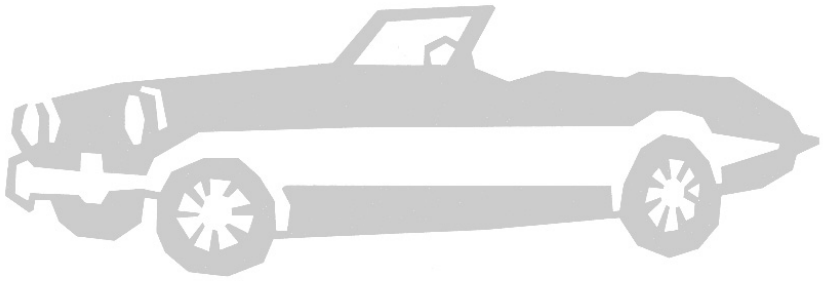
Let's Do Science

Grade Four

Building Devices and Vehicles that Move



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Building Devices and Vehicles that Move

Before You Begin

This unit gives students the opportunity to design and build devices and vehicles that move or perform a function based on the principles of simple machines introduced in the previous grade 4 unit, Wheels and Levers. The students explore various means of propulsion, from muscle power to gravitational energy and electricity. They also learn to evaluate their work based on the effectiveness of design and the appropriateness of materials used.

Topic C: Building Devices and Vehicles that Move

(Suggested time: 6-8 weeks)

This unit is ideal for the winter months, as it can be done indoors. It allows students to delve into building model devices that use one simple machine in conjunction with other simple machines. Sturdy, well-engineered components (either purchased, recycled or carefully made by students from available materials) are important for creating vehicles that run smoothly. Try using available materials for the vehicle body and incorporating inexpensive, reusable purchased components for the key moving parts. Hand tools and materials, such as those used in the grade 3 unit Building with a Variety of Materials, would be an asset.

Topics B and C would normally be taught with C following B directly.

Background Information

In the Wheels and Levers unit, we found that in order to do work—to move an object through a distance—force must be applied. Sir Isaac Newton summed up the concept nicely in his first law of motion: *Every body persists in its state of rest or of uniform motion in a straight line unless it is compelled to change that state by forces impressed upon it.* This tendency to keep the status quo is called *inertia*.

To overcome inertia—to make things move, change speed or change direction—force must be applied. This requires energy in one of its numerous guises: gravitational energy, thermal energy, electrical energy, magnetism, electromagnetic radiation, nuclear energy, chemical or biochemical energy.

The *law of conservation of energy* declares energy can neither be created nor destroyed. There is a finite, fixed amount of energy in the universe that transforms from one guise to another. The nuclear energy at the core of the sun changes to heat and light, which radiate into space. Sunlight falls on plants and is converted to stored chemical energy. This chemical energy is eaten as food and is eventually transformed into the biochemical energy that fuels our muscles, allowing us to move our bodies and push, pull or lift other objects (mechanical energy). Even mass can be thought of as an expression of energy. Remember Einstein's $E=mc^2$? (Energy = mass x the speed of light^2).

Sometimes it's not immediately evident where energy has gone. For example, when you lift an object from the floor to a table top, where does the energy you applied go? Apart from a bit of heat that warms your muscles imperceptibly, it doesn't appear to be present in any detectable form. But that doesn't mean it isn't there. You have actually transferred most of the energy to the object that you lifted against the force of gravity. It's present in the object as *potential energy*—energy that is being stored until it can be released in the form of *kinetic energy*—the energy of motion. In our example, if the object falls from the table, the potential energy you imparted to it will turn into kinetic energy as it falls to the floor under the influence of gravity. There are many other ways to store energy. Consider a stretched elastic, a compressed spring or a charged battery.

There is another factor at work that can make it appear kinetic energy is being lost rather than converted to another form of energy (a no-no according to the energy conservation law). The culprit is *friction*. It converts the energy of motion into heat when two surfaces rub together. When you are designing an energy-efficient machine, it is critical to minimize the friction between all moving parts. This will get the most motion out of your energy source, help prevent undesirable heat build-up and minimize wear on the moving parts. On the other hand, friction can come in handy when you want to slow or stop the machine. Friction is the operative principle behind brakes.

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 Expectations

Students will be able to:

- Construct a mechanical device for a designated purpose, using materials and design suggestions provided. (Note: One or more components of the task will be open-ended and require the student to determine the specific procedure to be followed.)
- Explore and evaluate variations to the design of a mechanical device, demonstrating that control is an important element in the design and construction of that device.

Specific Learner Expectations

Students will be able to:

1. Design and construct devices and vehicles that move or have moving parts (linkages, wheels and axles).
2. Use simple forces to power or propel a device (for example, direct pushes, pulls, cranking mechanisms, moving air, moving water and downhill motion).
3. Design and construct devices and vehicles that use energy-storing or energy-consuming components that will cause motion (for example, elastic bands, springs, gravity, wind, moving water).
4. Recognize the need for control in mechanical devices and apply control mechanisms where necessary.
5. Compare two designs, identifying the relative strengths and weaknesses of each.
6. Identify steps to be used in constructing a device or vehicle and work cooperatively with other students to construct the device or vehicle.
7. Design and construct several different models of a device and evaluate each model, working cooperatively with other students. Suggested evaluation criteria are identified under the Specific Learner Expectations, Reflect and Interpret.

Cross-curricular Connections

Mathematics

- Measuring (length, mass).

Language Arts

- Spelling.

Children's Alternative Frameworks

If you are aware of alternative frameworks related to this topic, write them in the space below.

Activities

Classroom teachers have identified the following activities that 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
Investigating how machines move and work	1, 2	*Innovations in Science, Level 4, On the Move (Move It)*, p. 8	old mechanical toys, chart paper	These activities allow the teacher to determine the students' prior knowledge about simple machines.
		Innovations in Science Level 4, Technology and You! (Open Up!), p. 8	discarded machines, newspapers, rags, tools, shoe boxes	
		Explorations in Science, Level 4, By Means of Machines (Flag Raising), p. 29	cardboard tubes, string, thread spools, scissors, tape, fabric	Build a working model of a flag pole.
Constructing a chassis	3	*Innovations in Science, Level 3, Roll It (Wheels and More Wheels)*, p. 26	cardboard, cans, cylinders, lids, pencils, straws, dowels, glue, ruler, scissors, hole punch, tape, string, an inclined plane, corrugated cardboard, drill, clothespins, dowels, 1 cm^2 lumber, cardboard triangles	Investigates wheels on a frame (chassis) by building three different chassis using a variety of materials.

Key Activity	SLE	Print Resources	Essential Materials	Comments
Manually Driven Mechanisms				
Building a crane	2	*Explorations in Science, Level 4, By Means of Machines (Crane Building)*, p. 27	straws, boxes, tongue depressors, paper fasteners, string, wire, glue, tape, scissors	Build a crane without using any gears or wheels.
		Blueprints: Technology Key Stage 1 (Gadd & Morton), p. 10	thread spool, dowels, plastic tubing, drill, wood strips, glue, string	Build a frame to support a pulley system.
Building spinners	2	*Explorations in Science, Level 4, On the Move (Keep on Spinning)*, p. 23	foil paper, Styrofoam plates, cardboard, plastic and metal lids, plastic containers, materials for shafts, timers	
Making a vehicle that can move and carry a load	3	*Explorations in Science, Level 4, On the Move (Wheeler's Challenge)*, p. 15	straws, Bristol board, scissors, different cylinders, small boxes, glue, plastic or metal lids	Exploring ways in which to make a box move and carry a heavy load.
Air-Driven Mechanisms				
Balloon-powered vehicles	2, 3, 4	*Explorations in Science, Level 4, On the Move (Blow It Up and Watch It Go)*, p. 18	balloons, boxes, cardboard, straws, lids, glue	Make a simple vehicle move using stored air power.
Mechanisms that Run on Stored Energy				
Making a vehicle move by using gravity	3	*Innovations in Science, Level 4, On the Move*, Activity Card 39, *Go With Gravity*	axles with wheels, string, cardboard, dowels, thread spool	Design and build a vehicle that will move as a weight falls.
Making a rubber-band-powered vehicle	3	*Blueprints: Technology Key Stage 1* (Gadd & Morton), p. 8	chassis with wheels, elastics	Power a vehicle using an elastic band.
Lifting weights using pulleys and gravity	3			
Controlling moving vehicles	4	*Explorations in Science, Level 4, On the Move (A Moving Challenge)*, p. 20	boxes, straws, cylinders, cardboard, fasteners, lids, containers, dowels, magnets, balloons, glue, tape	Open-ended activity to explore how a vehicle can travel a distance and come to a controlled stop.

Key Activity	SLE	Print Resources	Essential Materials	Comments
Motorized Mechanisms				
Inventing and evaluating a device that will perform a specific function		*Explorations in Science, Level 4, On the Move (Moving Along in the Future)*, p. 26	boxes, cylinders, cardboard, plastic containers and bottles, plates, lids, fasteners, balloons, magnets, string, straws	An open-ended activity to create a futuristic machine.
		Innovations in Science, Level 4, Technology and You! (Out of this World), p. 40	different materials as needed, blackline master 2	Open-ended activity to design and build a complex machine.
	5, 6, 7	*Explorations in Science, Level 4, By Means of Machines (Carnival Is In Town)*, p. 30		Cooperative consultation.

Extension Activities

Extension Activity	SLE	Print Resources	Essential Materials	Comments
Using roller skates to study the relationship between different masses and the distances they roll		*Innovations in Science, Level 4, On the Move (Roll Skate Roll!)*, p. 23	wooden boards, blocks or bricks, roller skates, various masses, measuring tapes, balance	
Inventing, building and marketing moving toys		*Innovations in Science, Level 4, On the Move (The Wind-Up!)*, p. 45	materials as needed	
Solving a mystery machine		*Innovations in Science, Level 4, Technology and You!*, Activity Card 33, *Mystery Machines*	box and different materials as needed	Build a mystery box that has an action happening outside the box and have the other students guess how it is done.
Making a different chassis	3	*Blueprints: Technology Key Stage 2* (Gadd & Morton), p. 32	wheels, axles, frame	Various ways to make a vehicle frame using different building materials.

Extension Activity	SLE	Print Resources	Essential Materials	Comments
Inventing a machine	7	*Innovations in Science, Level 4, Technology and You! (Invent It)*, Activity Card 35	as needed	Open-ended activity to invent a machine to perform a task.
Creating easy-to-make vehicles	1, 2	*Blueprints: Technology Key Stage 1* (Gadd & Morton), p. 12	thread spools, bulldog clips, tubing, wood or cardboard strips	Build various frames that will move using rollers.
Motorized Mechanisms				
Creating movement using cog wheels	4	*Blueprints: Technology Key Stage 2* (Gadd & Morton), p. 60, 82	cog wheels, wooden frame, dowels, wood strips, glue	Build devices that have movement using cog wheels.
Building a conveyor belt	1, 2	*Blueprints: Technology Key Stage 2* (Gadd & Morton), p. 112	thread spool, dowels, wood frame, drive belt	A simple conveyor belt to incorporate into a production line.
Air-Driven Mechanisms				
Building a water vehicle		*Innovations in Science, Level 4, On the Move, Activity* Card 42, *Water Skimmer*	elastics, boat shell, different materials as needed	Design and build a boat that can run on stored energy.
Using a windmill to do work		*Innovations in Science, Level 4, Technology and You!*, Activity Card 31, *Wind Winder*	different materials as needed	An open-ended activity to develop a wind-driven pulley system.
Making a wind-driven vehicle		*Innovations in Science, Level 4, On the Move*, Activity Card 40, *Wind Wagon*	scrap material as needed	An open-ended activity to develop a wind-driven vehicle.
Mechanisms that Run on Stored Energy				
Controlling energy in a moving device	3, 5, 8	*Blueprints: Technology Key Stage 2* (Gadd & Morton), p. 8	block of wood, dowels, wood strips, elastic, small container	Control the energy in a catapult.
Manually Driven Mechanisms				
Building an elevator		*Innovations in Science, Level 4, Technology and You!*, Activity Card 32, *Up and Down*	different materials as needed	Design and build an elevator system.

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**

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