- **www.fi.edu/time/Journey/Time/Escapements/escapemLG.html**
  The Science of Gears pages from the Franklin Institute provide information on clock 'escapements,' also known as gears.
- **www.mos.org/sln/Leonardo/InventorsToolbox.html**
  Featuring photographs and brief text explanations, this page provides an overview of the most common simple machines as well as machines that build upon the elements of simple machines, such as gears, cams, chains and belts.
- **www.ceeo.tufts.edu/curriculum/classroom/gears.html**
  Physics Concepts in the Classroom provides information and activities on gears and other machines used to transfer motion in order to do work.

Suggested Print Resources

- Glover, David. *Pulleys and Gears.* Heinemann Library, Crystal Lake, IL; 2002.
- Macaulay, David. *The New Way Things Work.* Houghton Mifflin Company, New York, NY; 1998.
- Oxlade, Chris. *Machines: Amazing Inventions That Made Life Easier (All About).* Southwater Publishing, London, UK; 2003.
- Sylvester, Doug. *Magnificent Machines: Levers, Pulleys, Wheels And Other Stuff.* Rainbow Horizons Publishing, San Diego, CA; 1999.

TEACHER'S GUIDE

Paula J. Bense, M.Ed.

Curriculum Specialist, Schlessinger Media

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TEACHER'S GUIDE

BASED ON THE BOOK BY
DAVID MACAULAY

Belts & Gears

Grades 3–6

Journey to Mammoth Island, a whimsical place where investigating scientific principles is always an adventure. Olive, a young girl, assisted by the Island's mammoth population and a visiting inventor helps the locals discover why and how machines work. Science facts are clearly demonstrated, giving kids an opportunity to see how important everyday machines are linked together by the science that drives them. Students come to see that science is a way of organizing information about the world, explaining why things work the way they do and allowing us to predict what might happen in new situations.

This guide provides a brief synopsis of the program, background on the science concepts presented, discussion topics, additional activities, vocabulary and suggested print and Internet resources.

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Program Summary

In *Belts & Gears*, inhabitants of Mammoth Island are getting ready for their annual fair. A young Islander, Olive, is determined to make this year's event better than ever, and she enlists the help of a visiting inventor in designing exciting new rides. Together they decide that belts and gears will be useful in making the fair a success. While belts and gears do not increase the amount of force applied, they can transfer the force to change direction or speed.

Gears are one way to transfer motion from one place to another. They work together in groups of two or more. One gear turns another, which may turn another, and so on. A gear is essentially a toothed wheel that when connected to another wheel, pushes the other wheel around. If the gears are different sizes, there will be a difference in their speed as they spin. Olive notices that when the smaller gear of her merry-go-round is turned first, it makes the larger gear spin slower. That's because the smaller gear has to turn many times to get the larger gear to spin once. On the other hand, spinning the large wheel first makes the small wheel spin much faster, giving the kids at the fair quite a ride!

Gears are used in all kinds of ways — on bicycles, to wind car windows up and down, even to work a lawn sprinkler! One reason that gears are used is to spin something slower or faster. For example, a hand mixer has a large 'crown' gear connected to two smaller 'bevel' gears to make the beaters spin quickly. Every time you spin the handle around once, the beaters spin around many times. The mixture is quickly forced through the rotating blades of the beaters in two directions at the same time!

There are several different kinds of gears that mesh together in different ways in order to get work done. Belts are flexible bands that are also used to transfer motion from one gear to another.

Glossary

The following words are included for teacher reference and for use with students to extend the subject matter in the show.

belts — Flexible bands that connect two separated wheels so that when one turns, the other will turn in the same direction.

bevel gears — Gears that mesh at an angle, changing the direction of rotation.

effort — The force applied to get work done.

energy — The ability to do work.

force — A push or a pull on an object that causes a change in motion.

gears — Toothed or pegged wheels meshed together to transmit motion and force. In any pair of gears the larger one will rotate more slowly than the smaller one, but will rotate with greater force.

machine — Any device that helps you do work.

mechanical advantage — The number of times a simple machine multiplies the effort force.

power — A measure of how quickly work is done.

rack and pinion gears — A gear system where one wheel, the pinion, meshes with a flat gear called the rack. This combination converts circular (spinning) motion to back and forth motion. Windshield wipers in cars are powered by a rack and pinion mechanism.

simple machines — Devices with few moving parts that can be used to reduce the amount of effort needed to do work. The six basic simple machines are the lever, the wheel and axle, the pulley, the inclined plane, the wedge and the screw.

(Continued)

spur gears — Gears that connect on the same plane, transferring motion in a straight line.

work — To move or change something. Doing work takes energy. When you use force to make something move, you are doing work.

worm gears — A combination of a gear meshed with the threads of a screw. This combination changes the direction of turning motion by ninety degrees.

Pre-viewing Discussion

- Ask students to define "work" and explain how work gets done.
- Explain that force is a push or a pull on an object. Use a small force to push open the classroom door, then illustrate that a larger force would push the door open even more. Ask students to come up with other examples of forces (pushes or pulls) that will move objects in the classroom.
- What is a gear? Which simple machine is most like a gear?
- How do gears work together?

Follow-up Questions & Activities

- What kinds of work can you do with gears? Have the class make a list of machines that contain gears.
- Find an old wind-up alarm clock that is no longer working. Carefully disassemble the clock and display all of the gears that you are able to find inside. Other sources for gears include small motorized cars and wind-up toys.
- In small groups, have students investigate how the gears of a bicycle make pedaling more efficient. Direct a student to mark the top of the rear tire of a geared bicycle with a piece of tape, making sure the bike chain is on the smallest gear in the front and the largest on the back. Holding the rear wheel off the ground, have one student turn the pedals one full revolution while another student observes how many times the rear wheel revolves. Move the bike chain to other gear positions and repeat the process, directing them to record their observations. Make a chart of the number of rear wheel revolutions that each combination of gears produces for one pedal revolution. Ask students to predict which gear would be best for climbing steep hills.
- Using plastic gears from a hobby shop, allow students to build pairs of gears and deduce the relationship between the size of each gear and the number of turns each gear makes. Once they realize the concept of a gear ratio, challenge interested students to devise a gear system with a gear ratio of 25:1.

Suggested Internet Resources

Periodically, Internet Resources are updated on our Web site at www.LibraryVideo.com

- **www.howstuffworks.com/gear.htm**
  These pages from How Stuff Works are an excellent introduction to how gears work and are accompanied by helpful visuals.
- **osv.org/education/WaterPower/Gear.html**
  The Old Sturbridge Village Web site contains great information about different kinds of mills and the belts and gears used to make work happen!

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