bones without muscles?) Questions should be phrased so that anyone can enter into the conversation. Opinion questions are especially good for this (What do you think . . . ?
How do you think . . . ? What if . . . ? Why . . . ?).

Provide plenty of **wait time** for students. Students give more **detailed and complex answers** when given sufficient wait time. Allow wait time after student responses. When students are engaged and thinking, they need time to process other responses before contributing. If the discussion is not progressing, have students engage in **partner talk**. Partner talk enables the teacher the opportunity to insert "overheard" ideas.

Helpful teacher prompts:

1. What outcome do you predict?
2. Say more about that.
3. What do you mean by . . . ?
4. How do you know?
5. Can you repeat what ____ said in another way?
6. Does anyone agree or disagree with . . . ?
7. Does anyone want to add to or build on to . . . ?
8. Who understands ___'s idea and can explain it in their own words?
9. Let me see if I have got your idea right. Are you saying . . . ?
10. So you are saying that . . .
11. What evidence helped you to think that?
12. Okay, we do not agree. How does each position fit the evidence? What else could we find out?

References:

Keeley, Page (2008). *Science Formative Assessment.* Thousand Oaks, CA: Corwin Press and Arlington, VA: NSTA Press

Michaels, Sarah, Shouse,Andrew W., and Schweingruber, Heidi A. (2008). *Ready, Set, SCIENCE!* Washington, DC: The National Academies Press

Materials List

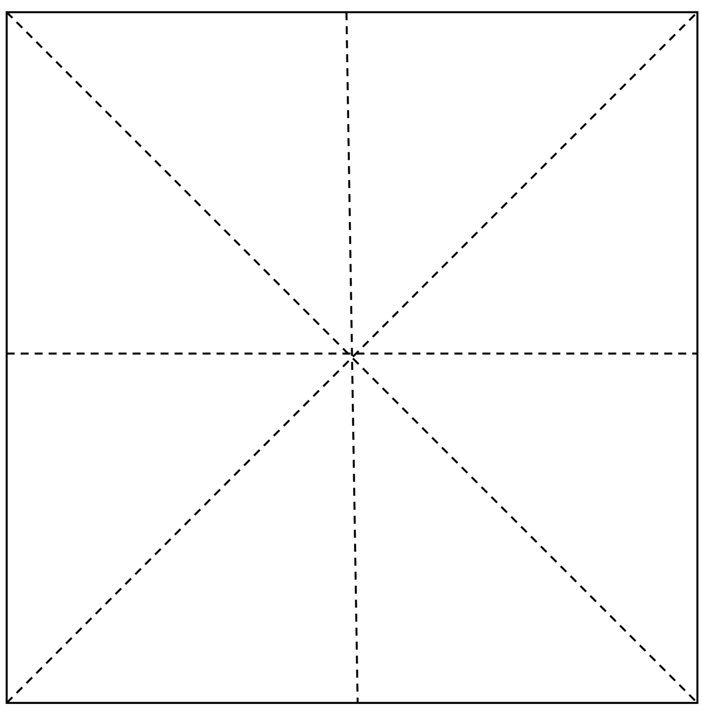
2 balloons
String
4 empty pop cans
2 ping pong balls
Funnel
Dixie cup
Pinwheel
About 20 drinking straws

Grade 6 Science kits given to schools in 2009 contain:

- 2 ping pong balls
- 1 funnel
- 2 giant microbes
- Sun, Earth, moon balls kit
- Canadian Space Agency kit and CD
- 10 clear microscope slides
- 10 cover slips
- 2 prepared slides: Euglena and Paramecium

To make a pinwheel:

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.



Student Version of Outcomes

104-5 Explain how you might get different results for the same experiment and why that might happen.

106-4 Describe examples of scientific ideas and discoveries that have led to new inventions and uses.

204-7 Plan a set of steps to solve a practical problem and carry out a fair test.

205-1 Follow instructions to do an experiment and make sure the tests are fair (variables are controlled).

205-5 Make observations and collect information that is important to the question.

207-2 Explain procedures and results (using lists, notes in point form, sentences, charts, graphs, drawings, and/or oral language)

303-33 Give examples of situations where you would see Bernoulli's principle in action.

303-32 Explain how lift helps overcome gravity and allows flight to happen.

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.

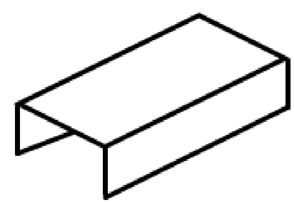
2 Pop Cans

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.

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.

Student Self-assessment

"Got it"	Student self-assessment	Teacher feedback
Written steps **are detailed** and in **sequential order**. Steps are detailed enough that **variables are controlled**. Procedure **could be replicated.**		
Spelling and grammar **errors are absent or rare**.		

Observation Chart Sheet

Outcomes:

name	**name**	**name**	**name**	**name**
name	**name**	**name**	**name**	**name**
name	**name**	**name**	**name**	**name**
name	**name**	**name**	**name**	**name**
name	**name**	**name**	**name**	**name**
name	**name**	**name**	**name**	**name**

Checklist Sheet

Outcomes	Correlations with Cycles	Yes	No
STSE			
104-5 describe how results of similar and repeated investigations may vary and suggest possible explanations and variations	1st cycle: Answering what was noticed after the activities 2nd cycle: Able to explain observations/results to class; controlled variables		
106-4 describe instances where scientific ideas and discoveries have led to new inventions and applications	4th cycle: Discussion/assignment on what items take advantage of the effect noted in Bernoulli’s principle		
SKILLS			
205-1 carry out procedures to explore a given problem and to ensure a fair test of a science-related idea	1st cycle: Repetition of paper strip activity in part 1 and ways of lifting paper in part 2 2nd cycle: Moving air activity		
205-5 make observations and collect information that is relevant to a given question or problem	1st cycle: Make/record observations 2nd cycle: Make/record observations		
207-2 communicate procedures and results, using lists, notes in point form, sentences, charts, graphs, drawing, and oral language	1st cycle: Record of paper strip activity observations 2nd cycle: Ability to select the best way for them to record their observations ie: chart 3rd cycle: Write instructions so classmates can come up with same results		
KNOWLEDGE			
303-32 describe the role of lift in overcoming gravity and enabling devices or living things to fly	4th cycle: Discussion; assessment item/journal		
303-33 identify situations which involve Bernouilli’s principle	2nd cycle: Noticing commonalities among experiments (Bernoulli principle) 3rd cycle: Noticing commonalities in experiments and what keeps things flying (Bernoulli’s principle) 4th cycle: Assessment question/journal		

Observation Checklist

names	104-5 Describe how results of similar and repeated investigations may vary and suggest possible explanations for variations	106-4 Describe instances where scientific ideas and discoveries have led to new inventions and applications	204-7 Plan a set of steps to solve a practical problem and to carry out a fair test of a science related idea	205-1 Carry out procedures to explore a given problem and to ensure a fair test of a 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	303-32 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

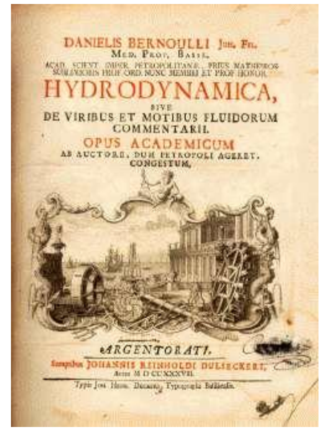
Student Record

Outcome goal	Evidence
I can explain the variation in experimental results. (104-5)	
I can give examples of scientific ideas that have led to new inventions and/or uses. (106-4)	
I can plan a set of steps to solve a problem and carry out a fair test. (204-7)	
I can follow instructions to do an experiment with controlled variables. (205-1)	
I can make observations and collect information important to the question. (205-5)	
I can explain procedures and results. (207-2)	
I can give examples of situations where you would see Bernoulli’s principle in action. (303-33)	
I can explain how lift helps overcome gravity and allows flight to happen. (303-32)	

Daniel Bernoulli

Daniel Bernoulli was born in 1700 in Groningen, Netherlands. He was the second of three sons. His father, Johann Bernoulli, was a noted mathematician.

When Daniel was five years old, his family returned to Basel, Switzerland where his father filled the chair of mathematics at the University of Basel. Daniel’s father tried to force Daniel into a career in business which Daniel resisted. He wanted to study mathematics. Daniel’s father said there was no money in mathematics. They agreed he should study medicine at university and Daniel’s father taught him mathematics on the side. Daniel’s relationship with his father appears to have been difficult throughout his life, allegedly because his father became jealous of Daniel’s accomplishments.



In 1725 Daniel went to St. Petersburg, Russia to take up the post of professor of mathematics. He worked on hydrodynamics and wrote a book titled *Hydrodynamica.* He described an extremely useful principle: when the speed of a moving fluid (liquid or gas) increases, pressure in the fluid decreases. The opposite is also true. His work pioneered the sciences of hydrodynamics and aerodynamics.

University of Basel

Daniel was unhappy in St. Petersburg and moved back to Basel, Switzerland around 1734. He was a professor of botany, later a professor of physiology, and finally was appointed to be the chair of natural philosophy (physics). He remained in that position until his retirement in 1776. He died in Basel in 1782.

During his lifetime, Daniel won or shared ten of the esteemed prizes of the Paris Academy of Sciences. The topics included astronomy, Newton's theory of tides, magnetism, a method of determining time at sea, best shape for a ship's anchor, ocean currents, effects of forces on ships, and proposals for reducing the pitching of ships in high seas.

In addition to hydrodynamics, Daniel Bernoulli's work included discoveries in the areas of probability, medicine, and music.

Picture sources:

Daniel Bernoulli http://en.wikipedia.org/wiki/Daniel_Bernoulli

Netherlands map http://wwp.greenwichmeantime.com/time-zone/europe/european-union/the-netherlands/map.htm

Switzerland map http://www2.canada.com/topics/travel/guides/lp.html?destination=switzerland

Hydrodynamica http://pass.maths.org.uk/issue1/bern/index.html

University of Basel http://en.wikipedia.org/wiki/University_of_Basel#History