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Science

Grade Six

Flight

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Flight

Before You Begin

Students apply their knowledge of aerodynamics to design a model aircraft, build it, test it, and solve the problems that inevitably arise. In the process, they learn about the parts of an aircraft, their role in controlled flight and the differences between aircraft and spacecraft.

Topic B: Flight

(Suggested time: 6-8 weeks)

This unit can be done any time of the year, but is best completed after, or as part of, the grade 6 unit Air and Aerodynamics. Ensure ahead of time that you have a large indoor area available for test flights of gliders, parachutes, helicopters and rockets. Enclosed areas such as gymnasiums, large classrooms and hallways are better for flight tests than open outdoor areas, because winds can make a controlled test impossible.

Send letters home informing parents about the unit and requesting assistance in locating guest speakers (e.g., a local remote-control plane enthusiast) and materials you may need.

Background Information

As early experimenters of flight discovered, it's one thing to get a craft airborne and quite another thing to exert control over where it ends up going! This unit focuses on the ingenious ways that have been developed to maneuver through the atmosphere.

Let's begin with the simple ups and downs of hot-air ballooning (lateral motion is governed entirely by the vagaries of local wind direction). Hot-air balloons float through the atmosphere thanks to a physical property of fluids known as *Archimedes' principle*. Briefly, this principle states: *An object partially or completely submerged in a fluid (gas or liquid) is acted upon by an upward force equal in magnitude to the weight of the fluid displaced by the object*. If the weight of an object is less than the weight of the displaced fluid, the object will rise. If the weight of the object is greater it will sink, but its apparent weight will be reduced by an amount equal to the weight of the displaced fluid.

A hot-air balloon has a burner above the basket and directly below the balloon cavity. When the burner is ignited the air inside the balloon is heated and expands. This forces some air out of the balloon. Eventually, the total mass of the rig (balloon, burner, basket and load) becomes less than the mass of the air it is displacing. It becomes buoyant and rises off the ground. If the burner is turned off and the air inside the balloon is allowed to cool, the air contracts and allows cold outside air to flow back in. The rig becomes heavier and, once it exceeds the mass of the air it displaces, the rig begins to descend.

Unlike the balloonist, who travels where the wind dictates, the pilot of an aircraft has almost total control over directional movement. ("Almost" because most planes can't be made to go backward through the air.) This maneuverability is achieved by using specially designed control surfaces that maintain the aircraft's stability and provide the means to reconfigure the shape of the aircraft in mid flight.

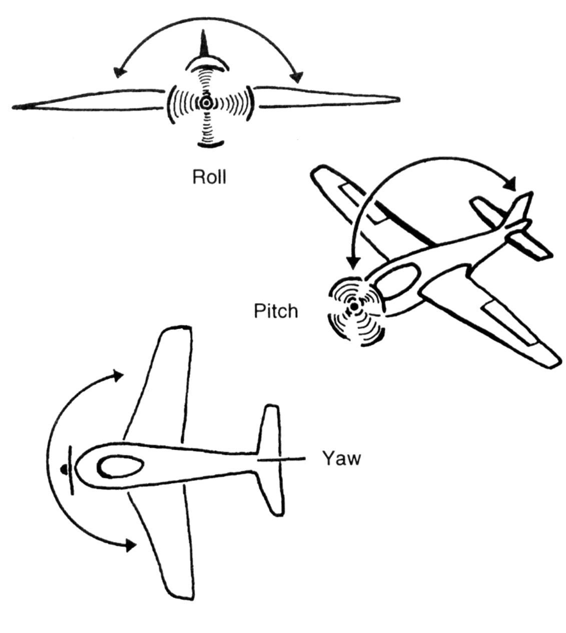

Figure 1.
Roll, pitch and yaw.

It's not always easy for ground-based creatures like ourselves to appreciate the challenge of maintaining stability in the air. An aircraft must balance around three axes. Rotation around the longitudinal (nose-tail) axis is called *roll*; motion around the lateral (wing tip to wing tip) axis is called *pitch;* and movement around the normal (top to bottom) axis is called *yaw* (see Fig. 1).

The following is a list of the primary control surfaces incorporated in fixed-wing aircraft design and their main function(s) (see Fig. 2).

- **Fuselage**: this is the body of the aircraft to which the wings and various other control surfaces are attached. Aside from being a convenient place to carry passengers and cargo, the fuselage anchors the wings in place, preventing them from spinning out of control when they encounter air resistance. (You might try flying a set of wings without a fuselage to demonstrate this effect!)

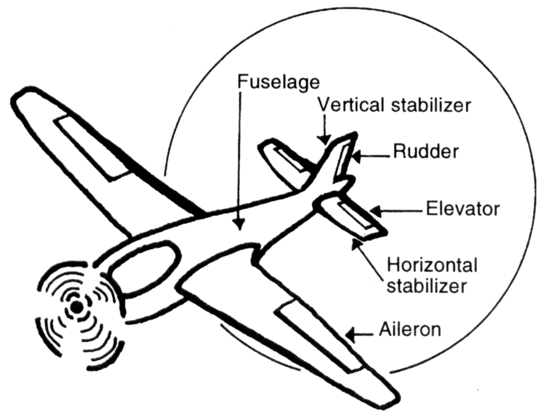

Figure 2.
Fixed-wing aircraft controls.

- **Horizontal stabilizers**: this is a set of control surfaces at the tail of the aircraft that look like miniature wings and keep the aircraft moving forward on an even plane. These incorporate a set of flaps called *elevators* that let the pilot point the nose of the aircraft up and down. In other words, horizontal stabilizers and elevators control the pitch. They work in unison. Elevators have another function as well. The drag they generate can slow the aircraft, so elevators help control airspeed.
- **Vertical stabilizer**: this is the upright fin at the tail end of the aircraft. It ensures the aircraft remains pointed in the direction the pilot wishes to go.
- **Rudder**: this is a flap on the vertical stabilizer that allows the pilot to change direction around the normal axis. In other words, to go right or left, the rudder controls yaw.
- **Ailerons**: these are flaps on the back edge of wings that control roll. Lowering the left aileron and raising the right aileron makes the plane roll to the right. The opposite configuration brings about a roll to the left.

All the above control surfaces work only in the presence of moving air. A means of forward propulsion is critical to sustained, stable flight. Fixed-wing aircraft rely on propellers or jet engines as propulsion systems. A spinning propeller creates a high-pressure area behind it and a low-pressure area in front of it. This generates lift in the direction of the low pressure, moving the propeller and the plane attached to it forward. Because each blade of the propeller is an airfoil (see the unit on aerodynamics) the rotating propeller also generates drag. So a source of constant energy—a motor—is required to keep the propeller turning. Increasing the number of rotor blades can increase thrust to a point, then the ratio of mass to fuel, as well as stability, begin to cause problems.

Jet propulsion can provide much greater thrust than propellers. A jet engine takes in ambient (surrounding) air, compresses it, then burns it with fuel in a combustion chamber to produce extremely hot gas that is discharged out of the rear of the jet engine. This provides enormous forward thrust, even at high speeds, where the efficiency of propellers drops off.

Now consider this: all the thrust in the world can't make control surfaces work if air isn't present. The rockets used to launch payloads into space need to be highly streamlined to minimize drag while traversing the Earth's atmosphere but, once in space, their aerodynamic surfaces serve no function. Space is a near vacuum, so spacecraft aren't slowed by drag. They can be any shape that suit the purpose of their mission. Spacecraft, be they television satellites or interplanetary probes, are maneuvered with thruster jets according to *Newton's third law of motion*: to every action there is an equal and opposite reaction. Fire a thruster on the right side of the craft and the craft moves left. Simplicity itself. Space shuttles are configured as aerodynamic forms because they must maneuver through the Earth's atmosphere on their return to the ground, but while in orbit they use thruster rockets, not control surfaces, to make course corrections.

With the exception of spacecraft that have left Earth's gravitational field for good, what goes up must eventually come down. How do you control descent if the craft you are in has lost its aerodynamic advantage? One or more parachutes attached to the craft (or to yourself) can usually do the trick.

Parachutes function on the principle of drag. As gravity pulls an object down through the atmosphere, the object's rate of descent can be slowed by using air resistance: the larger the surface area of the parachute, the greater the force of air pushing in the opposite direction, creating drag. Sometimes parachutes are used as brakes. They are flown behind an airplane or racecar to counteract the thrust once the draft is on the surface. The space shuttle uses three parachutes as brakes during landing.

A rigid, flat surface of any given size is as effective as a flexible, curved surface the same size—as long as you can keep the flat surface parallel to the ground. Let it tip on end and you suddenly have no drag working for you at all. Chances of this happening are greatly reduced if air is trapped inside the concave shape most fabric parachutes take on when they are deployed. Furthermore, parachutes can be maneuvered by letting this trapped air escape in a controlled manner. If the curve is relaxed, allowing air to burst out from under the parachute at one edge, the blast will propel the entire rig (you and the parachute) in the direction opposite that edge. Happy landing!

Elementary Science Program of Studies

General and Specific Learner Expectations

The following general and specific learner expectations have been taken directly from the 1996 Elementary Science Program of Studies. The specific learner expectations (SLEs) are referred to by number in the second column of the activities table.

General Learner Expectation

Students will be able to:

Construct devices that move through air and identify adaptations for controlling flight.

Specific Learner Expectations

Students will be able to:

1. Conduct tests of a model parachute design and identify design changes to improve the effectiveness of the design.
2. Describe the design of a hot-air balloon and the principles by which the rising and falling of a hot-air balloon are controlled.
3. Conduct tests of glider designs and modify a design so that it will go further, stay up longer or fly in a desired way; for example, fly in a loop, turn to the right.
4. Recognize the importance of stability and control to aircraft flight; and design, construct and test control surfaces.
5. Apply appropriate vocabulary in referring to control surfaces and major components of an aircraft. This vocabulary should include: wing, fuselage, vertical and horizontal stabilizers, elevators, ailerons, rudder.
6. Construct and test propellers and other devices for propelling a model aircraft.
7. Describe differences in design between aircraft and spacecraft and identify reasons for the design differences.

Note: Model aircraft or rockets may be constructed and used as part of this unit. It is recommended that these models be simple devices of the student's construction, not prefabricated models. Propulsion of rockets by chemical fuels is neither required nor recommended due to safety considerations.

Cross-curricular Connections

Mathematics

• Measure, chart and graph flight distances and flight time.

• Calculate averages, medians.

Language Learning/Social Studies

- Study the history of flight and the pioneers of flight.
- Write newspaper articles.

Children's Alternative Frameworks

Some children have difficulty making the connection between paper airplane and jet airplane flight. Some children also operate under the alternative framework that lift during bird and insect flight is entirely produced by flapping of wings.

Activities

Classroom teachers have identified the following activities that may be done to address the Specific Learner Expectations (SLEs) in the Program of Studies. The list is not prescriptive and teachers may select activities that are most appropriate for their students.

Activities have been listed under two headings: Key Activities and Extension Activities. Key activities are supported by authorized resources and identify "powerful and practical" means for achieving learner expectations. Extension activities represent alternative ways of achieving or supporting learner expectations.

Key Activities

Key Activity	SLE	Print Resources	Essential Materials	Comments
Determining students' prior knowledge about flight		*Innovations in Science, Level 6, Flight (Flight Storming)*, p. 8	mural paper, coloured pencils, crayons, watercolour paints, scissors	Initial brainstorming will provide the teacher with insight into the students' knowledge of flight. For this reason, it may be beneficial to have children first work independently in their journals or notebooks.
Designing and testing parachutes	1	*Explorations in Science, Level 6, Flights of Fantasy (Playing with Parachutes),* p. 20 *Innovations in Science, Level 6, Flight (Fall Breakers)*, p. 25 *Innovations in Science, Level 6, Flight (Slow Down)*, p. 11	plastic bags, metal washers, other light materials (nylon, cotton, silk) garbage bags, cargo (soil or sand), measuring tape or metre stick, markers, string, tape, stopwatch, self-sticking hole reinforcements, twist ties sheets of paper, stopwatch	Encourage students to develop parachute designs and then to test them. You can encourage students to make design changes to their parachutes by giving them tasks. (For example: decrease the fall rate of the chute, give precious cargo to be landed safely from a given height, e.g., an egg). This is a good opportunity to reinforce the concept of fair tests and to collect and record data.

Key Activity	SLE	Print Resources	Essential Materials	Comments
Designing and testing parachutes (cont'd)		*Up, Up and Away: The Science of Flight* (Darling) *(Model Parachutes)*, p. 46	lightweight paper, thread, stopwatch	
		Explorations in Science, Level 6, High Fliers (Parachutes), p. 15	string, plastic bags, metal washers	
Designing and testing hot-air balloons	2	*Explorations in Science, Level 6, Flights of Fantasy (My Beautiful Balloon)*, p. 22	dry-cleaning bags, silicone glue, hair dryer, cardboard scraps, thread	A number of hair dryers that produce a good source of hot air are essential to these activities. You may wish to attempt these activities outside on a still, cool day: a greater difference in atmosphere and balloon air temperature will result in higher flights. Extension cords will be necessary. Watch for water if outside. Also be aware of hazards such as power lines.
		Explorations in Science, Level 6, Flights of Fantasy (Tissue Balloons), p. 30	tissue paper, glue sticks, scissors, light wire, string, tape, hair dryer, stop-watches, measuring tapes	
		Innovations in Science, Level 6, Flight (Full of Hot Air), p. 16	dry-cleaning bags, thread, hair dryer	
		Up, Up and Away: The Science of Flight (Darling) *(A Lot of Hot Air)*, p. 40	tissue paper, hair dryer	
		Exploring Technology: Flight (Dixon) *(Make a Hot-air Balloon)*, p. 19	large plastic bags, string, hair dryer	
Exploring glider designs	3, 4	*Innovations in Science, Level 6, Flight (Learner's License)*, p. 34	stiff paper, tape, line master B	Allow students to become familiar with a few basic glider designs and how to fly them, then introduce challenges to encourage students to modify designs to solve the challenges. Some example challenges could be to fly further, increase flight time, fly around obstacles or land on target. Encourage the students to develop the ideas for what the challenge will be. These should be carried out before introducing students to formal control surfaces (rudders, stabilizers, etc.) to allow for creative problem solving and attention to plane design.
		Explorations in Science, Level 6, Flights of Fantasy (Speedy Darts), p. 13	paper, cardboard, scissors, elastics, staples, short pieces of wood	
			paper, tape, paper clips, straws, flat pieces of styrene foam, aluminum foil, waxed paper, toilet paper rolls, balsa wood	
		Explorations in Science, Level 6, High Fliers (Simple Fliers and Gliders), p. 16	different sizes and types of paper, tape, paper clips	
		Explorations in Science, Level 6, High Fliers (Straw Gliders), p. 17	different sizes of straws, paper strips	
		Explorations in Science, Level 6, High Fliers (Along for the Glide), p. 18	Styrofoam trays and sheets, aluminum foil, waxed paper, toilet paper rolls, small pieces of balsa wood	

Key Activity	SLE	Print Resources	Essential Materials	Comments
Exploring glider designs (cont'd)		*Super Flyers* (Francis) *(The Delta Dart and The Origami Aerobat)*, p. 10	paper, tape, scissors, ruler	
		Up, Up and Away: The Science of Flight (Darling) *(Test Flights)*, p. 22	paper	
Becoming familiar with the major components and control surfaces of aircraft	4, 5	*Eyewitness Books: Flying Machine* (Nahum) *(Controlling the Plane)*, p. 40 *Super Flyers* (Francis) (*Trimming the Delta Dart and The Ailerons and How Controls Change Flight Direction),* p. 12 *Explorations in Science, Level 6, Flights of Fantasy (Super Stunt Fliers—Science Note)*, p. 17 *Exploring Technology, Flight* (Dixon) *(Wings and Control)*, p. 8 *Up, Up and Away: The Science of Flight* (Darling) *(At the Controls)*, p. 23 *Innovations in Science, Level 6, Flight (Learner's Licence)*, p. 34 *Innovations in Science, Level 6, Flight (More to Explore)*, p. 23, 30	reference materials, airplane models	The introduction to control surfaces leads directly to the next key activity that has students "trimming" their gliders to gain more control over flight patterns. If students bring model planes from home, these features can be seen here as well. This is also a good time to have guest speakers visit, if they have operating models of planes, to show how the control surfaces work. It's also a good time to visit a local airplane owner or airport where students can see control devices on an actual airplane. Check field trip regulations for your school jurisdiction.
Constructing and testing control surfaces on gliders	4, 5	*Super Flyers* (Francis) (*Trimming the Delta Dart, The Starship Delta, Trimming the Origami Aerobat and The Flying Meat Tray*), p. 12	paper, styrene food trays, tape, scissors	Have students experiment or give them structured tasks involving a variety of control surfaces on paper or food tray gliders. These activities could lead to an "air show" or "competition" that incorporates knowledge about design and control surfaces. For additional ideas, see the Extension Activities.
		Explorations in Science, Level 6, Flights of Fantasy (Super Stunt Fliers), p. 15 *Exploring Technology: Flight* (Dixon) *(Make a Delta-wing Glider)*, p. 35 *Up, Up and Away: The Science of Flight* (Darling) *(At the Controls)*, p. 23	paper, cardboard, scissors, staples, paper cups, fan, dental floss	

Key Activity	SLE	Print Resources	Essential Materials	Comments
Constructing and testing propeller designs	6	*Super Flyers* (Francis) *(The Rotoglide and The Heliostraw)*, p. 42 *Exploring Technology: Flight* (Dixon) *(Make a Helicopter)*, p. 31 *Up, Up and Away: The Science of Flight* (Darling) *(Going for a Spin)*, p. 35 *Explorations in Science, Level 6, Flights of Fantasy (Whirling Wings),* p. 18	cardboard, plastic straws cardboard, plastic straws cardboard, plastic thread spools, thread cardboard, thread spool	These activities provide an introduction to propeller designs. One or two of these will suffice as an introduction.
Using propellers to propel aircraft	6	*Exploring Technology: Flight* (Dixon) *(Rubber Band Power and Make a Powered Aircraft)*, p. 27	plastic pipe, cork, elastics, balsa wood, glue, plastic wing fixing, bead	These activities are involved and more costly because they require balsa wood and other materials. They also involve the use of sharp blades. Teachers may wish to do this activity as a demonstration, with students designing propellers to be tested on the model plane. Propellers could be constructed out of materials such as plastic, tin, balsa wood, etc.
Examining the differences in design between aircraft and spacecraft	7	*Up, Up and Away: The Science of Flight* (Darling) *(Space Plane 2000),* p. 50 *Exploring Technology: Flight* (Dixon) *(Space Flight)*, p. 40 *Explorations in Science, Level 6, Flights of Fantasy (Air Rockets)*, p. 24 *Innovations in Science, Level 6, Flight (Ready, Set, Thrust-off),* p.28	fishing line, straws, balloons	These readings and balloon activities introduce students to the principles behind rocket flight. Control surfaces can also be introduced by having students design fins and attach them to balloons without fishing line to maintain control. If you wish to take this concept further, see the Extension Activities.

Extension Activities

Extension Activity	SLE	Print Resources	Essential Materials	Comments
Designing a flying craft that combines two or more previously made model crafts	1, 2, 3, 4, 6	*Explorations in Science, Level 6, Flights of Fantasy (Fantasy Fliers)*, p. 32 *Innovations in Science, Level 6, Flight (The Biggest Little Air Show!)*, p. 43	a variety of materials used during the unit	This culminating activity could be a reorganization of the above depending on the emphasis of the activity. The purpose is to have students apply their learning to problems such as "glider golf" or to demonstrate and share their learning with other students in the school.
Constructing and flying kites		*Innovations in Science, Level 6, Flight (Sky Sleds)*, p. 39 *Super Flyers* (Francis) *(Kites)*, p. 67 *Explorations in Science, Level 6, High Fliers (Let's Go Fly a Kite)*, p. 24	plastic garbage bags, large brown paper bags, plastic drinking straws, dowels or sticks, kite string or strong fishing line, 5 mm dowel, string	Roll up newsprint around diagonally placed straw to produce long, strong, supporting "dowels" for kite, glue the ends down to keep it from unravelling.
Reading and writing about flight		Check with your library		Many resources contain ideas that help integrate language learning and the science of flight.

Assessment

For a broader discussion of science classroom assessment techniques see *Assessing Student Learning* in the introduction of this publication on p. 15. Good places to begin looking for the unit-related ideas are *Explorations in Science* assessment handbooks, *Innovations in Science* teaching notes, Unit tests and Portfolio ideas, Alberta Education sample tests at **www.education.gov.ab.ca** and Alberta Assessment Consortium at **www.aac.ab.ca**

Bibliography

Adair, Stan et al. *AIMS: The Sky's the Limit*. Fresno, California: AIMS Education Foundation, 1994. ISBN 1-881431-44-4.

Bosak, Susan V. *Science Is…* (First Edition). Kitchener, Ontario: Youth Science Foundation, 1986. ISBN 0-921181-00-0.

Butzow, Carol and John. *Science Through Children's Literature*. Englewood, Colorado: Teacher Idea Press, 1989. ISBN 0-87287-667-5.

Campbell, Steve et al. *Explorations in Science, Level 6, Flights of Fantasy.* Don Mills, Ontario: Addison-Wesley, 1993. ISBN 0-201-88171-3.

Campbell, Steve et al. *Explorations in Science, Level 6, High Fliers*. Don Mills, Ontario: Addison-Wesley, 1992. ISBN 0-201-88148-9.

Cash, Terry. *Fun with Physics: Puff, Squeeze, Bang, Blow*. New York: Simon & Schuster Young, 1991. ISBN 0-7500-0868-7.

Darling, David. *Up, Up and Away: The Science of Flight*. New York: Dillon Press, Macmillan, 1991. ISBN 0-87518-479-0.

Dixon, Malcolm. *Exploring Technology: Flight*. East Sussex, England: Wayland, 1990. ISBN 1-85210-931-9.

Francis, Neil. *Super Flyers*. Toronto: Kids Can Press, 1988. ISBN 0-921103-37-9.

Harrison, Patricia and Chris Ryan. *Folens Technology in Action, Unit 3*. Dunstable, England: Folens, 1991. ISBN 1-85276-117-2.

Hetzel. Flight, *Investigations in Science*. Scholar's Choice, 1995. ISBN 1574-71608-5.

Hillerman, Tony. "A Ballooning Interest: Albuquerque's Hot Air Festival," *National Geographic Traveler*, vol, 2, no. 2 (Summer 1985), p. 142-149.

Kaner, Etta. *Balloon Science*. Toronto: Kids Can Press, 1989. ISBN 0-921103-61-1. (This book is also available in French.)

Knapp, Brian, *Science in Our World: Flight.* Toronto: Grolier, 1991. ISBN 0-7172-2773-1.

McCormick, Frank. *Experiments with Flight*. Bath, Avon: Cherrytree Press, 1992. ISBN 0-7451-5116-7.

Nahum, Andrew. *Eyewitness Books: Flying Machine*. London, England: Dorling Kindersley, 1990. ISBN 0-7737-2411-7.

Peturson, Rod and Neil McAllister. *Innovations in Science, Process and Inquiry, Level 6*. Toronto: Harcourt Brace & Company, Canada, 1996. ISBN 0-7747-0182-X.

Provensen, Alice and Martin. *The Glorious Flight*. New York: Viking Penguin, 1993. ISBN 0-317-636-510.

Richards, Roy. *101 Science Tricks: Fun Experiments with Everyday Materials*. New York: Sterling, 1990. ISBN 0-8069-8388-4.

Sabin, Louis. *Wilbur and Orville Wright: The Flight to Adventure*. New Jersey: Troll Associates, 1983. ISBN 0-89375-852-3.

Taylor, Richard. *The First Solo Flight Around the World*. New York: Franklin Watts, 1993. ISBN 0-531-20160-0.

Ward, Brian. *Flying Models*. New York: Franklin Watts, 1992. ISBN 0-531-14241-8.

Williams, John. *Starting Technology: Flight.* Sussex, England: Wayland, 1991. ISBN 0-7502-0918-6.