Simple Machines

Summary

Students will complete several activities that reinforce the concept that all simple machines transfer force.

Materials

Peaceful Penny
- Drinking glass or cup
- Index card
- Penny

Sudden Stop
- One clay marble
- Ruler
- One small toy car
- Masking tape
- One pencil
- Three books (about 1" thick)
- Paper Grid (pdf)

Moving Possibilities
- Penny or paper clip

Uphill--Inclined Plane
- Plank of wood
- Spring scale (0-500g)
- Rubber band
- Five thick books
- One cup of rice
- Tube sock
- Uphill-Inclined Plane worksheet (pdf)

Twirling Helicopter Toy--Screw

For each student:
- Toy Helicopter Pattern (pdf)
- One large paper clip
- One small paper clip
- Scissors

Soap Carving--Wedge
- IVORY soap
- Plastic knife
- Paper (cut into 4 1/4" x 5 1/2")
- Paper towels
- Pencils
- Scissors

All Geared Up--Wheels and Axles (Gears)
- Two plastic milk caps
- One lid that is larger than a milk cap (e.g., a yogurt cup lid, cottage cheese container lid, or a Cool Whip lid)
- Three strips of corrugated cardboard (1/2" x perimeter of each lid)

Glue
Scissors

Flag Raiser--Fixed Pulley

Thread spool
Pencil or wooden dowel (small enough to slide through the hole in the thread spool)
String (4 ft. in length)
Scissors
Paper for flag (4 1/4" x 5 1/2")
Crayons

Additional Resources

Books

- *3rd Grade CORE Academy Resource Book*
  , 2003
- *Push and Pull*
  , by Patricia J. Murphy; ISBN 0516268643
- *Pushing and Pulling (Science For Fun)*
  , by Gary Gibson; ISBN 0761304614
- *How Do You Lift A Lion?*
  , by Robert E. Wells; ISBN 0807534218
- *The New Way Things Work*
  , by David Macauley (1998); ISBN 0395938473
- *Simple Machines*
  , by Deborah Hodge; ISBN 1550743996
- *Machines--Spectacular Science Projects*
  , by Janice Van Cleave; ISBN 0471571083
- *Physics Lab in the Hardware Store*
  , by Bob Friedhoffer; ISBN 0531158233
- *Playground Physics--Simple Machines*
  , by Bob DeWeese; ISBN 1557993017
- *Science Experiments With Simple Machines*
  , by Sally Nanivell-Aston; ISBN 0531154459

Laser discs

- *Windows on Science, Primary Vol. 3*
  , Force and Motion, Lessons 1-3, 5
- *Windows on Science, Primary Vol. 3*
  , Work and Machines, Lesson 1
- *Science Alliance # 3*
  , Machines

Background for Teachers

Objects at rest will remain at rest unless acted upon by an unbalanced force. Objects in motion will remain in motion at the same speed and direction unless acted upon by an unbalanced force. A force is a push or a pull.

A simple machine is a device that makes work easier. The six simple machines are: *inclined plane, wedge, screw, lever, wheel and axle,* and *pulley*. All simple machines transfer force. Some *change the direction of force*, while others *change the strength of the force*. Still others change *both* the direction and the strength. Most simple machines make work easier by allowing you to use less force over a greater distance to move an object. Some machines make work easier by allowing you to

move things farther and/or faster. In these machines, a larger force is required, but over a shorter distance.

Intended Learning Outcomes

1. Use Science Process and Thinking Skills
2. Manifest Scientific Attitudes and Interests
3. Understand Science Concepts and Principles
4. Communicate Effectively Using Science Language and Reasoning

Instructional Procedures

Invitation to Learn

Peaceful Penny

Set an index card over the mouth of a glass/cup. Set a penny on the card directly over the mouth. Have the students predict the movement/action of the penny if the paper is flicked off the glass/cup. Flick the card with your finger. Where does the penny go? Why? (The penny is at rest and wants to remain at rest. The flicking force is applied to the card, so the card moves and the penny drops into the glass/cup.)

Sudden Stop!

- Place one end of the ruler ramp onto one book.
- Place the *Paper Grid* about two car lengths away from the bottom end of the ramp.
- Tape a pencil along the edge of the *Paper Grid* closest to the ramp/book.
- Position the car, with the clay marble sitting on top, at the top of the raised ramp.
- Have the students predict what will happen to the car and the clay marble when the car hits the pencil.
- Let go of the car and allow it to roll down the ramp and collide into the pencil.
- Measure how far the clay marble falls from the car.
- Repeat the procedure using two books, then three books.
- Discuss what happened and why. (The car stops when it hits the pencil, but the clay marble continues to move forward until the force of gravity and air molecules brings it to a stop. Raising the height of the ramp causes the car to reach a higher speed before it hits the pencil. Therefore, the clay marble moves at a higher speed and will move farther before the force of gravity and air molecules brings it to a stop.)

Moving Possibilities

- Remind the students that objects will only move when a force is applied. A force is either a *push* or a *pull*.
- The students will write down many, varied, and unusual ways to move a penny (or a paper clip, etc.) one foot (12 inches).
- The students will categorize their ideas into pushing forces, pulling forces, or both.

Uphill--Inclin ed Plane

- Pour the rice into the sock. Close the end with a rubber band or string.
- Attach the spring scale to the rubber band or string and lift the rice-filled sock straight up to the height of *three* books.
- Observe how much force is needed and record on the *Uphill-Inclined Plane* worksheet.
- Place one end of the plank of wood on top of *five* books and the other end on the table to form a ramp.
- Place the sock (with the spring scale attached) on the bottom part of the ramp. Pull the sock to the top of the ramp.
- Observe and record how much force is needed.
- Repeat steps 4 -- 6 using *three* books

Repeat steps 4 -- 6 using *one* book.

Analyze the results and discuss how they relate to F = W x D. (The ramp is an inclined plane. It is used to move an object to a higher level with less force than lifting straight up. When using an inclined plane, you must move the object a greater distance than if you lifted it straight up, but it takes less force.)

Twirling Helicopter Toy--Screw

Print the *Toy Helicopter Pattern* on both regular weight paper and cardstock.

Give each student one pattern printed on regular weight paper, one pattern printed on cardstock, one large paper clip, and one small paper clip.

Tell the students that they are going to be making helicopters that require one pattern and one paper clip each. Ask the students to come up with all the different possible combinations and write them on the board.

Have the students predict which combination will produce the gentlest decent. (*Option*: Record the number of predictions for each combination by using tally marks.)

Instruct the students to cut out the patterns on solid lines A, B and F and to fold on dotted lines C and D. Then, fold along dotted line E.

Have each student test each of the possible combinations by lifting his/her toy helicopter up high and letting go.

Review student predictions. Were they correct?

Analyze how the helicopter is acting as a simple machine. (The toy helicopter twirls in a spiral as it drops. The twirling blades act as a screw that helps you lower (or lift) things with less force. Turning in a spiral allows the helicopter to drop with less force. It lands softly instead of crashing down.)

Soap Carving--Wedge

Unwrap the bar of soap.

Trace around the bar of soap onto the paper.

Draw a simple design onto the paper (no larger than the bar of soap).

Cut out the design.

Lay the cut-out design onto the bar of soap and trace around the design.

Turn the bar of soap over and lay the design onto the side of the bar of soap (being careful of the placement) and trace around the design again.

Place the bar of soap onto a paper towel.

Carefully carve the design out of the soap by first cutting the soap into a "block," followed by rounding the edges, and finally carving the details (encouraging the students to try to keep the shavings on the paper towel).

The soap can be smoothed by rubbing the surface with a small amount of water.

Analyze how the knife was being used as a simple machine to make work easier. (The knife is a wedge shaped like two inclined planes back-to-back. The narrow edge of the knife blade enters and makes a path for the larger part of the knife that follows. Once an opening is made, the soap is easily pried apart by the gradually widening body of the knife blade.)

All Geared Up--Wheels and Axles (Gears)

Glue the strip of cardboard around the edge of each lid.

Trim the cardboard to the correct length.

Interlock the two milk cap lid gears and gently rotate each.

Analyze the direction that each gear turns.

Interlock two different sizes of lids. Mark each gear where they originally touch. Gently rotate each. Count how many times the small gear rotates for each single rotation of the large gear.

Analyze how the gears are working like a simple machine. (Gears are wheels with teeth that turn and work together. Different sizes and arrangements of gears do different jobs. A large gear

turning a smaller one will give you more speed. A small gear turning a large one will give you more power.)

Flag Raiser--Fixed Pulley

Decorate/color a flag created using the 4 1/4" x 5 1/2" paper.
Place the pencil/wooden dowel through the hole in the thread spool, making sure that the spool can turn easily.
Tie the ends of the string together.
Tape one side of the flag to the string.
Place the loop of the string over the spool, with the flag hanging near the bottom of the loop.
Have one student hold the ends of the pencil/wooden dowel high over his/her head.
Have the other student pull down on the string opposite the flag.
Observe the distance the string is pulled and the distance and direction the flag moves up.
Relate this to simple machines. (The spool is a fixed pulley that allows you to pull down on the string and raise the flag upward. Placing a fixed pulley at the top of a tall flagpole makes the job of raising a flag easier than if you had to carry the flag up the pole. A fixed pulley makes work easier by changing the direction of the force. Pulling down is easier because you can use the weight of your body and the force of gravity to help you.)

Weighty Mistakes--Levers

See 3rd Grade CORE Academy Resource Book, 2003.

Rolling Along--Wheels and Axles

See 3rd Grade CORE Academy Resource Book, 2003.

Extensions

Physical Education

Tool Box--To be played similar to "Fruit Bowl"

Writing

Research a simple or compound machine. Write a report detailing when, where, why, how, and by whom the machine was invented. The student may also include technological advances in the machine since its original invention.
Make a classroom book entitled *The ABC's of Simple Machines.*

Creative Dance

Divide the students into groups of four. Instruct the students to explore movements representative of simple machines. Each group will become a compound machine. When the machine is "turned on," one part (one student) of the machine begins operating. In a sequential order, each part (student) is activated by the part (student) next to them by pushing or pulling on him/her.

Theatre

Pantomime activities that involve a push, a pull, or push. The rest of the class has to guess the activity and the force involved.

Family Connections

Simple Machine Hunt

Have the students, with the help of their family, identify and classify simple machines found in and around their homes. Students record their findings on the Simple Machine Hunt worksheet (pdf).

Peaceful Penny

Have the students share this activity with their family and the scientific principle involved.

Simple Machines Bingo

Family members take turns spinning the Simple Machine Bingo Spinner (pdf) and marking a corresponding spot on his/her Simple Machine Bingo Card (pdf) .

Mouse Trap Game

Purchase a *Mouse Trap* game for the class. Have the students take turns taking it home to play with

their family. Have the family work together to write down the different pushes and pulls *or* simple machines incorporated in the game.

Assessment Plan

Push/Pull Spoons

Give each student a spoon labeled “Push,” a spoon labeled “Pull,” and a spoon labeled “Push and Pull.” Instruct the student to hold up the correct spoon(s) that identifies the force(s) being used in various situations (e.g., hitting a baseball, sharpening a pencil in a manual crank machine, opening the drapes, etc.).

Science Journal Writing

Have the students write in their science journals about each of the simple machines and explain how each simple machine makes work easier.

Authors

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