# Simple Machines

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# About **Simple Machines**

## **DeltaScienceModules**, THIRD EDITION

Students explore *Simple Machines* with twelve hands-on activities and the Delta Science Reader. By measuring force as they lift, push, and pull loads, your class will determine the mathematical relationship between force and work. Students build and/or operate classroom versions of the six simple machines: lever, wheel and axle, pulley, inclined plane, wedge, and screw. They investigate how (and how much) each one makes work easier by magnifying, modifying, transferring, or changing the direction of the applied force. By calculating such factors as gear ratios and the negative effects of friction, students discover the tradeoff between force and distance. Students also identify and examine household or other everyday simple machines.

In the Delta Science Reader *Simple Machines,* students explore the world of simple machines and the energy that makes them work. Students read about the six simple machines—the inclined plane, the lever, the wheel and axle, the pulley, the wedge, and the screw—and understand the difference between simple and compound machines. In biographical sketches, students meet ancient Greek mathematician Archimedes and modern inventor Lillian Gilbreth, and discover how they put simple machines to work. Students also read about the scientific formula for calculating work, the many levers in the human body, and how a roller coaster works.

# Overview Chart for Hands-on Activities

| Hands-on Activity | Student Objectives |
|---|---|
| 1 **Doing Work** *page 13* | • measure the force required to move an object<br>• measure the distance the object was moved<br>• calculate how much work was done when the object was moved a measured distance |
| 2 **Levers** *page 19* | • construct a lever<br>• investigate the mechanical advantage of a lever by experimenting with the position of the fulcrum, load, and effort |
| 3 **Friction** *page 25* | • observe the effects of friction<br>• examine variables that increase and decrease friction<br>• discover one method of reducing friction |
| 4 **Inventing the Wheel** *page 33* | • measure the amount of force needed to move an object a certain distance<br>• predict how using wheels will affect the amount of force needed to move that same object the same distance<br>• observe how even the most primitive wheels reduce the amount of force needed to move an object, and thereby the amount of work performed |
| 5 **The Wheel and Axle** *page 39* | • assemble a tractor<br>• investigate the transfer of force between the axles and the wheels of the tractor<br>• discover the mechanical advantage of a wheel and axle simple machine |
| 6 **Tractor Traction** *page 49* | • discover how traction affects the forward motion of a rotating object<br>• discover how friction affects the distance a rotating object will travel |
| 7 **Gears** *page 57* | • examine the structure of a gear<br>• observe how gears interact to transfer force<br>• discuss gear ratio |
| 8 **Pulleys** *page 65* | • construct a simple pulley<br>• measure the force required to lift an object, with and without the use of a pulley<br>• observe that a pulley reverses the direction of applied force |
| 9 **Inclined Planes** *page 71* | • measure the amount of force needed to do a given amount of work, with and without the use of an inclined plane<br>• discover how an inclined plane enables them to use less force to do about the same amount of work by distributing the force over a greater distance |
| 10 **Wedges** *page 77* | • observe the use of inclined planes in wedges<br>• use a wedge to perform work<br>• observe how wedges make doing work easier |
| 11 **Screws** *page 83* | • build a model of a screw by wrapping an inclined plane around a cylinder<br>• compare the force used to drive a screw with that used to drive a nail<br>• discuss how screws make work easier |
| 12 **Domestic Simple Machines** *page 91* | • identify examples of simple machines found in the home<br>• discuss the features of these household devices that make them simple machines<br>• design and construct a mobile |
| **Assessment** *page 97* | • See page 97. |

| Process Skills | Vocabulary | Delta Science Reader |
|---|---|---|
| measure, compare, use numbers, collect data | **force, joule, newton, work** | pages 2, 3 |
| make and use models, infer | **arm, effort, fulcrum, lever, load, machine, mechanical advantage, simple machine** | pages 5–6, 14 |
| observe, use variables, infer | **friction, lubricant** | page 2 |
| measure, predict, observe | **wheel** | pages 7, 10, 15 |
| make and use models, predict, infer | **axle** | page 7 |
| predict, measure, infer | **traction** | pages 2, 11 |
| observe, communicate | **driven gear, driving gear, gear, gear ratio** | pages 10–11 |
| make and use models, measure, observe | **pulley** | pages 8, 10, 15 |
| measure, infer | **inclined plane, ramp** | page 4 |
| observe, make and use models | **wedge** | page 9 |
| make and use models, compare, measure, communicate | **screw, thread** | pages 9, 12 |
| classify, communicate, make and use models | **mobile** | page 4 |

See the following page for the Delta Science Reader Overview Chart.

# Overview Chart for Delta Science Reader
## *Simple Machines*

| Selections | Vocabulary | Related Activity |
|---|---|---|
| **Think About...** | | |
| **What Makes Things Move?** *page 2* | force, friction, gravity, inertia, motion, newton, speed | 1 |
| **How Are Work and Energy Related?** *page 3* | distance, energy, joule, kinetic energy, potential energy, work | 1, 3 |
| **What Are Simple Machines?** • Inclined Plane • Lever • Wheel and Axle • Pulley • Wedge • Screw *pages 4–9* | efficiency, effort, fulcrum, inclined plane, lever, machine, pulley, resistance, screw, simple machine, wedge, wheel and axle | 2, 4, 5, 6, 7, 8, 9, 10, 11 |
| **What Are Compound Machines?** *page 10* | compound machine | 12 |
| **People in Science** | | |
| • **Archimedes** *page 12* | | 2 |
| • **Lillian Gilbreth** *page 13* | | |
| **Did You Know?** | | |
| • **Your Body Has Levers** *page 14* | | 2 |
| • **How a Roller Coaster Works** *page 15* | | 8 |

See pages 105–115 for teaching suggestions for the Delta Science Reader.

# MATERIALS LIST

## Simple Machines

| Quantity | Description |
|---|---|
| 8 | bricks, half† |
| 16 | cups, plastic |
| 40 | dowels |
| 1 | fishing line, 100 m |
| 8 | fulcrums |
| 8 | gear bases |
| 1 | gear cover |
| 8 | gear handles |
| 8 | gear pointers |
| 8 | gears, large |
| 8 | gears, medium |
| 8 | gears, small |
| 24 | hex nuts |
| 1 | nails, p/64* |
| 4 | paper clips, p/100 |
| 8 | pegboard beams |
| 1 | petroleum jelly, 1 oz* |
| 8 | pulleys |
| 8 | rivets* |
| 1 | rubber bands, long, p/25 |
| 1 | rubber bands, short, p/25 |
| 1 | rubber bands, wide, p/25 |
| 8 | sandpaper, sheets* |
| 32 | screws* |
| 8 | spring scales |
| 1 | string, 129 m* |
| 1 | tape, masking* |
| 1 | thread* |
| 8 | tractor kits |
| 16 | waxed paper, 30 cm × 30 cm* |
| 8 | wooden boards† |
| 1 | Teacher's Guide |
| 8 | Delta Science Readers |

| Quantity | Description |
|---|---|
| **TEACHER-PROVIDED ITEMS** | |
| 32 | books |
| 8 | hammers |
| 1 | hole punch |
| 8 | index cards, 3 in. × 5 in. |
| 8 | markers, wide |
| 8 | metersticks |
| 8 | paper, sheets* |
| – | paper towels* |
| 8 | pencils |
| 8 | rulers, metric |
| 32 | safety goggles |
| 8 | scissors |
| 8 | screwdrivers, flat-slot |
| 8 | wood, scraps* |

* = consumable item

† = in separate box

To order consumable items or refill kits, please call 1-800-442-5444.

# ACTIVITY SUMMARY

**This Delta Science Module begins an investigation of simple machines by introducing students to the concepts of force and work.**

**ACTIVITY 1** Students determine the amount of force necessary to move objects. Then they learn how to calculate the amount of work done when an object is moved over a measured distance.

**ACTIVITY 2** Students examine the lever, the first of six types of simple machines. They construct a lever and discover the mechanical advantage of this device: that they can move an object with less effort simply by repositioning the fulcrum.

**ACTIVITY 3** Students examine friction—the number-one enemy of machines. They observe how friction increases the amount of force necessary to move objects and do work. They also experiment with surfaces that produce varying degrees of friction, as well as observe one method of reducing friction.

**ACTIVITY 4** Students discover how even the most primitive wheels reduce the amount of friction between an object and the surface over which it moves, thereby reducing the amount of force necessary to move the object.

**ACTIVITY 5** Students continue their examination of the wheel and are introduced to another simple machine—the wheel and axle. While experimenting with a tractor, they discover that force is transferred between the axle and the wheel and the tractor moves. Taking a closer look at the forces involved, they see that force is decreased when transferred from the axle to the wheel (as in the tractor) and magnified when transferred from the wheel to the axle (as in a screwdriver). They then examine a screwdriver to see how it makes use of this mechanical advantage.

**ACTIVITY 6** Students discover that friction can be useful. They experiment with traction (moving friction) and how it improves the performance of their tractors.

**ACTIVITY 7** Students look at a special type of wheel called a *gear*. They examine the structure of a gear and observe how force that is applied to a driving gear is transferred to a driven gear. They discuss gear ratio and how it affects the distance each gear will move.

**ACTIVITY 8** Students examine a third type of simple machine: the pulley. They observe how a pulley redirects applied force, enabling them to lift an object by pulling down on a string.

**ACTIVITY 9** Students conduct an investigation of inclined planes—a fourth type of simple machine. They perform experiments and discover that the inclined plane allows them to do the same amount of work while exerting less effort.

**ACTIVITY 10** Students discuss the properties of the wedge that enable it to be classified as a fifth type of simple machine. They discover that a wedge is comprised of two or more inclined planes positioned to form a point, and that the tip of a nail is actually a wedge, which makes it easier to drive into wood than a blunt-ended rivet.

**ACTIVITY 11** Students examine the screw—a sixth type of simple machine. Students discover that a screw consists of an inclined plane wrapped around a cylinder. They compare the relative force used to drive a screw with that used to drive a nail, and discover how screws make work easier.

**ACTIVITY 12** Students compare lists of simple machines found in the home. They then build a mobile from dowels.