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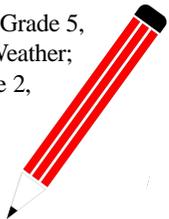
Grade 6

## **Cluster 2: Flight**

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### **Overview**

In this cluster, a study of the properties of fluids helps students to understand how flight can be achieved. Through the testing of models, students explore how the forces of thrust, drag, lift, and gravity act on living things or devices that fly through the air. They learn how specific adaptations or modifications can alter lift or drag. Different means of propulsion are compared and the use of unbalanced forces to steer aircraft and spacecraft are described. Students apply their understanding of forces and flight through the construction of a prototype that flies and meets specific performance criteria. Students also examine the history of the development of air travel and identify its impact on the way people work and live.

PRESCRIBED LEARNING OUTCOMES	SUGGESTIONS FOR INSTRUCTION
<p><i>Students will...</i></p> <p><b>6-2-01</b> Use appropriate vocabulary related to their investigations of flight.</p> <p>Include: fluid, pressure, lift, gravity, thrust, drag, Bernoulli's principle, propulsion, unbalanced forces.</p> <p>GLO: C6, D4</p>	<p style="text-align: center;"><b>Teacher Notes</b></p> <p><b>Prior Knowledge</b> Students have had previous experiences related to this cluster in Grade 5, Cluster 3: Forces and Simple Machines; in Grade 5, Cluster 4: Weather; in Grade 3, Cluster 3: Forces That Attract or Repel; and in Grade 2, Cluster 2: Properties of Solids, Liquids, and Gases.</p>  <ul style="list-style-type: none"><li>➤ Introduce, explain, use, and reinforce vocabulary throughout this cluster.</li><li>➤ <b>Sort and Predict</b> Give students a set of terms related to this cluster. Have them work in groups to predict the meaning of the words and sort them into categories. Have groups share their categories with the class. As a class, identify words for which students need more information to be able to categorize with clarity. Post these words and clarify them as the study of flight progresses. (For a BLM of a Sort and Predict think sheet, see <i>SYSTH</i>, Attachment 10.3, or <i>Success</i>, p. 6.100.)</li></ul>

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**SUGGESTIONS FOR ASSESSMENT**

**SUGGESTED LEARNING RESOURCES**

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PRESCRIBED LEARNING OUTCOMES
<i>Students will...</i>
<p><b>6-2-02</b> Describe properties of fluids using air and water as examples, and identify manifestations of these properties in daily life.</p> <p>Include: air and water flow and exert pressure; objects can flow through air and water; warm air and water rise.</p> <p>GLO: B1, D3, E1</p>
<p><b>6-0-3a</b> Formulate a prediction/hypothesis that identifies a cause and effect relationship. GLO: A2, C2 (Math: SP-I.1.6)</p> <p><b>6-0-5a</b>  Make observations that are relevant to a specific question. GLO: A1, A2, C2</p> <p><b>6-0-7a</b> Draw a conclusion that explains investigation results. Include: explaining patterns in data; supporting or rejecting a prediction/hypothesis. GLO: A1, A2, C2 (ELA Grade 6, 3.3.4)</p> <p><b>6-0-7h</b> Identify potential applications of investigation results. GLO: C4</p>
<p><i>(continued)</i></p>

SUGGESTIONS FOR INSTRUCTION

➤ **Accessing Prior Knowledge**

As a class, brainstorm a list of “facts” about air. Record these “facts” on a class chart under the headings “What We Know” and “What We Think We Know” (for anything of which students may be unsure). Add to the chart as the study of flight progresses.

➤ **Investigating Air Pressure**

Provide students with a plastic pop bottle with several holes punched into the bottom. Ask students to lower the open bottle into a container of water and leave it there for one minute. Have them lift the bottle out of the water, noting what happens to the water in the bottle.

Ask students to predict what would happen if

- they covered the top of the bottle with their thumb before submerging it (only a small amount of water would enter the bottle)
- they left the bottle open in the water but covered the top of the bottle before taking it out of the water (water would not stream out of the bottle)

Have students investigate to determine whether their predictions are correct. Ask students whether they can explain the results.

➤ **Fluid Dynamics**

Ask students to describe what happens in a quickly moving stream when the water comes in contact with a large boulder. (The water flows around the boulder.) Students should recognize that the ability to flow around objects is a characteristic of water (fluids). Have students observe air (also a fluid) dynamics by conducting the following class demonstration.

Light a candle and place it about 5 cm behind a pop bottle. Have students try to blow out the candle with the pop bottle between them and the candle. Gradually move the candle further back from the bottle. Have students continue to try to blow out the candle. Have students discuss their observations and draw a diagram of what they think is taking place. (Air is flowing around the bottle.) Ask the following questions:

1. At what distance was it easiest to blow out the candle?
2. What effect would changing the size of the bottle have on the optimal distance for blowing out the candle? Explain.
3. How is air like water? (They both flow around objects.)

*(continued)*

SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES

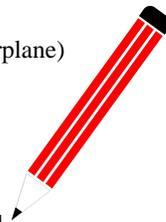
Teacher Notes

**Background Information**

Fluids are gases and liquids that flow. Flowing air is called an *air stream*.

Properties of air are as follows:

- expands in warm temperatures
- contracts in cold temperatures
- rises when warmed
- moves (flows), creating wind and weather
- takes up space
- is made up of particles we cannot see
- can exert pressure (enough pressure to support a heavy airplane)
- has mass, weight, and volume
- is made up of different gases
- is lighter than water



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**PRESCRIBED LEARNING OUTCOMES**

**SUGGESTIONS FOR INSTRUCTION**

*Students will...*

**6-2-02** (continued)

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➤ **Air and Water in Daily Life**

Use explicit instruction to introduce to students the concept that both liquids and solids are called *fluids* because of their ability to flow.

Have students provide examples of how fluids (e.g., air and water) demonstrate the following characteristics in daily life:

- they flow (e.g., orange juice flows out of a pitcher; air flows out of a balloon)
- they exert pressure (e.g., deep-sea divers experience the effects of water pressure when they dive deep into the ocean; a balloon-powered car moves when the balloon is opened up)
- they rise when warm (e.g., it is hotter near the ceiling than on the floor in the winter; water in a lake is colder down deep than it is near the surface)

SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES



**Extended Response**

Provide students with the following:

**Properties of Fluids**



What did you learn about the properties of fluids from the investigations and demonstrations? Refer to both *air* and *water* in your answer.

Look for:

- reference to *air* and *water*
- an indication that both air and water exert pressure
- an indication that both warm air and warm water rise
- an indication that objects can flow through both air and water

PRESCRIBED LEARNING OUTCOMES
<i>Students will...</i>
<p><b>6-2-03</b> Identify adaptations that enable living things to propel themselves through air, water, or to be transported by the wind.</p> <p><i>Examples: the streamlined shape of dolphins and barn swallows, the helicopter-like motion of the winged fruit of maple trees, the parachute-shaped fruit of dandelions...</i></p> <p>GLO: D1, D4, E1</p>
<p><b>6-0-4c</b> Work cooperatively with group members to carry out a plan, and troubleshoot problems as they arise. GLO: C7 (ELA Grade 6, 5.2.2)</p> <p><b>6-0-4d</b> Assume various roles to achieve group goals. GLO: C7 (ELA Grade 6, 5.2.2)</p> <p><b>6-0-5a</b> Make observations that are relevant to a specific question. GLO: A1, A2, C2</p> <p><b>6-0-7f</b> Reflect on prior knowledge and experiences to construct new understanding, and apply this new knowledge in other contexts. GLO: A2, C4 (ELA Grade 6, 1.2.1)</p>

SUGGESTIONS FOR INSTRUCTION

➤ **Movement through Fluids**

Provide small groups of students with models or pictures (e.g., of animals) that illustrate movement through fluids. Include examples of adaptations for movements such as diving, gliding, spinning, hovering, and parachuting. Ask students to look at the models/pictures and decide what features or ways of moving can be grouped together. Subcategories should be agreed upon by group consensus. Once each group has sorted the features and recorded information, have students present their ideas to the class.

Have groups use a KWL Plus Map to categorize and sort the models/pictures and to record the characteristics of movement through fluids.

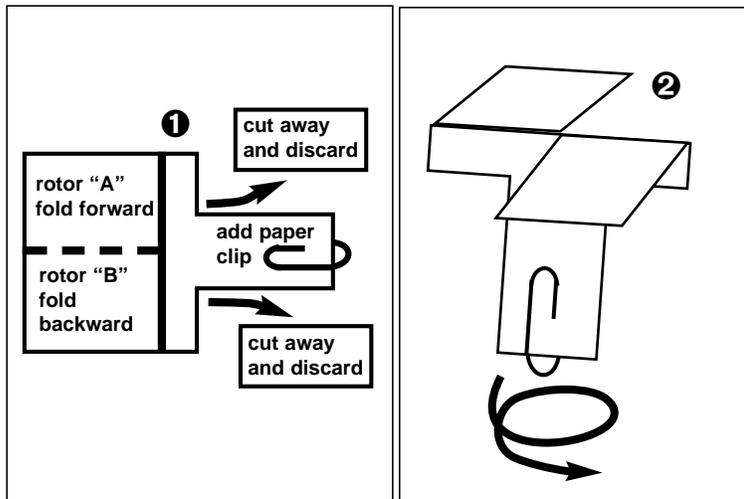
(For a BLM of a KWL Plus Map, see 5-8 ELA, BLM-66.)

➤ **Maple Seed Travel**

Have students

- look at maple tree seeds to determine how their design enables them to travel (flow through air)
- construct a spinner to represent a maple seed
- determine the effects of dropping the spinner from various heights
- attach a paper clip to the bottom of the rotor shaft to add weight for some stability during flight

Example:



SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES



**Extended Response**

Provide students with the following:

*Discover Flight* (p. 65)

**Adaptations for Movement through Fluids**

Look at the following pictures. Explain how each is adapted to propel itself through air or water, or to be transported by the wind. Be specific.



octopus

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dolphin

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eagle

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tree seed

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PRESCRIBED LEARNING OUTCOMES
<i>Students will...</i>
<p><b>6-2-04</b> Recognize that in order for devices or living things to fly they must have sufficient lift to overcome the downward force of gravity, and that the force of gravity increases as mass increases. GLO: D4</p>
<p><b>6-0-1b</b> Identify various methods for finding the answer to a specific question and select one to implement. <i>Examples: generating experimental data; accessing information from a variety of sources...</i> GLO: C2 (ELA Grade 6, 3.2.2; Math: SP-I.2.6, SP-II.1.6)</p> <p><b>6-0-4a</b> Carry out procedures that comprise a fair test. Include: controlling variables; repeating measurements to increase accuracy and reliability. GLO: C2</p> <p><b>6-0-7b</b>  Base conclusions on evidence rather than pre-conceived ideas or hunches. GLO: C2, C4</p> <p><b>6-0-7f</b> Reflect on prior knowledge and experiences to construct new understanding, and apply this new knowledge in other contexts. GLO: A2, C4 (ELA Grade 6, 1.2.1)</p>

SUGGESTIONS FOR INSTRUCTION

➤ **Demonstration: The Force of Gravity**

Bring to class two identical resealable plastic containers. Fill one with a light stuffing such as popcorn or cotton balls, and the other with a heavier stuffing such as marbles or small lead weights (the heavier the better). Challenge the class to come up with as many strategies as possible

to prove that one container has more mass, and therefore has a greater force of gravity pulling on it. Possible strategies include: using a balance, using a spring scale, or dropping both containers from the same height into sand and measuring the depth of the crater formed.

**Teacher Notes**

This demonstration is linked to learning outcome 6-4-11 (from Cluster 4: Space) and can be used to reinforce or introduce the differentiation between mass and weight. Refer to Cluster 4 for background information on this concept.

➤ **Overcoming Gravity**

Use explicit instruction to introduce students to the concept of *lift* (the upward force used to overcome gravity and to achieve flight). Have students brainstorm ways in which different objects or living things achieve lift (or get off the ground).

➤ **Investigating Lift**

Use air speed to demonstrate one way in which lift overcomes gravity to move an object upward. Provide students with a strip of paper (20 cm x 3 cm) and have them

- hold the strip at one end so that the other end hangs down
- predict what will happen when they blow across the top of the strip
- bring the held end close to their lips and gently blow straight ahead (this increases the speed of the air on top of the paper to create lift, and causes the paper to rise until it is parallel to the floor)
- describe the direction the other end of the paper moved and explain why
- investigate the effect that increasing the thickness or width of the paper will have on this investigation

**Teacher Notes**

The phenomenon demonstrated by this learning activity is part of Bernoulli's principle (see learning outcome 6-2-06).

## SUGGESTIONS FOR ASSESSMENT

## SUGGESTED LEARNING RESOURCES

**Restricted Response**

Provide students with the following:

**Lift and Gravity**

Complete the following statements:

1. All objects within the Earth's atmosphere are pulled downward by \_\_\_\_\_.
2. The upward force that enables an object to fly is called \_\_\_\_\_.
3. In order to fly, objects must overcome \_\_\_\_\_ and attain \_\_\_\_\_.
4. The greater the mass of the object, the \_\_\_\_\_ the attraction of gravity.
5. The greater the mass of the object, the \_\_\_\_\_ the force of lift required.

Look for:

1. gravity
2. lift
3. gravity, lift
4. greater
5. greater

*Science Everywhere 6* (p. 228)

*Discover Flight* (p. 19)

PRESCRIBED LEARNING OUTCOMES
<i>Students will...</i>
<p><b>6-2-05</b> Describe how “lighter-than-air flying devices” are able to achieve lift.</p> <p>Include: hot-air balloons, helium balloons.</p> <p>GLO: D4</p>
<p><b>6-0-1c</b> Identify practical problems to solve. <i>Examples: How can I make a hot-air balloon? Which type of light bulb should I buy?...</i> GLO: C3</p> <p><b>6-0-3d</b> <b>C</b> Develop criteria to evaluate a prototype or consumer product. Include: function, aesthetics, use of recycled materials, cost, reliability. GLO: C3</p> <p><b>6-0-3e</b> <b>C</b> Create a written plan to solve a problem. Include: materials, safety considerations, labelled diagrams of top and side views, steps to follow. GLO: C1, C3, C6</p> <p><b>6-0-4b</b> <b>C</b> Construct a prototype. GLO: C3</p> <p><b>6-0-4e</b> <b>C</b> Use tools and materials in a manner that ensures personal safety and the safety of others. Include: keeping an uncluttered workspace; putting equipment away after its use; handling glassware with care. GLO: C1</p> <p><b>6-0-5b</b> <b>C</b> Test a prototype or consumer product, using predetermined criteria. GLO: C3, C5</p> <p><b>6-0-5c</b> Select and use tools and instruments to observe, measure, and construct. <i>Examples: hand lens, telescope, binoculars...</i> GLO: C2, C3, C5</p> <p><b>6-0-6d</b> <b>C</b> Identify and make improvements to a prototype, and explain the rationale for the changes. GLO: C3, C4</p> <p><b>6-0-7d</b> <b>C</b> Propose and justify a solution to the initial problem. GLO: C3</p> <p><b>6-0-7e</b> <b>C</b> Identify new practical problems to solve. GLO: C3</p> <p><b>6-0-9c</b> <b>C</b> Demonstrate confidence in their ability to carry out investigations. GLO: C5</p>

SUGGESTIONS FOR INSTRUCTION

➤ **Activating Prior Knowledge**

To demonstrate that warm air rises, have students

- make a “spiral snake” by cutting a circle of paper into smaller and smaller continuous circles, creating a spiral
- attach a string to the head of the spiral
- hold the spiral over a light bulb or other heat source
- use what they know about air to explain what happens (Air around the light bulb is heated and then rises, creating drafts that cause the spiral snake to spin.)

➤ **Making Hot-Air Balloons**

Have students construct hot-air balloons using a large, lightweight plastic bag, a small plastic container or bag, tape, a hole punch, string, and a source of hot air such as a blow dryer. Have students follow these directions:

- Take one of the lightweight plastic bags, stand on a chair, hold the bag above your head and let it go. What happens to the bag? (It falls to the floor.)
- Have another student fill the lightweight plastic bag with hot air from a blow dryer. Then repeat step 1, using the bag filled with hot air. Observe what happens. (The bag rises.)
- Punch four evenly spaced holes close to the opening of the bag. Attach a piece of string to each hole. The strings should be the same length.
- Attach a small plastic container or bag to the four strings to act as a basket for the hot-air balloon.
- Fill the balloon with hot air. Observe what happens.
- Place small objects into the basket and observe what happens.
- In your science notebook, explain how the hot air balloon was able to achieve lift.

➤ **Helium Balloons: Design Challenge**

Have students plan, construct, and test a helium balloon prototype that meets identified criteria (developed by the teacher with the class). Sample criteria include:

- carries a specified passenger (an object of a particular mass)
- travels the width of the room using a propulsion method that doesn’t directly touch the balloon (e.g., blowing on the prototype, fanning it)

Refer to page 15 of this document for a description of the design process.

## SUGGESTIONS FOR ASSESSMENT

## SUGGESTED LEARNING RESOURCES

**Extended Response**

Provide students with the following:

**Balloons and Flight**

In your science notebook, explain how hot-air balloons and helium balloons are able to achieve lift.

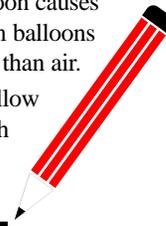
Look for:

- Hot-air balloons: The heated air in the balloon causes the balloon to become less dense (lighter) than the air around it. As a result, the balloon rises.
- Helium balloons: The helium gas in the balloon is less dense (lighter) than the air around the balloon. This causes the balloon to rise.

**Teacher Notes**

“Lighter-than-air flying devices” achieve lift through the use of a balloon containing a gas that is “lighter” or less dense than the air around it. This results in an upward buoyant force that is greater than the downward force of gravity. In a hot-air balloon, heating of the air inside the balloon causes it to be less dense than the air around it (warm air rises). Helium balloons are able to achieve lift because helium is less dense or “lighter” than air.

The learning activities suggested for learning outcome 6-2-05 allow students to explore the relationship between mass and lift, which applies to learning outcome 6-2-15.



*Science Everywhere 6* (p. 218)

*Discover Flight* (p. 82)

PRESCRIBED LEARNING OUTCOMES
<i>Students will...</i>
<p><b>6-2-06</b> Test models of aircraft to observe Bernoulli’s principle.</p> <p>Include: the shape of a wing affects the speed of airflow, creating lift in a “heavier-than-air flying device.”</p> <p>GLO: C2, C3, D3, D4</p>
<p><b>6-0-3a</b> Formulate a prediction/hypothesis that identifies a cause and effect relationship. GLO: A2, C2 (Math: SP-I.1.6)</p> <p><b>6-0-4e</b>  Use tools and materials in a manner that ensures personal safety and the safety of others. Include: keeping an uncluttered workspace; putting equipment away after its use; handling glassware with care. GLO: C1</p> <p><b>6-0-5a</b>  Make observations that are relevant to a specific question. GLO: A1, A2, C2</p> <p><b>6-0-7f</b> Reflect on prior knowledge and experiences to construct new understanding, and apply this new knowledge in other contexts. GLO: A2, C4 (ELA Grade 6, 1.2.1)</p>
<p><i>(continued)</i></p>

SUGGESTIONS FOR INSTRUCTION

➤ **Introducing Bernoulli: Part 1**

Place a ping-pong ball in a freshly washed funnel. Have students

- predict what will happen to the ping-pong ball if they blow into the bottom of the funnel (The ball will remain in the funnel.)
- blow into the bottom of the funnel and observe what happens (Blowing into the funnel speeds up the air directly under the ball and lowers the air pressure; therefore, the greater air pressure above the ping pong ball keeps it in the funnel. The harder the student blows, the more firmly the ball stays in the funnel.)
- discuss the results and develop an explanation using the terms *air speed* and *air pressure*
- think of a way to get the ping-pong ball out of the funnel, using their knowledge of air pressure (Blow over the top of the funnel. This will create an increase in air speed over the top of the ball and thus decrease the air pressure in that area, resulting in the ball being pushed out of the funnel by the higher air pressure coming from underneath.)

➤ **Introducing Bernoulli: Part 2**

As a class demonstration, hang two small empty plastic pop bottles (or two paper strips, or two ping-pong balls) about 5 cm apart. (String can be attached to the cap of the bottle with a glue gun or by making a small hole in the cap, threading it through, and tying it in the inside of the cap.) Have students

- predict what will happen if you blow hard between the two bottles
- test whether their predictions are correct (The bottles will come together. Blowing between the bottles lowers the air pressure between them. The pressure on the outside of the bottles is greater and forces the bottles to move together.)
- explain their results, including a diagram, in their science notebooks

*(continued)*

## SUGGESTIONS FOR ASSESSMENT

## SUGGESTED LEARNING RESOURCES

## Teacher Notes

**Background Information**

Daniel Bernoulli, a Swiss scientist born in 1700, discovered that fast-moving air exerts less pressure than slow-moving air. This principle—Bernoulli's principle—is important in understanding flight.

Bird wings, for example, are relatively flat on the bottom and convex on the top. When a bird is moving forward, the air flowing over the wing has farther to go in a given amount of time than the air beneath the wing (the shortest distance between two points is a straight line). As a result, the air pressure is greater below the wing (slower-moving air) than it is above the wing (faster-moving air), and the bird is pushed up. This same principle allows airplanes and gliders to fly. The shape of airplane wings (called a cambered airfoil) is designed to make air flow faster over the top than under the bottom of the wing. The faster-moving air above the wing produces an area of low pressure; thus, the greater pressure below the wing exerts an upward force (lift) on the wing.



*Science Everywhere 6* (p. 240)

*Discover Flight* (p. 104)

**PRESCRIBED LEARNING OUTCOMES**

*Students will...*

**6-2-06** (continued)

*(continued)*

**SUGGESTIONS FOR INSTRUCTION**

*(continued)*

➤ **Testing Airfoils**

Have students make and experiment with an airfoil using the following directions:

1. Take a 15 cm x 5 cm strip of paper and fold it in half widthwise.
2. Tape the top edge of the paper so that it is 1 cm shorter than the bottom edge, curving the top half of the paper like the top of a wing (see Fig. 1).

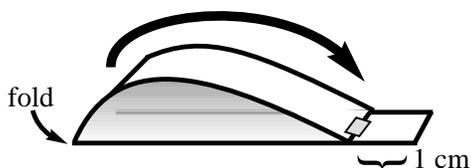


Fig. 1

3. Slide the “wing” over a pencil so that the curved side is facing up and the folded seam is facing you (see Fig. 2).

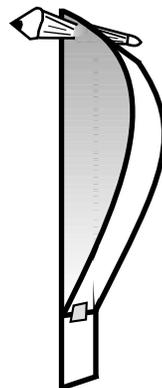


Fig. 2

4. Hold the wing in front of you (see Fig. 2) and blow straight at the folded seam and observe what happens (see Fig. 3). (The wing will lift up from its hanging, at-rest position.)

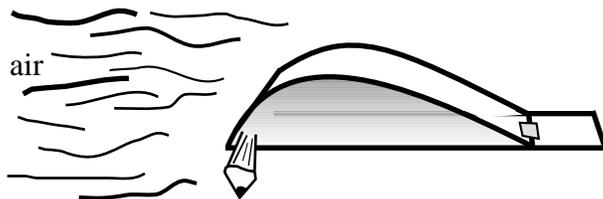


Fig. 3

*(continued)*

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**SUGGESTIONS FOR ASSESSMENT**

**SUGGESTED LEARNING RESOURCES**

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**PRESCRIBED LEARNING OUTCOMES**

*Students will...*

**6-2-06** (continued)

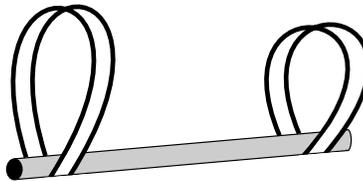
**SUGGESTIONS FOR INSTRUCTION**

(continued)

➤ **Making a Straw Flier**

Have students use paper and a straw to construct a straw flier, following these directions:

1. Cut two paper strips. One strip should be 2 cm x 24 cm and the other 1.5 cm x 18 cm.
2. Tape the ends of each strip together to form two loops or circular “wings” of different sizes.
3. Tape the straw ends to the inside of each loop to create a flier.



4. Launch the flier by throwing it into the air (the way you would throw a paper airplane). What happens when you throw it? Why does it fly? (Air moves faster above each circular wing than it does below the wing, thus creating lift.)
5. Experiment with different throwing methods, different sizes of circular wings, and different positions for the circular wings.

**SUGGESTIONS FOR ASSESSMENT**

**SUGGESTED LEARNING RESOURCES**



**Extended Response**

Have students complete the following in their science notebooks:



**Bernoulli's Principle**

Think about the investigations, demonstrations, and experiments completed in this section. Based on your observations, explain Bernoulli's principle.

Look for:

- fast-moving air exerts less pressure than slow-moving air
- this principle can be applied in the design of objects/devices to create lift

PRESCRIBED LEARNING OUTCOMES
<i>Students will...</i>
<p><b>6-2-07</b> Explain how Bernoulli's principle is applied in a device other than an aircraft.</p> <p><i>Examples: paint sprayer, perfume mister...</i></p> <p>GLO: A5, B1, D4</p>
<p><b>6-0-4e</b> Use tools and materials in a manner that ensures personal safety and the safety of others. Include: keeping an uncluttered workspace; putting equipment away after its use; handling glassware with care. GLO: C1</p> <p><b>6-0-5a</b> Make observations that are relevant to a specific question. GLO: A1, A2, C2</p> <p><b>6-0-7f</b> Reflect on prior knowledge and experiences to construct new understanding, and apply this new knowledge in other contexts. GLO: A2, C4 (ELA Grade 6, 1.2.1)</p> <p><b>6-0-7h</b> Identify potential applications of investigation results. GLO: C4</p>

SUGGESTIONS FOR INSTRUCTION

➤ **Bernoulli's Principle in Action**

Have students brainstorm a list of devices they have used or situations they have observed in everyday life where Bernoulli's principle applies.

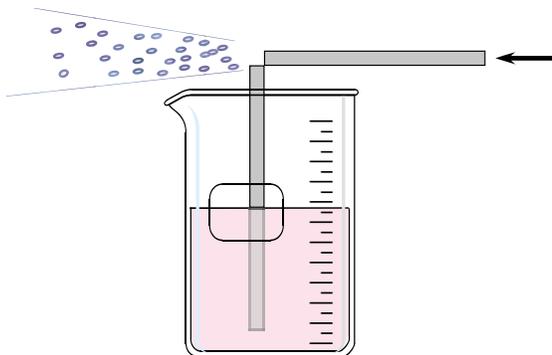
Examples:

- the flight of a concave plastic disc
- a shower curtain sticking to you when the water is turned on
- the flight of a kite
- the spin on a baseball or tennis ball
- the spray from an aerosol can
- hair sometimes blowing forward when a person is driving a car with the window open

➤ **Creating a Simple Sprayer**

Have students investigate how a paint sprayer works by constructing a simple sprayer, following these directions:

1. Place a straw into a glass of water, holding it upright and keeping the bottom of the straw just off the bottom of the glass.
2. Blow a short, hard blast of air through a second straw, holding it so that it is perpendicular to the first straw and their ends are touching. Observe what happens. (A mist of water sprays out from the first straw.)



3. In your science notebook, explain how the sprayer works, using diagrams and a written explanation. (The normal air pressure pushing down on the water is decreased by the speed of the air flowing out of the horizontal straw. This decrease in normal air pressure forces some water up the tube and it gets blown out.)

**SUGGESTIONS FOR ASSESSMENT**

**SUGGESTED LEARNING RESOURCES**



**Extended Response**

Provide students with the following:



**Bernoulli's Principle in Action**

Give two examples of devices or situations in which you have observed Bernoulli's principle in action. Explain how the principle works in each case.

*Science Everywhere 6* (p. 240)

*Discover Flight* (p. 101)

PRESCRIBED LEARNING OUTCOMES
<i>Students will...</i>
<p><b>6-2-08</b> Provide examples of design features or adaptations that enhance or reduce lift, and explain how they work.</p> <p><i>Examples: race car spoilers reduce lift; bird wing shapes enhance lift...</i></p> <p>GLO: A5, B1, D1, D4</p>
<p><b>6-0-5a c</b> Make observations that are relevant to a specific question. GLO: A1, A2, C2</p> <p><b>6-0-7f</b> Reflect on prior knowledge and experiences to construct new understanding, and apply this new knowledge in other contexts. GLO: A2, C4 (ELA Grade 6, 1.2.1)</p> <p><b>6-0-7h</b> Identify potential applications of investigation results. GLO: C4</p>

SUGGESTIONS FOR INSTRUCTION

➤ **Wind Tunnel Investigation**

Have students use a simple wind tunnel to test various wing and airplane designs and observe the features that reduce or enhance lift. A small electric fan with varying speeds and a cage for safety would be suitable as a source of air flow.

Have students test wing shapes by following these directions:

- Create three “wings” by folding paper (or use the airfoil from the Testing Airfoils learning activity in conjunction with learning outcome 6-2-07) to create airfoils with different cambers.
- Attach a thread to the top of each camber to act as an indicator.
- Hold each airfoil camber in front of a blowing fan and observe what happens to the string. Which design has more lift? Which design has more lift in slower airstream? in faster airstream?
- Use the information gathered in this investigation to determine how the shape of a bird’s wing enables it to enhance or reduce lift.

➤ **Why Doesn’t It Fly?**

Show students a model or picture of a racing car with spoilers. Have students brainstorm the reasons why, despite travelling at an enormous speed, the racing car will remain on the ground. (The spoilers divert the airflow, preventing the lowering of air pressure that would lift the rear end of the car.)

➤ **Investigating the Flight of Birds**

Have students work in small groups to match the wing shape of birds with the correct description of the type of flight (see “Wing Shapes,” BLM 6-A).

**SUGGESTIONS FOR ASSESSMENT**

**SUGGESTED LEARNING RESOURCES**

*Discover Flight* (p. 25)

<p><b>PRESCRIBED LEARNING OUTCOMES</b></p>
<p><i>Students will...</i></p>
<p><b>6-2-09</b> Provide examples of design features or adaptations that enhance or reduce drag, and explain how they work.</p> <p><i>Examples: pilots use flaps to increase drag when landing aircraft; birds tuck their wings to decrease drag when diving...</i></p> <p>GLO: A5, B1, D1, D4</p>
<p><b>6-0-4c</b> Work cooperatively with group members to carry out a plan, and troubleshoot problems as they arise. GLO: C7 (ELA Grade 6, 5.2.2)</p> <p><b>6-0-4e</b> Use tools and materials in a manner that ensures personal safety and the safety of others. Include: keeping an uncluttered workspace; putting equipment away after its use; handling glassware with care. GLO: C1</p> <p><b>6-0-5a</b> Make observations that are relevant to a specific question. GLO: A1, A2, C2</p> <p><b>6-0-7f</b> Reflect on prior knowledge and experiences to construct new understanding, and apply this new knowledge in other contexts. GLO: A2, C4 (ELA Grade 6, 1.2.1)</p> <p><b>6-0-7h</b> Identify potential applications of investigation results. GLO: C4</p>
<p style="text-align: right;"><i>(continued)</i></p>

**SUGGESTIONS FOR INSTRUCTION**

➤ **Investigating Drag**

Have students experience the effects of drag on various shapes and sizes of surface area by completing the following:

- Hold a large piece of cardboard outdoors on a windy day so that
  - the wind blows against the flat side
  - the edge is facing the wind
- Fold or cut the cardboard into different shapes.
- Experiment with shapes that are similar to airplanes and that provide the least resistance to the air flow (wind).
- Record findings in an appropriate format.

Have students answer the following questions, based on their investigations:

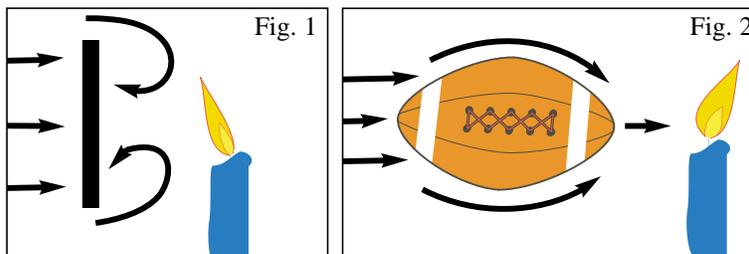
1. What shapes allow air to flow more efficiently? (streamlined shapes)
2. What is the relationship between the size of the surface area and the amount of drag that can be felt? (A larger surface area results in greater drag.)

➤ **Demonstrating Drag**

Have students observe drag caused by air turbulence through the following teacher demonstration (see Fig. 1):

- Hold a 5 cm square of cardboard about 5 cm in front of a burning candle.
- Blow in the direction of the flame from about 10 cm in front of the cardboard.
- Observe the movement of the flame.

Continue the demonstration by using pieces of cardboard of different sizes, various curved shapes (such as a bottle, an apple, toy cars or airplanes, a round ball, a football, or a box), and objects with different surface types (rough versus smooth, jagged versus rounded). (See Fig. 2.)



*(continued)*

SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES

Teacher Notes

**Background Information**

Drag can be increased or decreased by

- changing surface area
- changing shape
- changing surface type (smooth versus rough)

Drag is not always detrimental. It can be useful (e.g., for parachuting, airplane landings) but its effect must be reduced for efficient flight.



*Science Everywhere 6* (p. 249)

*Discover Flight* (p. 105)

PRESCRIBED LEARNING OUTCOMES
<i>Students will...</i>
<p><b>6-2-09</b> <i>(continued)</i></p>

**SUGGESTIONS FOR INSTRUCTION**

*(continued)*

Have students diagram which shapes cause turbulence (drag) and which shapes are aerodynamic (i.e., the shapes that allow fluids to move freely past). Students should draw conclusions regarding the role that reducing or increasing drag plays in transportation (e.g., boats, planes), in safety (e.g., landings, slowing down), and in the flight of birds.

➤ **Improving the Airfoil**

Have students use print or multimedia resources to explore the role of flaps and slats in airplane wings to answer the following questions:

1. How do flaps and slats affect lift? (Flaps and slats help adjust the curvature of the wings to increase drag and reduce speed.)
2. When would a pilot use a flap or a slat? (A flap or a slat would be used in landing a plane.)

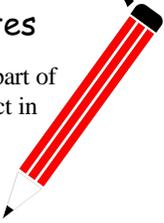
➤ **Investigating Kites**

Have students experiment with various kite designs to determine how differences in design affect performance. Kites can be purchased in kits, made from patterns in books or on the Internet, or designed by students. Have students investigate (in small groups or as a class) to answer the following questions:

1. Which design
  - was easiest to launch?
  - flew best in very windy conditions?
  - flew best in light wind conditions?
2. What can be done to produce lift when the kite drops?

**Teacher Notes**

Kites may be used as part of a design process project in relation to learning outcome 6-2-15.

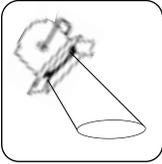


➤ **Looking at Sports Equipment**

Have students work in small groups to brainstorm a list of sports where drag is a factor, and to list the equipment associated with these sports (e.g., bicycle racing helmets, racing canoes, shuttlecocks). Have students identify the design adaptations of the equipment and determine whether the design enhances or reduces drag.

## SUGGESTIONS FOR ASSESSMENT

## SUGGESTED LEARNING RESOURCES

**Demonstrating Drag**

Provide students with a pre-made paper airplane. Instruct students to use the paper airplane to answer the following questions. **Note:** Let students know they may make modifications to the design of the paper airplane if necessary.

1. How can drag can be increased?
2. How can drag can be decreased?

<b>Scoring Rubric</b>	
<b>Score</b>	<b>Criteria</b>
3	The student understands the meaning of the term <i>drag</i> , and successfully demonstrates how drag can be both increased and decreased by changing surface area and/or shape.
2	The student understands the meaning of the term <i>drag</i> , and demonstrates either how drag can be increased or how it can be decreased by changing surface area and/or shape.
1	The student understands the meaning of the term <i>drag</i> , but does not demonstrate how drag can be increased or decreased.

PRESCRIBED LEARNING OUTCOMES
<i>Students will...</i>
<p><b>6-2-10</b> Identify and diagram the four forces that act on living things or devices that fly through the air.                      Include: lift, gravity, thrust, drag.                      GLO: C6, D4</p>
<p><b>6-0-7f</b> Reflect on prior knowledge and experiences to construct new understanding, and apply this new knowledge in other contexts.                      GLO: A2, C4 (ELA Grade 6, 1.2.1)</p>

**SUGGESTIONS FOR INSTRUCTION**

➤ **Four Forces**

Have students summarize and reflect on what they have learned about *lift*, *gravity*, *thrust*, and *drag* by completing a vocabulary think sheet such as the Three-Point Approach for Words and Concepts (Simons, 1991), including definitions, diagrams, and examples.

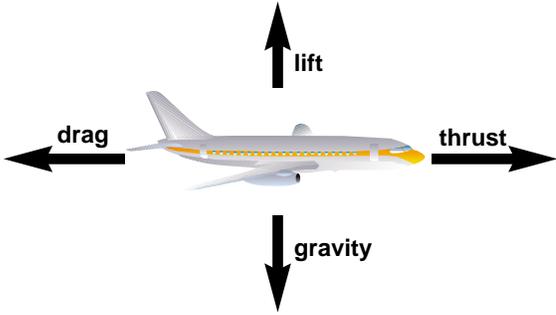
(For a BLM of a Three-Point Approach for Words and Concepts, see *SYSTH*, Attachment 10.2, or *Success*, p. 6.101.)

➤ **Diagramming Forces**

Ask students to collect pictures of living things or devices that fly. Have students work in pairs to select a picture and draw a diagram showing the four forces that act on the selected living thing or device. Have them present their diagrams to the class and explain how the forces work to enable the living thing or device to fly.

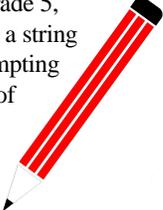
**Teacher Notes**

**Background Information**  
 Forces act in pairs. For flight, lift and gravity exert force in opposite directions, as do thrust and drag.



The diagram shows a side view of a white airplane with yellow accents. Four black arrows represent forces acting on it: an upward arrow labeled 'lift' from the top, a downward arrow labeled 'gravity' from the bottom, a rightward arrow labeled 'thrust' from the front, and a leftward arrow labeled 'drag' from the back.

**Planning Note**  
 Students were introduced to the concept of force diagrams in Grade 5, Cluster 3: Forces and Simple Machines. Students should picture a string attached to the object pulling in a particular direction when attempting to illustrate forces acting on an object using force arrows. Pairs of forces are usually drawn, and their relative lengths indicate the strengths of the forces.



SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES



**Restricted Response**

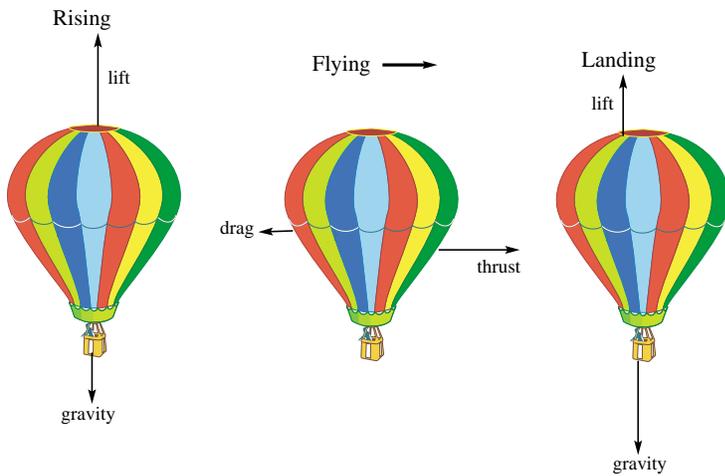
Provide students with the following:

**Forces and Lift**



In your science notebook, list the forces acting on a hot-air balloon as it rises, flies, and lands. Draw and label a diagram to illustrate each of the three processes and the relative strengths of the forces as the balloon rises, flies, and lands.

Look for:



*Science Everywhere 6* (pp. 228, 249)

*Discover Flight* (p. 89)

PRESCRIBED LEARNING OUTCOMES
<i>Students will...</i>
<p><b>6-2-11</b> Compare a variety of propulsion methods that are used to produce thrust in animals and flying devices.</p> <p><i>Examples: rockets for spacecraft, propellers, or jet engines for aircraft, wings for flying animals...</i></p> <p>GLO: B1, D1, D4, E4</p>
<p><b>6-0-4c</b> Work cooperatively with group members to carry out a plan, and troubleshoot problems as they arise. GLO: C7 (ELA Grade 6, 5.2.2)</p> <p><b>6-0-4d</b> Assume various roles to achieve group goals. GLO: C7 (ELA Grade 6, 5.2.2)</p> <p><b>6-0-4e</b> Use tools and materials in a manner that ensures personal safety and the safety of others. Include: keeping an uncluttered workspace; putting equipment away after its use; handling glassware with care. GLO: C1</p> <p><b>6-0-5a</b> Make observations that are relevant to a specific question. GLO: A1, A2, C2</p> <p><b>6-0-7a</b> Draw a conclusion that explains investigation results. Include: explaining patterns in data; supporting or rejecting a prediction/hypothesis. GLO: A1, A2, C2 (ELA Grade 6, 3.3.4)</p> <p><b>6-0-7h</b> Identify potential applications of investigation results. GLO: C4</p>
<p>(continued)</p>

SUGGESTIONS FOR INSTRUCTION

➤ **Rocket /Jet Engine Thrust**

To explore how thrust is produced, have students construct a model rocket/jet engine, following these steps:

- Inflate a long balloon and close the opening with a clothespin.
- Tape a straw to the side of the balloon.
- Thread a long string or fishing line through the straw.
- Tie the string to fixed objects on opposite sides of the room to create a taut “clothesline” across the room.
- Bring the balloon to one end of the string and release the clothespin.
- Observe and describe what happens.

Have students explain how the balloon is able to move and identify where this principle is used (e.g., in airplanes).

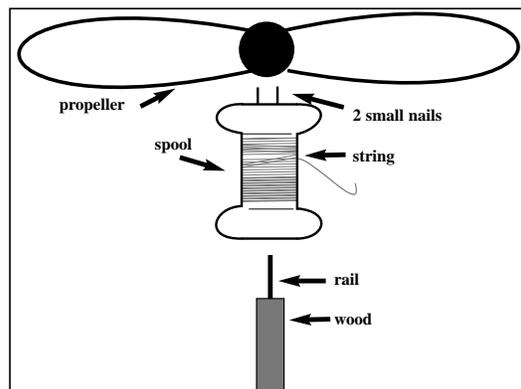
➤ **Whirlybird Flier**

Have students experiment with the upward thrust created by spinning rotor blades, following these directions:

- Make rotors by taping cardboard “wings” to a straw.
- Firmly tape the rotor blade to another straw that will act as a rotor shaft.
- Put the rotor shaft between your hands with your palms facing each other.
- Slide your palms in opposite directions to spin the shaft and release the flier.
- Observe what happens.
- Draw a diagram to explain the forces involved.

➤ **Investigating Propellers**

Have students assemble a propeller launcher (see diagram) to experiment with different sizes and designs of propellers.



(continued)

SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES



**Extended Response**

Provide students with the following:

**Propulsion**



In your science notebook, give examples of three different methods of propulsion used to produce thrust in animals and flying devices. Explain how each method of propulsion works.

Look for:

- examples in living things, such as wings, birds running
- examples in flying devices, such as rockets, propellers, jet engines
- clear explanation for each example

*Science Everywhere 6* (p. 246)

*Discover Flight* (p. 83)

PRESCRIBED LEARNING OUTCOMES
<i>Students will...</i>
<p><b>6-2-11</b> (continued)</p>
<p><b>6-2-12</b> Describe how unbalanced forces are used to steer aircraft and spacecraft. GLO: A5, D4, D6</p>
<p><b>6-0-2a</b>  Access information using a variety of sources. <i>Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet...</i> GLO: C6 (ELA Grade 6, 3.2.2; Math: SP-II.1.6; TFS 2.2.1)</p> <p><b>6-0-2c</b> Make notes on a topic, combining information from more than one source and referencing sources appropriately. GLO: C6 (ELA Grade 6, 3.3.2)</p> <p><b>6-0-4b</b>  Construct a prototype. GLO: C3</p> <p><b>6-0-5b</b>  Test a prototype or consumer product, using predetermined criteria. GLO: C3, C5</p> <p><b>6-0-6d</b>  Identify and make improvements to a prototype, and explain the rationale for the changes. GLO: C3, C4</p> <p><b>6-0-7g</b>  Communicate methods, results, conclusions, and new knowledge in a variety of ways. <i>Examples: oral, written, multimedia presentations...</i> GLO: C6 (ELA Grade 6, 4.4.1; TFS: 3.2.2, 3.2.3)</p>

SUGGESTIONS FOR INSTRUCTION

(continued)

- Purchase different propellers or make them from recycled thick plastic or balsa wood.
- Place each propeller (in turn) on the launcher and pull the string to rotate the propeller.
- Observe what happens.
- Record the size and design that creates the most lift.

➤ **How Do Birds Get off the Ground?**

Have students compile a list of various means of propulsion used by birds to get off the ground (e.g., they run along the water to obtain lift).

➤ **Experimenting with Paper Airplanes**

Have students modify a paper airplane/glider to move in different ways:

- fly straight and level
- turn to the right or left
- do a loop-the-loop (circle in a vertical loop)
- ascend or descend

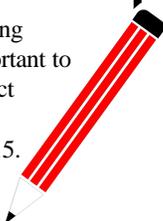
Have students note the changes that were made to achieve the different motions. Ask them to explain what happened in relation to the forces involved. Have students brainstorm ways in which these motions are achieved in aircraft. (If students are unable to come up with ideas, present them with the terminology.)

➤ **Controlling Spacecraft**

Have students research how a spacecraft is controlled, with the purpose of identifying similarities and differences between a spacecraft and an aircraft. Have them present their findings to the class.

**Teacher Notes**

The results of this learning experience may be important to the design process project suggested in relation to learning outcome 6-12-15.



## SUGGESTIONS FOR ASSESSMENT

## SUGGESTED LEARNING RESOURCES

## Teacher Notes

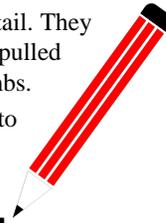
**Background Information**

An aircraft has the capacity to make the following types of motions:

- *Pitch*: the nose of an aircraft rises up or moves downward.
- *Roll*: one wing rises while the other wing moves downward.
- *Yaw*: the nose of an aircraft sways to the left or right while the tail moves in the opposite direction.

An aircraft has moveable parts that enable pilots to control these motions:

- *Ailerons* are located at the rear of the wings. They control the up and down motion of the wing tips. When one aileron goes up, the one on the opposite wing goes down. This either makes the aircraft roll over to the left or to the right, or holds the wings level.
- *Elevators* are located on the horizontal stabilizers on the tail. They control the up and down motion of the nose. If the tail is pulled up the aircraft dives; if it is pushed down the aircraft climbs.
- The *rudder* pushes the vertical tail to the left or the right to create yaw. The rudder enables the aircraft to turn.



*Science Everywhere 6* (p. 235)

*Discover Flight* (p. 106)

PRESCRIBED LEARNING OUTCOMES
<i>Students will...</i>
<p><b>6-2-13</b> Explain why the design of aircraft and spacecraft differs.</p> <p>GLO: B1, C3, D4, D6</p>
<p><b>6-0-2a</b>  Access information using a variety of sources. <i>Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet...</i></p> <p>GLO: C6 (ELA Grade 6, 3.2.2; Math: SP-II.1.6; TFS 2.2.1)</p> <p><b>6-0-2b</b>  Review information to determine its usefulness, using predetermined criteria. GLO: C6, C8 (ELA Grade 6, 3.2.3)</p> <p><b>6-0-2c</b> Make notes on a topic, combining information from more than one source and referencing sources appropriately. GLO: C6 (ELA Grade 6, 3.3.2)</p>

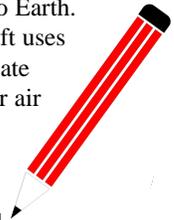
SUGGESTIONS FOR INSTRUCTION

Teacher Notes

**Background Information**

The forces acting on an aircraft and a spacecraft differ.

- An aircraft is affected by four forces: *drag, lift, thrust, and gravity*. A spacecraft (rocket) is affected by two forces: *thrust and gravity*.
- An aircraft requires wings to achieve lift and to maintain lift. A rocket design does not include wings since maintaining lift is not necessary. A space shuttle has wings to help it glide back to Earth.
- A spacecraft requires tremendous thrust and stability to escape from the Earth’s gravitational field, whereas an aircraft only requires enough thrust to gain limited altitude. Special seating is needed in spacecrafts to allow astronauts to withstand high speeds and acceleration.
- A spacecraft needs to be made of specific materials that will allow the craft to withstand the heat caused by re-entering the Earth’s atmosphere. An airplane needs to be made of specific materials to allow it to withstand a range of atmospheric temperatures including extreme cold.
- A retrorocket is necessary to slow a spacecraft’s descent to Earth. Parachutes also assist with gentle, soft landings. An aircraft uses flaps and slats to control speed and lift. These features create drag to slow down the plane. Some planes have spoilers or air brakes to increase drag. Slower speeds cause the wings to begin to stall, which greatly decreases lift.



➤ **Aircraft-Spacecraft Comparison**

Have students complete a Venn diagram to compare an aircraft and a spacecraft. Students should consider: purpose, where it travels, how it creates thrust and lift, and the resulting design differences (e.g., in size, shape, materials). Students could research both types of craft using print resources, videos, CD-ROMs, and/or the Internet.

Have students share their findings with the class. (If students do not mention important points listed in the Teacher Notes above, introduce these points at this time.)

**SUGGESTIONS FOR ASSESSMENT**

**SUGGESTED LEARNING RESOURCES**



**Extended Response**

Provide students with the following:

**Comparing an Aircraft and a Spacecraft**



Compare and contrast an aircraft and a spacecraft. Consider the following in your answer:

- design
- lift and thrust
- steering
- purpose

Scoring Rubric	
Score	Criteria
4	All four areas are discussed. The answer is thorough, clear, and accurate.
3	Three areas are discussed. The answer is thorough, clear, and accurate.
2	Two areas are discussed. The answer is thorough, clear, and accurate. Two or three areas are discussed. The answer is not well developed or is unclear.
1	One area is thoroughly and accurately discussed.

PRESCRIBED LEARNING OUTCOMES
<i>Students will...</i>
<p><b>6-2-14</b> Identify milestones in the history of air travel and describe their impacts on daily life. GLO: A4, B1, B2, D4</p>
<p><b>6-0-2a</b> <b>C</b> Access information using a variety of sources. <i>Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet...</i> GLO: C6 (ELA Grade 6, 3.2.2; Math: SP-II.1.6; TFS 2.2.1)</p> <p><b>6-0-2b</b> <b>C</b> Review information to determine its usefulness, using predetermined criteria. GLO: C6, C8 (ELA Grade 6, 3.2.3)</p> <p><b>6-0-2c</b> Make notes on a topic, combining information from more than one source and referencing sources appropriately. GLO: C6 (ELA Grade 6, 3.3.2)</p> <p><b>6-0-8c</b> <b>C</b> Recognize that technology is a way of solving problems in response to human needs. GLO: A3, B2</p> <p><b>6-0-8d</b> <b>C</b> Provide examples of technologies from the past and describe how they have evolved over time. GLO: B1</p> <p><b>6-0-8g</b> <b>C</b> Describe positive and negative effects of scientific and technological endeavours. Include: effects on themselves, society, the environment, and the economy. GLO: A1, B1, B3, B5</p> <p><b>6-0-9b</b> <b>C</b> Show interest in the activities of individuals working in scientific and technological fields. GLO: B4</p>

SUGGESTIONS FOR INSTRUCTION

➤ **Milestones of Flight**

Have students work in small groups to research milestones in the history of air travel. Have students use a W-5 Chart (Who? What? Where? When? Why?) to record and organize the research information. Students should use at least two sources of information. Alternatively, provide students with a timeline and ask them to select one of the events mentioned and research it. Have students present their findings in one of the following ways:

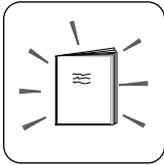
- a newspaper report, with students acting as interviewers
- a timeline
- a story about a specific milestone, which can be developed using a story map
- a biography of an inventor or aviator

➤ **Impact of Air Travel**

Have students use a T-chart, with the headings “Then” and “Now,” to look at the world-wide impact that air travel has had on human transportation, mail service, the shipment of goods and resources, warfare, space travel, and pollution.

**SUGGESTIONS FOR ASSESSMENT**

**SUGGESTED LEARNING RESOURCES**



**Milestones of Flight Project**

When assessing students' Milestones of Flight projects, look for indications of the following:

Rating Scale					
Criteria	Poor	Good	Excellent		
The project					
• presents well-developed ideas, expressed in sentences and paragraphs	1	2	3	4	5
• answers to the 5 Ws (Who? What? Where? When? Why?)	1	2	3	4	5
• shows evidence that at least two different sources were used	1	2	3	4	5
• includes a bibliography	1	2	3	4	5
• is an informative and interesting presentation	1	2	3	4	5

*Science Everywhere 6* (p. 255)

*Discover Flight* (p. 118)

PRESCRIBED LEARNING OUTCOMES
<i>Students will...</i>
<p><b>6-2-15</b> Use the design process to construct a prototype that can fly and meet specific performance criteria.</p> <p><i>Examples: a glider that can loop; a hot-air balloon that can stay aloft for a given time...</i></p> <p>GLO: C3, D4</p>
<p><b>6-0-1c</b> Identify practical problems to solve. <i>Examples: How can I make a hot-air balloon? Which type of light bulb should I buy?...</i> GLO: C3</p> <p><b>6-0-1d</b> Identify various methods to solve a practical problem, and select and justify one to implement. <i>Examples: constructing and testing a prototype; evaluating consumer products; accessing information from a variety of sources...</i> GLO: C3 (Math: SP-I.2.6, SP-II.1.6)</p> <p><b>6-0-3d</b> Develop criteria to evaluate a prototype or consumer product. Include: function, aesthetics, use of recycled materials, cost, reliability. GLO: C3</p> <p><b>6-0-3e</b> Create a written plan to solve a problem. Include: materials, safety considerations, labelled diagrams of top and side views, steps to follow. GLO: C1, C3, C6</p> <p><b>6-0-4b</b> Construct a prototype. GLO: C3</p> <p><b>6-0-5b</b> Test a prototype or consumer product, using predetermined criteria. GLO: C3, C5</p> <p><b>6-0-6d</b> Identify and make improvements to a prototype, and explain the rationale for the changes. GLO: C3, C4</p> <p><b>6-0-7d</b> Propose and justify a solution to the initial problem. GLO: C3</p> <p><b>6-0-9d</b> Appreciate the importance of creativity, accuracy, honesty, and perseverance as scientific and technological habits of mind. GLO: C5</p>

SUGGESTIONS FOR INSTRUCTION

➤ **Constructing Prototypes**

This learning outcome (6-2-15) may be addressed in conjunction with other learning experiences such as Experimenting with Paper Airplanes (learning outcome 6-2-12) or Making Hot-Air Balloons (learning outcome 6-2-05).

OR

Have students use the design process to construct one of the following prototypes:

- Using only one piece of paper, design a plane that can fly the length of a gymnasium.
- Using only one piece of paper, design a plane that can remain aloft for a specified period of time.
- Design a plane that will perform a loop-the-loop.

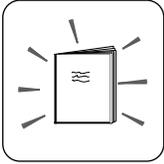
In addition to devising criteria related to materials used and performance, have students suggest additional criteria such as reliability, aesthetics, etc. Have students present their prototypes to the class.

**Note:** The Helium Balloons—Design Challenge (learning outcome 6-2-05) is another example of a design process learning experience.

Students may use the “Design Project Report” (BLM 6-E) to record their work.

**SUGGESTIONS FOR ASSESSMENT**

**SUGGESTED LEARNING RESOURCES**



When assessing student prototypes, refer to “Design Project Report: Assessment” (BLM 6-F).



**Self-Assessment: Design Process**

Provide students with the following self-assessment tool:

**Self-Assessment of Flying Prototype**

I chose to make \_\_\_\_\_

1. One problem I had was \_\_\_\_\_

2. One thing I did well was \_\_\_\_\_

3. If I did this project again I would \_\_\_\_\_

4. I would still like to learn more about \_\_\_\_\_

5. I think my design \_\_\_\_\_

\_\_\_\_\_

*Science Everywhere 6* (p. 254)

*Discover Flight* (pp. 54-55, 97)

*By Design: Technology Exploration & Integration* (Design Process Reference and Tools)

*Design and Technology System* (Design Process Reference and Tools)

*Mathematics, Science, & Technology Connections* (Design Process Reference and Tools)

## **Notes**