

SIMPLE MACHINES I and II

A LEGOLAND® California Educational Resource Guide Grades 2-5



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Welcome to LEGOLAND California

Education Programs: "Simple Machines" was developed by the LEGOLAND Education Department, in cooperation with LEGO® Education. For information on LEGOLAND Education programs, visit www.LEGOLAND.com/education .

Arrival and Entry: Please arrive 30 minutes before your program. Teachers must be present during staff-facilitated 45-minute program.

Extended Learning in the Park: Lab Notes are provided to guide your experience on recommended rides and attractions, to enhance the Simple Machines-themed educational experience and provide applied learning.

Recommended Rides and Attractions enhance the educational experience and extend applied learning. Worksheets are provided to guide your experience.

Lunches: School groups may bring lunches in disposable containers and use self-storage bins. Lunches may be pre-ordered when you book your program, or purchased at LEGOLAND restaurants.

Safety: LEGOLAND Parks are built to the highest standards of quality and safety. Height restrictions apply on selected attractions throughout the park.

Background Information

Simple Machines make work easier.

Have you ever used a shovel in the sand? Have you ridden a bicycle? Have you seen a flag raised on a flagpole? If so, then you have seen three simple machines at work—levers, pulleys, and gears!

LEVERS

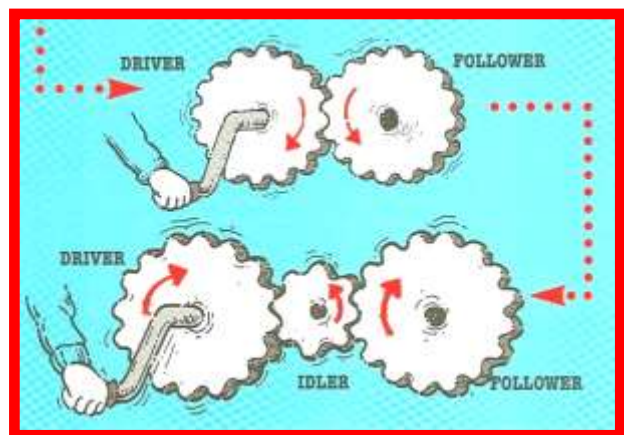
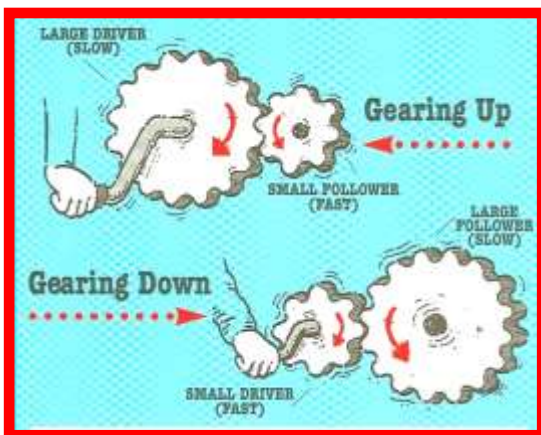
Levers move diagonally, and help us to lift heavy objects easily.

A shovel can be used as a lever to lift dirt, and a screwdriver can be used as a lever to open a paint can.

PULLEYS

Pulleys, like those on a flagpole, are smooth wheels with a groove around the wheel. A cable or belt fits into the groove of the pulley wheel. Two pulleys can be connected by the belt, so that one pulley turns the other. Window blinds and tow trucks use pulleys.

Like gears, pulleys cause faster or slower movement when the size of the pulley wheels are changed. Using a pulley helps lift or move things more easily, and reduces friction.



GEARS

Gears are wheels with teeth. Gears always work together. When the teeth of two gears **mesh**, the **driver** gear's teeth push the **follower** gear's teeth and make it move.

Gears can change the direction of movement.

When the teeth of two gears mesh, they turn in opposite directions. You can see this work on a hand-held can opener. An **idler** gear makes the neighboring gears turn in the same direction.

Gears can change the speed of a machine.

When two gears of the same size mesh, each gear turns at the same speed.

Gearing up is when a large gear turns a small gear. A machine goes faster with less power.

When you gear up on your bicycle, your pedal cranks a large gear that drives a small gear, and your pedals turn faster, easier.

Gearing down is when a small gear turns a large gear. A bicycle gearing down goes slower with more power.

Discovery and Learning at LEGOLAND

Which simple machine is at work?

Remember:

Gears are wheels with teeth. They mesh with other gears to cause movement in a circle.

Levers move diagonally to help lift heavy objects more easily.

Pulleys use a belt or cable to help move things more easily, with less friction.



Bionicle Blaster turns in a circle. Which simple machine causes this movement? _____
Hint: It is hidden inside the ride, but one is shown for decoration on top and underneath the ridecar!

Kid Power Tower Riders pull a cable to help them get to the top. Name the simple machine riders use.

The Big Test features a fire truck with a crane. The crane works at an angle to lift heavy objects easily. What simple machine is at work? _____

Kid Power Towers

The car weighs about 200 lbs. Estimate the weight of two riders. About how much total weight do riders lift when they pull on the motorized pulley cable?

Can riders lift this weight without the help of machines? _____

Kid Power Towers' motors and gears create a smooth, powered, free fall when riders let go of the cable. What is it called when gears are used to slow down? _____

Before and After the Visit

Gearing Up

Gearing up means a large gear drives a small gear. The machine moves fast. In this picture, the two gears don't mesh, but they are connected with a chain, so they work together.

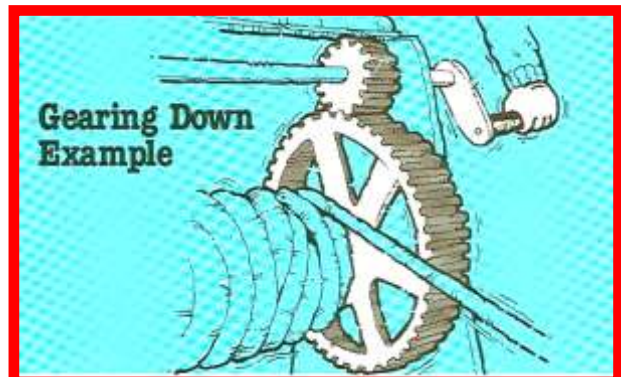
1. FIND the DRIVER gear in the picture. Color it RED. Hint: Driver gears have a crank.
2. FIND the FOLLOWER gear in the picture. Color it YELLOW.
3. DRAW a large gear (a circle with teeth). Draw a crank on it. It is the Driver. Color it RED.
4. DRAW a small gear touching the large gear. This is the Follower. Color it YELLOW.



Gearing Down

Gearing down means a small gear drives a large gear. A machine moves slowly with more power.

1. FIND the DRIVER gear in the picture. Color it RED. Hint: Driver gears have a crank.
2. FIND the FOLLOWER gear in the picture. Color it YELLOW.
3. DRAW a small gear with a crank. This is the Driver. Color it RED.
4. DRAW a large gear meshing with the small gear. This is the Follower. Color it YELLOW.



Hands-On Activities

Build a simple machine that works!

Enter the Imagination Zone! LEGOLAND staff facilitates this program as students learn to build amazing simple machines!

Discover levers, gears, and pulleys and how they work, and then use the simple machines to build a mini-theme park ride!



Simple Machines I: Funtastic Gears

Students learn how gears can make machines change speed and direction.

They work in pairs to build a theme park ride.

Challenge: How do you make your ride go faster? Slower?

Change the gears to make the ride spin in a different direction.

Students show their models to the class.

Students tell how their ride is designed. Does it go fast or slow? Does it gear up or gear down?

Simple Machines II: Motorized Machine

Students work in pairs to build a motorized model that uses gears and pulleys.

Make sure that gears mesh and pulley belts are in the groove of the pulley wheels.

If the model has been built well, with gears and pulleys in position, the machine will run!

About Simple Machines

Learning Outcomes

- Learn about gears, levers, and pulleys.
- Design and build a model that uses gears to change speed and direction, and run with a motor.
- Experience simple machines at work on LEGOLAND rides.

California Next Generation Science Standards

K-2 Engineering Design

K-2-ETS1-1. ...Define a simple problem that can be solved through development of a new or improved object or tool.

K-2-ETS1-2. Develop a simple...physical model to illustrate how the shape ...helps it function to solve a given problem.

K-2-ETS1-3. (T)est two objects designed to solve the same problem to compare strengths and weaknesses of each....

K-2 Matter and Its Interactions

2-PS1-3. Make observations to construct an evidence-based account of how an object made of a small set of pieces can be disassembled and made into a new object. [Clarification Statement: Examples of pieces could include...building bricks...]

GRADE 3-5 Engineering Design

3-5-ETS1-1. Define a simple design problem...that includes criteria for success and constraints on materials, time, or cost.

3-5-ETS1-2. Generate and compare multiple possible solutions...based on how well each is likely to meet the criteria....

3-5-ETS1-3. Plan and carry out fair tests...to identify aspects of a model or prototype that can be improved.

The performance expectations above were developed using NRC Framework for K-12 Science Education:

Science and Engineering Practices

Asking Questions and Defining Problems

Ask Q's based on observations to find...info about the designed world. (K-2-ETS1-1) & based on patterns such as cause and effect (3-PS2-3)

Define a simple problem that can be solved thru development of a new/improved object...(K-2-ETS1-1) & includes...criteria for success....(3-5-ETS1-1)

Define a simple problem that can be solved through the development of a new or improved object or tool. (3-PS2-4)

Developing and Using Models... based on evidence to represent a proposed object or tool. (K-2-ETS1-2)

Analyzing and Interpret Data from tests of an object...to determine if it works as intended. (K-2-ETS1-3)

Planning and Carrying Out Investigations ...to...test a design solution. (3-PS2-2)

Construct Explanations and Design Solutions Generate & compare solutions...based on how well they meet criteria....(3-5-ETS1-2)

Disciplinary Core Ideas

ETS1.A: Defining and Delimiting Engineering Problems

- A situation people want to change or create can be approached as a problem to be solved through engineering.(K-2-ETS1-1)
- Asking questions, making observations, and gathering information are helpful in thinking about problems. (K-2-ETS1-1)
- Before beginning to design a solution, it is important to clearly understand the problem. (K-2-ETS1-1)
- ...Different...solutions can be compared on the basis of how well each one meets the criteria for success.... (3-5-ETS1-1)

ETS1.B: Develop Possible Solutions

- Designs can be conveyed through...models (and) are useful in communicating...solutions. (K-2-ETS1-2)
- ...Testing a solution involves investigating how well it performs under a range of likely conditions. (3-5-ETS1-2)
- Communicating with peers about proposed solutions...can lead to improved designs. (3-5-ETS1-2)
- Tests are often designed to identify...difficulties, which suggest elements...that need to be improved. (3-5-ETS1-3)

ETS1.C: Optimizing the Design Solution

- Because there is always more than one possible solution to a problem, it is useful to compare and test designs. (K-2-ETS1-3)
- A great variety of objects can be built up from a small set of pieces. (2-PS1-3)
- (Test) different solutions to determine which best solves the problem, given the criteria and constraints. (3-5-ETS1-3)

Crosscutting Concepts

Structure and Function Shape and stability of structures of ...designed objects are related to their function(s). (K-2-ETS1-2)

Cause and Effect Events have causes that generate observable patterns. (2-PS1-4).

Simple tests can be designed to gather evidence to support or refute student ideas about causes. (2-PS1-2)

Energy and Matter Objects may break into smaller pieces and be put together into larger pieces, or change shapes. (2-PS1-)

Cause and Effect relationships are routinely identified (3-PS2-1), tested, and used to explain change. (3-PS2-3)

Common Core State Standards Connections K-2 and Grades 3-5

ELA/Literacy –

W.2.8 Recall information from experiences...to answer a question. (K-2-ETS1-1),(K-2-ETS1-3)

SL.2.5 Create...visual displays to...recount experiences...to clarify ideas.... (K-2-ETS1-2)

SL.3.3 Ask and answer questions about information from a speaker, offering appropriate elaboration and detail. (3-PS2-3)

Mathematics –MP.2 Reason abstractly and quantitatively. (K-2-ETS1-1),(K-2-ETS1-3) (3-PS2-1)

MP.5 Use appropriate tools strategically. (K-2-ETS1-1),(K-2-ETS1-3) (3-PS2-1)