TECHNOLOGY

INTRODUCTION

As described in the introduction to this manual, technology means using knowledge of the physical world for practical purposes such as creating something or solving a problem. The earliest **technologies**, the inventions and developments that make humans' work easier, were simple ones that helped people meet their basic needs for survival. Stone tools that humans used to crush seeds or kill small game are examples of early technologies. Technologies have advanced and continue to advance thanks to thousands of individuals' work and ingenuity. These individuals have come from many different parts of the world and many different times in history.

Technologies affect people's quality of life in countless ways today. For example, medical technologies make it possible to take X-rays of broken bones, and water treatment technologies mean that cities can provide safe drinking water to their inhabitants. Technologies benefit from new scientific knowledge. For example, microscope technology has improved over time as scientists develop a better understanding of lenses. Similarly, science benefits from advances in technology. For example, as microscopes become more powerful, people are able to see smaller and smaller objects.

Technology changes the way people do things and can have both positive and negative effects. For example, in many parts of the world, people no longer need to visit the bank to withdraw money from their bank accounts. They can simply go to an automated banking machine. The advantage is convenience, but the disadvantage is that an opportunity for social contact is lost. In a world full of wondrous inventions, where it is easy to be swayed by the latest gadget, it is important for students to be able to assess both benefits and disadvantages, both to themselves and to people in other parts of the world. Teachers can help students develop this awareness by making links like these:

- showing how a technology developed in one part of the world affects people in another part of the world (e.g., medicine)
- comparing how a technology is used in two different parts of the world (e.g., motorized vehicles)
- debating with the students the benefits and disadvantages of technologies (e.g., nuclear energy)
- discussing what barriers exist for some people to access technologies (e.g., lack of opportunity, education, adequate finances)
- showing the close relationship between technologies and the **environment**, the surroundings and conditions affecting all living things on earth

The following sections provide background information and activities associated with three aspects of technology:

- Simple Machines — encourages students to investigate the properties of the ramp, wedge, screw, lever, wheel and axle, and pulley.
- Technologies to Meet Basic Needs — gives students the opportunity to explore some primitive or ancient technologies such as making tools, starting fires, and making pottery and bricks.
- Engineering Technologies — invites student to build their own Roman arch, windmill, and water wheel.

SIMPLE MACHINES

Background Information

People have always used tools to help them to do their work, which in science, simply means moving objects by using force. A **force** is a power capable of making an object change its speed or direction. A **simple machine** is a device that makes it easier to lift or move an object, or that changes the direction of a force. Technology would not exist if not for simple machines, which are the basic elements of more complicated machines such as automobiles.

There are six simple machines, which fall into two families:

- The **inclined plane family** of machines includes the ramp, wedge, and screw.

- The **lever family** of machines includes the lever, wheel and axle, and pulley.

The inclined plane family of machines

A **ramp**, also called an **inclined plane**, is a slope. Less force is needed to move a heavy object up a ramp than to lift or push the object straight up. This is why movers use a ramp to load furniture into a moving van. It is also why mountain roads often wind around a hill rather than going straight up a hill. If a ramp is steep, stairs may be cut into it so people do not lose their footing while climbing the ramp.

Although less force is needed when using a ramp, the same total amount of energy is needed to move a load up a ramp because the trip up the ramp takes longer than would the trip straight up.

Less force is needed to push a load up a ramp than to push it straight up

A **wedge** looks like a ramp, or like a pair of ramps back to back. Most wedges are used to push things apart. When a wedge is driven into wood, for example, the downward force on the wedge creates an outward (sideways) force on the slanted side or sides of the wedge, thereby pushing the wood apart. Examples of wedges that push things apart are an ax, a chisel, a knife, a saw, and a ship's bow. A few wedges hold things together, for example nails or doorstops.

Most wedges are used to push things apart

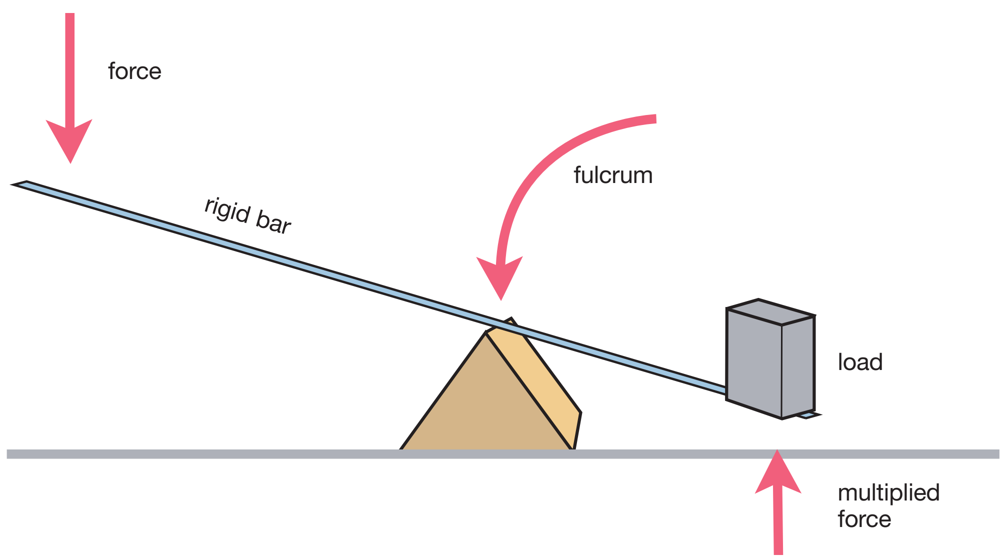
The screw is a ramp wrapped around a cylinder

The screw changes a force from a circular direction to a straight line

A **screw** is a ramp wrapped around a central post. The ridges formed by the ramp are called the **threads** of the screw. A screw changes the direction of a force from a circular motion to a straight line. For example, turning a screw with a screwdriver advances the screw straight forward.

Ordinary screws are used to hold materials such as wood or metal together. Screws are also used in car jacks, corkscrews, and hand augers.

It is easy to demonstrate that a screw is a ramp wrapped around a cylinder. First a triangle is cut out of paper and its long side is colored. Then the triangle is wrapped around a pencil. The colored line will spiral around the pencil like the thread of a screw.



The lever

The lever family of machines

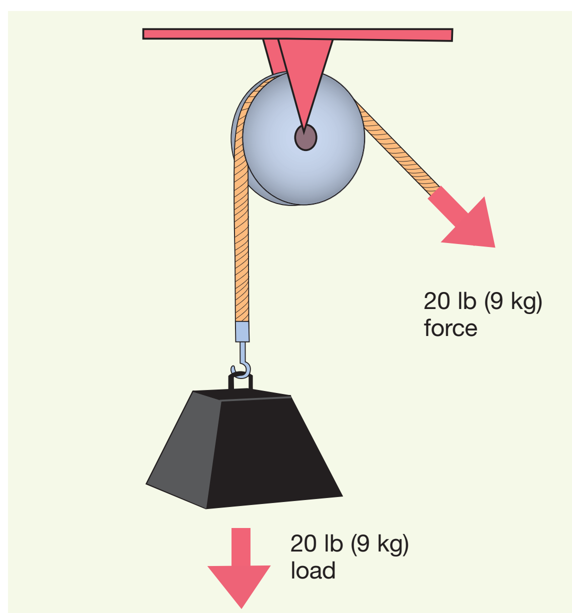
A **lever** is a rigid bar or pole that turns on a supporting point called a **fulcrum**. A playground seesaw is a lever familiar to most people. Levers work by multiplying the pushing force under a load so it can be moved or lifted more easily. The closer the fulcrum is to the load, the easier the load is to lift. Also, the longer the lever, the easier the lifting. The different types of levers that exist have many uses. Some familiar levers are a pair of pliers, a crowbar, a car jack, a pair of scissors, fingernail clippers, a balance, a wheelbarrow, and a nutcracker.

A **wheel and axle** consists of two wheels attached at their centers, the smaller wheel being the axle. The wheel works like a lever that is free to rotate through a complete circle. If a force is applied to the wheel, the axle turns in a smaller circle with more force. Examples include faucet handles, skateboards, steering wheels, doorknobs, windmills, and gears. The force can also be applied to the axle to make the wheel or wheels go around, as in a car, for example.

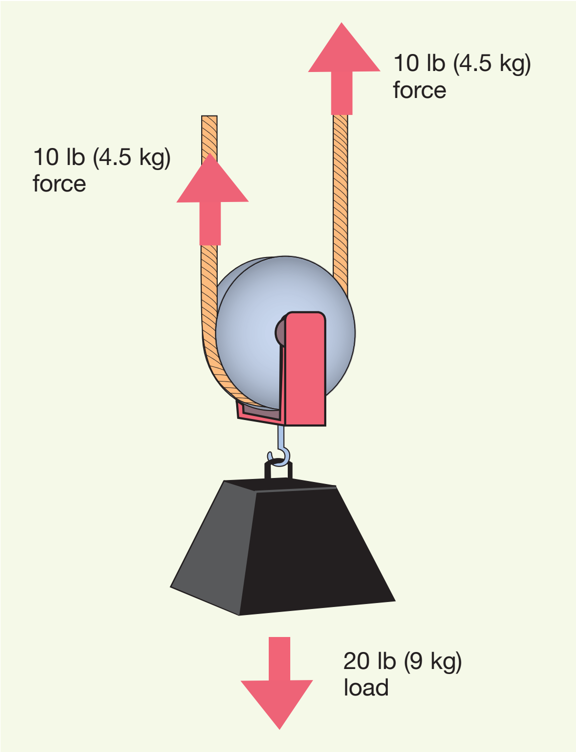
It is important to understand that a wheel and axle used as a simple machine are different from a wheel and axle used simply as rollers. For example, the front wheel of a bicycle is really just a roller. However, the rear wheel of the bicycle is a wheel and axle in the sense of a simple machine. This is because the force driving the bicycle is applied to the rear axle, which is firmly attached to the rear wheel.

A **pulley** is a wheel with a grooved rim, around which a rope or chain passes. A pulley is used to change the direction of a force or to decrease the force needed to lift a load. The simplest kind of pulley is a **fixed pulley**, which stays in one place. The load on a fixed pulley is carried at the rim. Fixed pulleys are used for hoisting flags and sails or for drawing curtains. A fixed pulley makes work easier by changing the direction of a force. For example, it is much easier to hoist a sail while standing on the deck than by climbing the mast dragging a sail behind! However, a fixed pulley does not change the amount of force needed.

A wheel and axle consists of a large and a small wheel attached at their centers



The fixed pulley makes work easier by changing the direction of a force



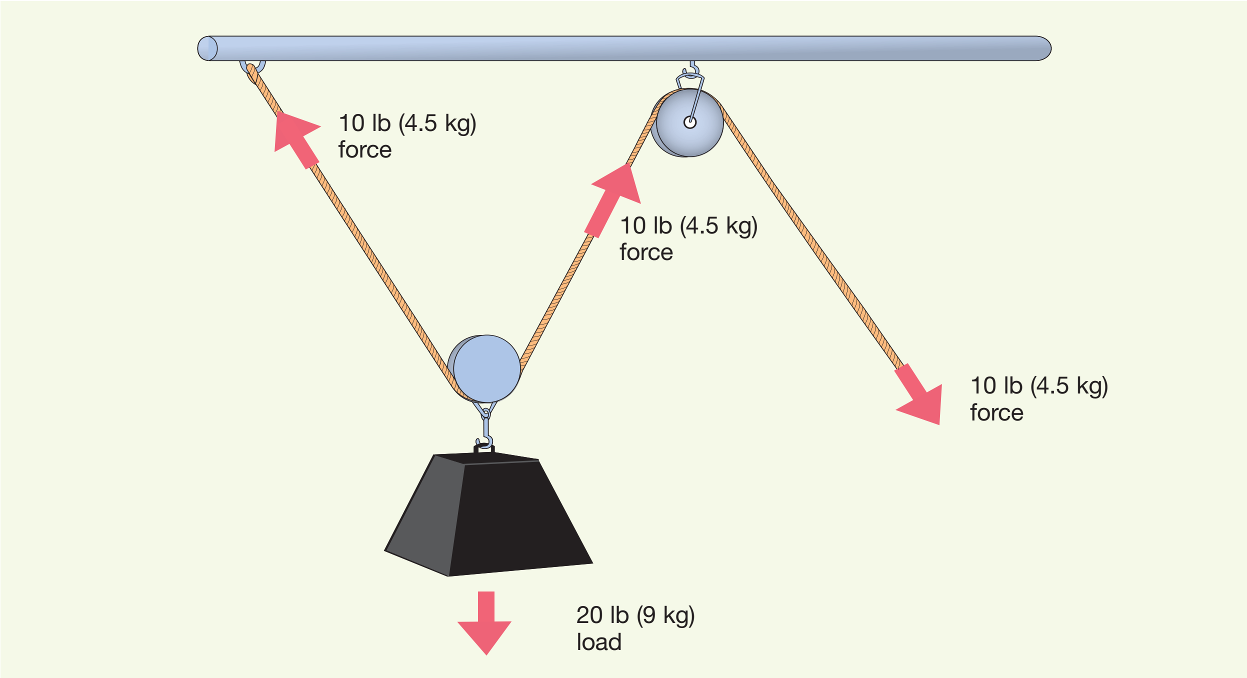
A movable pulley splits a load two ways so only half as much force is needed

The other kind of pulley is a **movable pulley**, which can travel along a rope. On a movable pulley, it is the axle that carries the load. Movable pulleys reduce the force needed to lift a load because they split the total load between two or more ropes. A single movable pulley, for example, splits the load two ways. It is as if two separate ropes were holding up the weight.

If more movable pulleys are added to the system, the weight is split more ways, and even less force is needed to pull on the rope. Large sailing ships and construction cranes commonly use several movable pulleys. A movable pulley has a pulley wheel with two or more grooves instead of one, so the rope can loop around the pulley twice or more.

It is often useful to combine a fixed pulley and a movable pulley in an arrangement called a **block and tackle**. A block and tackle makes it easier to lift a heavy weight for two reasons:

- The fixed pulley means a person can apply force by leaning down on the rope. This is easier than pulling up.



A block and tackle combines the advantages of the fixed pulley and movable pulley

- The movable pulley cuts in half the amount of force needed.

Summary chart for simple machines

At the end of this section is a summary chart showing the six simple machines, their structure and function, and some examples of how the machines are applied in the world. Teachers can copy this chart on single pages for students to use in activities, and/or copy the chart onto a poster board to keep in the science area of the classroom.

Summary chart: The six simple machines

Machine	Structure	Function	Applications
Ramp	A slope (or inclined plane).	Decreases effort required to move loads upward.	Moving ramp, stairs, escalator, mountain road.
Wedge	A pair of ramps back to back (some wedges are a single ramp).	Changes direction of a force to push apart or split objects.	Ax, chisel, ship's bow, knife.
Screw	A ramp wrapped around a central post.	Changes direction of a force from circular to straight; holds things together.	Wood screw, car jack, corkscrew, hand auger.
Lever	A rigid bar or pole that pivots on a fulcrum.	Multiplies force, decreases effort required to move and lift loads.	Seesaw, human arm.
Wheel and axle	Two wheels attached at their centers, the smaller wheel being the axle.	Multiplies force required to move loads.	Doorknob, steering wheel, windmill, gear.
Pulley	A wheel with a grooved rim, around which a rope or chain passes.	Changes direction of force (fixed pulley); decreases the force needed to lift a load (movable pulley).	Flagpole, sails, curtain and blind cords.

Did you know?

- In the 3rd century BC the Greek scientist, Archimedes (287–212 BC), put a large screw inside a tube and used his invention, called an **Archimedes' screw**, to lift water from streams to agricultural fields. Archimedes' screws are still used for irrigation in Egypt, for moving grain inside threshers or grain mills, and for moving powdered material in factories.
- The human arm is a lever with the elbow as a fulcrum.
- A machine made from a combination of two or more simple machines is called a **compound machine**. For example, scissors are made up of two blades (wedges) that act as levers with a screw as a fulcrum.

Resources

There are many excellent resources about technology and simple machines. Here are some examples:

- Taylor, Barbara. Force and Movement. (Science Starters.) New York, NY: Franklin Watts, 1990.
- Canada Science and Technology Museum. <http://www.sciencetech.technomuses.ca/english/schoolzone/Info_Simple_Machines.cfm>
- NASA for Students, Simple Machines. <http://nasaexplores.nasa.gov/show_k4_student_st.php?id=030306134805>

ACTIVITY 1

Pulling a Load Up a Ramp

Purpose

To explore technology by examining the first of six simple machines — the ramp — and to discover that pulling a load up a ramp requires less force than lifting the load straight up.

Material

Illustration of a ramp.

Whiteboard and marker.

Sturdy chair.

Plank of wood about 3 ft (1 m) long or longer.

Brick (or other heavy object).

Toy car with moving wheels.

Roll of string.

Scissors.

Large, strong elastic band.

Yardstick (meterstick) and ruler.

Scientific Method & Technology journals and pencils.

Presentation

- Most Montessori teachers present this concept in Year 5.

- Announce that the students will have the opportunity to explore the ramp, the first of six simple machines that are the basis of technology.

BACKGROUND

- Define and discuss technology. Ask for and discuss examples of early and modern technology.

- Define and discuss work, force, and simple machines. Explain that technology is based on six simple machines, the first being the ramp, also called an inclined plane.

- Display the illustration of a basic ramp and explain how it is used. Draw on the whiteboard other examples of ramps (e.g., stairs, winding mountain roads) and discuss their workings. Ask students for examples of ramps they have used or seen.

- Review that a ramp is a simple tool because it makes it easier to do work, which in science, means moving things. Ask students to imagine how humans might have first discovered how to use a ramp.

MAKING AND USING A RAMP

- Invite the students to lean the plank on the chair to make a ramp. (It may be necessary to place a brick at the bottom of the ramp to keep it in place.)

- Invite a student to cut a length of string about 3 ft (1 m) long and tie it to the toy car.

- Invite a student to tie the elastic band to the other end of the string.

- Invite a student to hold the end of the elastic band and pull the toy straight up off the ground as if to place the toy on the chair.

- Ask a student to take the ruler and measure how long the elastic band is with the toy hanging from it, and report the measurement to the group. Ask the students to use their journals to record the length.

- Invite a student to hold the end of the elastic and pull the toy car part way up the ramp, then stop and hold still while another student takes a measurement.

- Ask a student to measure and report how long the elastic is while the toy is held in place on the ramp. Ask students to record their measurements in their journals.

- Ask the students to compare the lengths of the elastics and say whether more force was needed to pull the toy straight up or to pull it up the ramp.

- Discuss how the ramp affected lifting the load of the car.

- Ask the students to use their journals to draw a ramp, write a paragraph about how a ramp works and give examples of ramps, then describe what happened in this activity.

Extensions

- Modify the above activity by making the ramp steeper or less steep and see how the change affects the length of the elastic and the lifting of the load.

- Formulate a question and hypothesis, then design and carry out a science experiment involving a ramp. Be sure to record the experiment, following the science experiment template included in the Resources section of this manual.

- Conduct experiments that compare the time it takes to move a load up a ramp with the time it takes to lift the load straight up.

- Take a walk around your house, school, and neighborhood to look for ramps in everyday life. Make a list of at least five ramps. (Examples: the slope of a sidewalk across the end of a driveway, a multi-level parking garage, a wheelchair ramp, a flight of stairs.)

- Next time you are on a bike, skateboard, or scooter, go up and down some ramps such as hills or other inclines. Think about how much harder it would be to go up and down without the ramps.

- Create and perform a short play that demonstrates how early humans may have first discovered and used the ramp.

- Research and write a short illustrated report about the history of the ramp.

ACTIVITY 2

Cutting Through Cardboard With a Wedge

Purpose

To explore technology by examining the second of six simple machines — the wedge — and to discover that a wedge makes it easier to split things apart.

Material

Illustration of a wedge.

Whiteboard and marker.

Sheet of thick corrugated cardboard.

New, unsharpened pencil.

New, sharpened pencil.

Scientific Method & Technology journals and pencils.

Presentation

- Most Montessori teachers present this concept in Year 5.

- Announce that the students will have the opportunity to explore the wedge, the second of six simple machines that are the basis of technology.

BACKGROUND

- Briefly review technology, simple machines, work, and force.

- Display the illustration of the wedge, then define the wedge and discuss how it works.

- Encourage students to provide examples of wedges and draw them on the whiteboard.

- Review that a wedge is a simple tool because it makes it easier to do work, which in science, means moving things. Ask students to imagine how humans might have first discovered how to use a wedge.

MAKING AND USING A WEDGE

- Invite a student to lay the corrugated cardboard and unsharpened pencil on a table.

- Invite the students to take turns pressing one flat end of the unsharpened pencil into the cardboard to try making a hole in the cardboard. (It will be difficult.)

- Demonstrate the sharpened pencil.

- Invite the students to take turns pressing the sharpened end of the pencil into the cardboard to make a hole in the cardboard. (It will be easy.)

- Encourage the students to discuss their observations. (It was easier to poke the sharpened pencil end into the cardboard.)

- Explain that the pointed pencil tip acted like a wedge to push the cardboard sideways out of the way of the pencil.

- Review how the wedge (sharpened pencil) moved the cardboard, and how wedges are simple machines that help humans perform work, which in science means moving objects with the use of force.

- Ask the students to use their journals to draw a wedge, write a paragraph about how a wedge works and give examples of wedges, then describe what happened in this activity.

Extensions

- Modify the above activity by making the wedge point duller or sharper and see how the change affects the work the wedge can do.

- Formulate a question and hypothesis, then design and carry out a science experiment involving a wedge. Be sure to record the experiment, following the science experiment template included in the Resources section of this manual.

- Visit a hardware store, building supply store, or workshop and make a list of all the different kinds of wedges you can see.

- Write a story about how someone lost in the woods survives by using two kinds of wedges.

- Research and write a short illustrated report about the history of the wedge.

ACTIVITY 3

Discovering That a Screw is a Type of Ramp

Purpose

To explore technology by examining the third of six simple machines — the screw — and to discover that a screw is a ramp wrapped around a cylinder.

Material

Illustration of a screw.

Several different types of screws.

Letter-size sheets of blank paper (one per two students).

Scissors (one pair per two students).

Adhesive tape (one roll per two students).

Colored felt markers, wide-tipped (one per student).

New, unsharpened pencils (one per student). Screwdrivers (one per two students).

Large, soft board that will easily take screws.

Scientific Method & Technology journals and pencils.

Presentation

- Most Montessori teachers present this concept in Year 5.

- Announce that the students will have the opportunity to explore the screw, the third of six simple machines that are the basis of technology, and to see how the screw is really a ramp wrapped around a cylinder.

BACKGROUND

- Briefly review technology, simple machines, work, and force.

- Display the illustration of the screw, then define the screw and discuss how it works. Explain that a screw is really a ramp wrapped around a central cylinder.

- Review the concept of a ramp. Invite the students to look at and handle the different screws. Ask them to notice the threads on the screws and how the threads are arranged. Encourage the students to trace the path of a thread from the bottom of the screw to the top. (The thread spirals up the central post of the screw.)

- Review that a screw is a simple tool because it makes it easier to do work, which in science, means moving things. Ask students to imagine how humans might have first discovered how to make and use a screw.

MAKING A SCREW WITH PAPER AND PENCIL

- Invite students to work in pairs, and for each pair to take two brand new unsharpened pencils, one pair of scissors, two colored markers, a roll of tape, and one sheet of blank paper.

- Ask the pairs of students to cut their piece of paper diagonally in half to make two long triangles, one for each student in the pair.

- Point out that a triangular piece of paper is shaped like a ramp.

- Invite each student to find the longest edge of a paper triangle. Check that each student has correctly identified the longest edge.

- Ask the students to use the wide-tipped felt markers to make a colored strip right next to the longest edge of their triangles.

- Pick up a new unsharpened pencil and point out that the pencil is shaped like a cylinder.

- Invite the students to tape the shortest edge of their triangles along the length of their pencils. (The colored edge of the triangle should be facing outward, not facing the pencil.)

- Invite the students to tightly roll up their pencils in the paper triangle, then to place a piece of tape at the very last tip of the triangle to hold the paper triangle in place around the pencil.

- Encourage the students to look at the colored strip and see how the paper triangle (ramp) wrapped around the pencil (cylinder) has made a spiral around the pencil, similar to how threads spiral along a real screw.

- Ask the students to draw in their journals the paper triangle as it looked before and after wrapping it around the pencil.

USING A SCREW

- Review that a screw is a simple machine that helps humans perform work, which in science means moving objects with the use of force.

- Explain that a screw changes the direction of a force from circular to straight. Ask students what screws are used for, and discuss how screws can hold things together, or, draw material upward, as in the Archimedes' screw.

- Take a screw, screwdriver, and soft board. Demonstrate how to drive the screw into the board, pointing out how the circular force drives the screw straight into the board.
- Encourage students to use screwdrivers to drive screws into the board.
- Ask the students to use their journals to draw a screw, write a paragraph describing how a screw is a ramp wrapped around a cylinder, and give examples of how screws are used.

Extensions

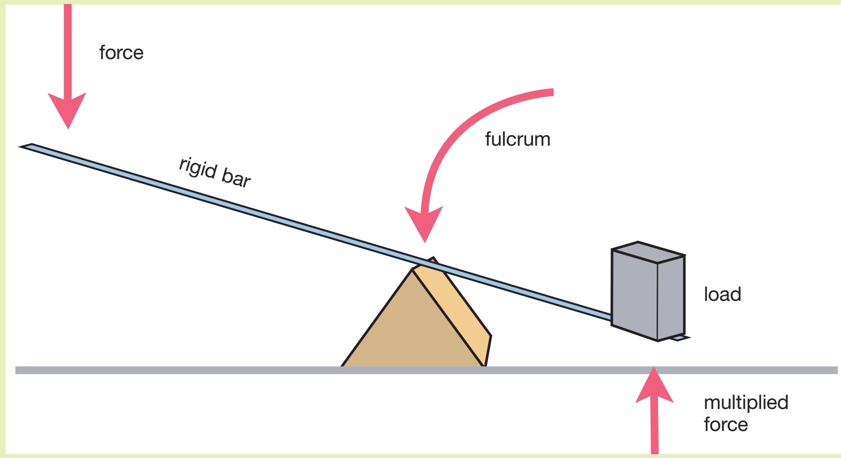
- Hold the head of a screw between the fingers, and with the other hand, hold the very tip of the screw between two fingernails. Turn the screw and watch it spiral past your fingernails.
- Formulate a question and hypothesis, then design and carry out a science experiment involving a screw. Be sure to record the experiment, following the science experiment template included in the Resources section of this manual.
- Visit a hardware or building supply store and make a list of the different kinds of screws.
- Find out how a car jack, corkscrew, or a hand auger works. If possible and with adult supervision, try using each of these tools.
- With an adult, build an object from wood, using screws to hold the pieces together.

ACTIVITY 4

Lifting an Object With a Lever

Purpose

To explore technology by examining the fourth of six simple machines — the lever — and to discover how a lever makes lifting easier.



The lever

Material

Illustration of a lever with the following parts labeled: rigid bar, load, fulcrum, force, multiplied force.

Wooden ruler (one per student).

Small hardcover book (one per student).

Large table or several small tables.

Scientific Method & Technology journals and pencils.

Presentation

- Most Montessori teachers present this concept in Year 5.

- Announce that the students will have the opportunity to explore the lever, the fourth of six simple machines that are the basis of technology, and to experience how the lever makes lifting loads easier.

BACKGROUND

- Briefly review technology, simple machines, work, and force.

- Display the illustration of the lever, define the lever, and discuss how it works. Point out the lever's parts: rigid bar, load, and fulcrum. Do not discuss the force and multiplied force yet.

- Review that a lever is a simple tool because it makes it easier to do work, which in science, means moving things. Ask students to imagine how humans might have first discovered how to make and use a lever.

MAKING AND USING A LEVER

- Invite each student to lay a wooden ruler on the table with one end sticking out about 1 inch (2.5 cm) beyond the edge of the table. Explain that the ruler is the rigid bar of the lever.

- Invite each student to lay a small hardcover book sideways across the part of the ruler that is on the table. The entire width of the book should be on the ruler, and the ruler should not stick out beyond the book on the side far from the edge of the table.

- Point out that the book is the load, the ruler is the lever, and that the edge of the table is the fulcrum, on which the ruler will pivot.
- Invite the students to grasp, between thumb and index finger, the end of the ruler that is extending past the table edge. Encourage students to push this end of ruler downward to try to lift the book. (This should be impossible or difficult. If it is easy, use a heavier book.)
- Ask the students to pull the ruler-and-book arrangement forward until about 3 inches (7.6 cm) of ruler sticks out beyond the table edge. Invite students to hold the end of the ruler between thumb and finger as before, and push down until the book lifts. (This should be possible but take some effort.)
- Invite the students to pull the ruler-and-book arrangement forward until the book is at or very near the edge of the table. All the exposed part of the ruler will be sticking out beyond the table.
- Encourage the students to hold the ruler as before, and push down. (It will be very easy to lift the book.)
- Invite the students to push down using just the tip of the baby finger. (Most students will likely be able to lift the book.)
- Discuss the result of the activity. Make sure students understand it is easiest to lift a load if the load is close to the lever's fulcrum, and if the downward push is applied far from the fulcrum.
- Discuss the force students are applying and how the lever multiplies the force to make lifting the book easy. Refer to the illustration of a lever to point out where the force and multiplied force act.
- Ask the students to use their journals to draw a lever and label its parts, and to write a paragraph about positioning the lever's fulcrum and the load to make lifting easier.

Extensions

- Go to a playground that has a seesaw, and experiment with placing the load (your friend) and the downward force (you) closer to and farther from the seesaw's fulcrum.
- Formulate a question and hypothesis, then design and carry out a science experiment involving a lever. Be sure to record the experiment, following the science experiment template included in the Resources section of this manual.
- Research, list, and draw five different uses of the lever.
- Research and write a short illustrated report about the history of the lever, and give examples of how levers are used today.

ACTIVITY 5

Lifting a Load With a Wheel and Axle

Purpose

To explore technology by examining the fifth of six simple machines — the wheel and axle — and to discover why a wheel and axle makes lifting loads easier.

Material

Illustration of a lever (from previous activity).

Illustration of a wheel and axle.

Wheeled items such as cars, trucks, skateboard, and roller skates.

Wall-mounted classroom pencil sharpener that turns with a handle.

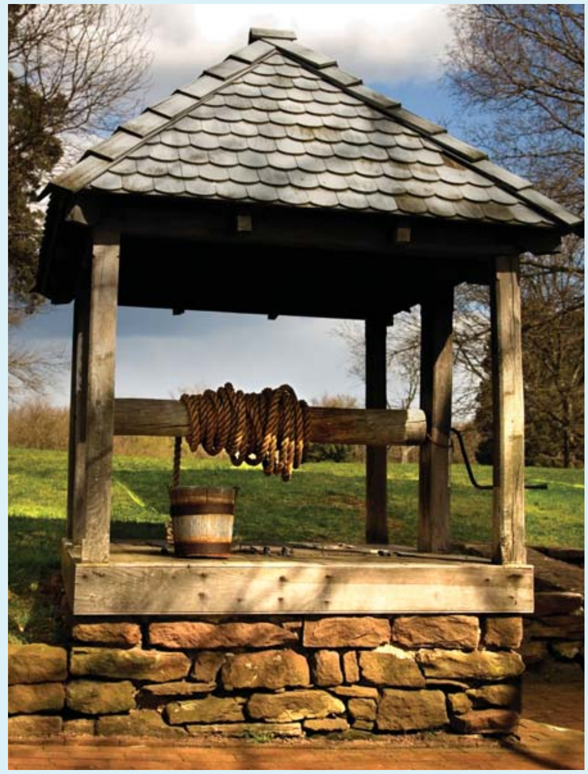
Roll of string.

Two books.

Scientific Method & Technology journals and pencils.

Presentation

- Most Montessori teachers present this concept in Year 5.
- Announce that the students will have the opportunity to explore the wheel and axle, the fifth of six simple machines that are the basis of technology, and to experience how the wheel and axle makes moving loads easier.



BACKGROUND

- Briefly review technology, simple machines, work, and force.
- Display the illustration of the wheel and axle, then define the wheel and axle and explain how it works.
- Review that a wheel and axle is a simple tool because it makes it easier to do work, which in science, means moving things with a force. Ask students to imagine how humans might have first discovered how to make and use a wheel and axle.

MAKING AND USING A WHEEL AND AXLE

- Invite the students to examine the wheeled items, and to point out the wheels and axles on the items. Point out the wheels and axles, if necessary.

- Briefly review levers and lever terminology (lever, rigid bar, fulcrum, load, force, multiplied force), referring to the illustration.

- Explain that: Axles do not only hold wheels in place. Some axles also transfer a force from the axle to the wheels or from the wheels to the axle. This kind of wheel and axle together is a simple machine.

- Explain that there is a connection between a lever and a wheel and axle: A wheel turning on an axle is like a lever turning on a fulcrum. It is as if the lever keeps turning all the way around the fulcrum. Thinking of a wheel with spokes may help visualize how the lever turns around the fulcrum.

- Invite a student to tie the books together with string. Ask him/her to leave enough extra string to reach from the floor to the pencil sharpener with about 6 inches (15 cm) left over.

- Ask the students to gather around the wall-mounted pencil sharpener. Invite a student to tie the loose end of the string to the shaft of the pencil sharpener. (The shaft is the narrow central part that sticks out of the sharpener, into which pencils are inserted.)

- Review terminology for the wheel and axle while referring to the pencil sharpener. Ask: Is there a wheel and axle in the pencil sharpener? Where is the wheel on the pencil sharpener? (Attached to the handle.) What does the handle do? (Extends the width of the wheel. This is like making the lever arm longer. It means less force is needed to turn the axle.) Where is the axle? (The string is tied around it.)

- Encourage a student to turn the handle on the pencil sharpener, thereby rolling up the string until the books are lifted a little way off the floor. Ask the student to notice how little force is needed to lift the books.

- Encourage all the students to take a turn using the pencil sharpener's wheel and axle to lift the books.

- Ask the students to use their journals to draw and label a wheel and axle, and write a paragraph about how the wheel and axle works. Ask students to also draw the pencil sharpener lifting the books, and to write down what effect its wheel and axle had on lifting the books.

Extensions

- Look closely at a bicycle. Notice that the rear wheel is very different from the front wheel. Look at how force is transferred from the pedals to the rear wheel but not to the front wheel.

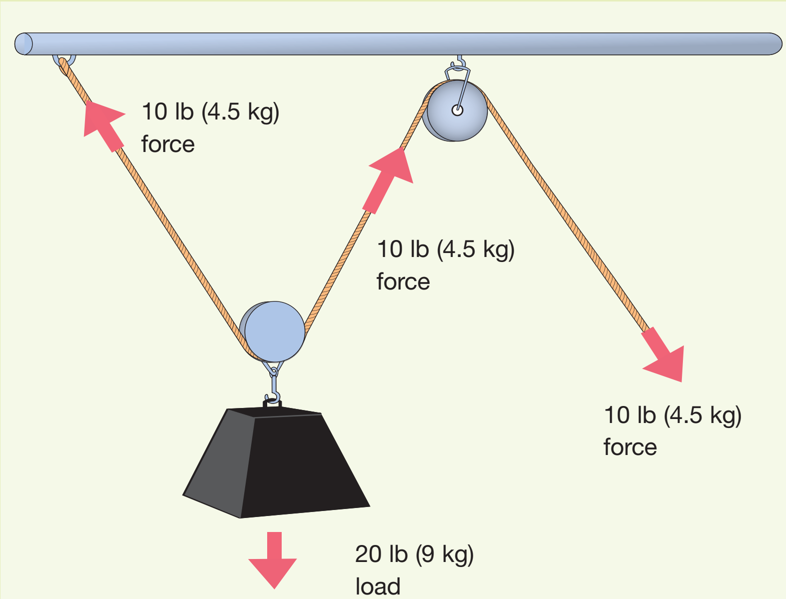
- Research, list, and draw five different types of wheel and axle. Write a paragraph about how each works.

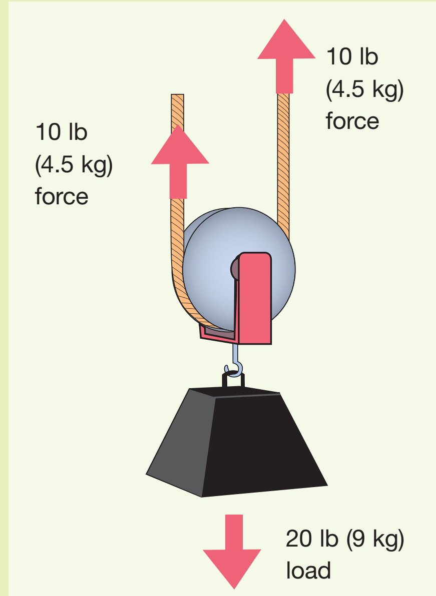
- Formulate a question and hypothesis, then design and carry out a science experiment involving the wheel and axle. Be sure to record the experiment, following the science experiment template included in the Resources section of this manual.

- Research and write a short illustrated report about the history of the wheel and axle, giving examples of how the wheel and axle was used long ago and how it is used today.

- Find out how simple gears work. Then, using ideas from the Internet or library books, make a simple set of gears.

Lifting a Brick With a Pulley





Purpose

To explore technology by examining the sixth of six simple machines — the pulley — and to discover why a pulley makes lifting loads easier.

Material

Illustration of a fixed pulley and a movable pulley.

Two empty thread spools.

Coat-hanger wire or other heavy wire.

Pliers.

Two strong cup hooks.

Plank of wood at least 4 ft (1.5 m) long.

Two sturdy chairs.

Thin rope about 3 yd (3 m) long.

Roll of string.

Brick.

Scientific Method & Technology journals and pencils.

Presentation

- Most Montessori teachers present this concept in Year 5.

- Announce that the students will have the opportunity to explore the pulley, the sixth of six simple machines that are the basis of technology, and to experience how the pulley makes moving loads easier.

BACKGROUND

- Briefly review technology, simple machines, work, and force.

- Display the illustrations of the different kinds of pulleys, define the pulley and explain how it works. Discuss how pulleys are used in clotheslines, flagpoles, and to lift and close curtains and blinds.

- Referring to the illustrations, point out that a fixed pulley changes only the direction of force, whereas a movable pulley reduces the force needed to lift a load.

- Review that a pulley is a simple tool because it makes it easier to do work, which in science, means moving things with a force. Ask students to imagine how humans might have first discovered how to make and use a pulley.

MAKING AND USING A PULLEY

- Refer to the illustrations of a fixed pulley, a movable pulley, and a block and tackle.

- Demonstrate how to build a simple fixed pulley, asking students to assist whenever possible. First, tie the string securely around the brick so the brick can be hung from a hook.

- Pass a piece of wire through a spool and bend the wire into a figure "8" shape. The second loop should be smaller than the loop passing through the spool. This assembly will be the fixed pulley.

- Pass a piece of the heavy wire through the other spool and bend the wire into a triangle. Twist the ends of the wire together and shape the wire into a hook. This assembly will be the movable pulley.

- Screw two cup hooks into the middle of the plank about 12 inches (30 cm) apart, making sure the hooks are very secure.

- Take the piece of rope and tie a secure loop in one end.

- Invite a student to place two sturdy chairs facing each other, with chair backs about 1 yd (1 m) apart.

- Encourage each student to try lifting up the brick by the string (without using the pulleys) to feel how heavy it is.

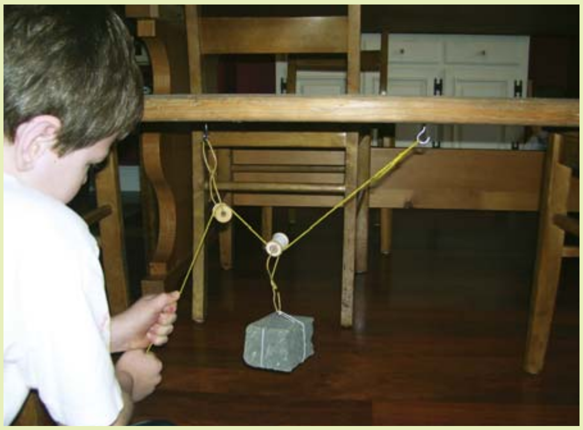
- Invite a student to lay the plank across the chairs, hooks down. Ask a student to stand at each end of the plank and hold the plank to keep it from slipping off the chairs.

- Invite a student to pick up the fixed pulley, then to use the wire loop on the pulley to hang the pulley from one of the hooks.

- Invite a student to pick up the rope, then to use the loop on the rope to attach the rope to the other hook. The loose end of the rope will dangle.

- Invite a student to pick up the loose end of the rope, then to pass the loose end through the movable pulley and then through the fixed pulley as in the movable pulley illustration.

- Encourage a student to hook the movable pulley to the brick.



- Invite each student in turn to raise the brick off the ground by pulling downward on the loose end of the rope.
- Make sure students continue to hold the plank secure while other students are hoisting the brick. Warn the students to keep their hands, feet, and heads out from under the brick and plank.
- Ask the students whether they found it easier to lift the brick with or without the pulley.
- Encourage the students to study the arrangement of ropes. Have them notice that there are actually two sections of rope supporting the brick as it hangs from the movable pulley. The brick's weight is split between the two ropes, and that is why it seems lighter than without the movable pulley.
- Remind students that the fixed pulley changes the direction a person must pull in to raise a load, whereas the movable pulley splits the weight of a load.
- Ask the students to use their journals to draw and label the fixed and movable pulleys, and to write a paragraph describing how the different pulleys work.

Extensions

- Find out what happens if more than one movable pulley is used to lift a load. (Even less force is needed.)
- Set up a pulley line (like a clothesline) across the classroom and use it to send messages across the room.
- Research, list, and draw five different uses of the pulley.
- Formulate a question and hypothesis, then design and carry out a science experiment involving the pulley. Be sure to record the experiment, following the science experiment template included in the Resources section of this manual.
- Research and write a short illustrated report about the history of the pulley, giving examples of how the pulley was used long ago and how it is used today.
- Think of something you would like to use a pulley for, and draw your idea. This could be a serious use or a wacky invention.
- Work in pairs and review all six simple machines using the summary chart: The six simple machines (from Background Information — teacher to provide copies).