

SECTION 4.2 INTRODUCTION

1 class period ►

4.2 Read

How Do Simple Machines Work Together?

Overview

Students read about complex machines and are provided with the explicit example of a wedge and a lever combined to form a shovel. Students then apply what they have learned by identifying and drawing a complex machine from their experiences. They describe the simple machines that the complex machine is composed of, the mechanical advantage of each simple machine and the complex machine, and how these simple machines work together. This prepares students for exploring more complex machines in the next section and constructing a solution for the challenge.

*A class period is considered to be one 40 to 50 minute class.

Targeted Concepts, Skills, and Nature of Science	Performance Expectations
There are six different simple machines all of which provide mechanical advantage: Inclined plane, wedge, screw, wheel and axle, lever, and pulley.	Students should be able to apply what they have learned to identify and describe complex machines in terms of simple machines.

Homework Options

Reflection and Preparation for 4.3

- **Science Content:** Have students complete the first three *Stop and Think* questions for a different machine than they did or heard about in class. (This is intended to provide students with more practice, which will help them in the next section.)

SECTION 4.2 IMPLEMENTATION

◀ 1 class period

4.2 Read**How Do Simple Machines Work Together?**

Think about some of the machines you have seen. You have looked at big machines such as cranes and backhoes. You have also examined pictures of handheld machines such as drills and screwdrivers. You have learned that some of the things you use everyday, such as scissors and pencil sharpeners are also machines. Sometimes it is easy to see that a machine is made up of different simple machines. At other times, it is not so easy. The photographs show complex machines. Each one is made up of two or more simple machines.

As you can see in these examples, in a complex machine two or more simple machines work together. The arm of a backhoe is actually a lever and a wedge that work together to get the job done. A wheel and axle and a wedge, working together, make up a screwdriver.



Crane



Backhoe



Screwdriver



Drill



Pencil sharpener

MBT 101

MOVING BIG THINGS

4.2 Read**How Do Simple Machines Work Together?**

20 min.

Have a discussion about the simple machines that compose complex machines.

Engage

Briefly elicit students' ideas about which simple machines compose the machines shown on the first page of *Section 4.2* of the student text (crane, backhoe, screwdriver, drill, and pencil sharpener). Record students' ideas.

TEACHER TALK

“Look at the images on the first page of *Section 4.2*. There are five machines shown: A crane, a backhoe, a screwdriver, a drill, and a pencil sharpener. What simple machine or machines are these machines made of?”



Some machines, such as a pocketknife or multi-purpose tool, look like complex machines, but they are not. They are made of several different simple machines, but the simple machines are each used separately. For example, you would use the file on a pocketknife at a different time than you would use the knife blade. These two simple machines do not work together so the pocketknife is not a complex machine.

A shovel is an easy machine to use. It does not have any wheels, knobs, or other moving parts. It seems pretty simple. However, a shovel is a complex machine. It is made of two simple machines working together.

One simple machine that makes up a shovel is a lever. When lifting dirt out of the ground, the handle of a shovel acts as a lever. As you push down on the handle, the bottom of the lever lifts the dirt up. The fulcrum is located at the point where the shovel pivots in the dirt. In this way, the handle changes the direction of the applied force.

You apply less force to the shovel than you would to pull the dirt it is lifting out of the ground. However, your hands move down a larger distance than the dirt moves up. You are applying the force through a greater distance. The mechanical advantage of using the handle of a shovel is that you need to apply less force. Also, the handle changes the direction of the force. The tradeoff is that you need to apply the force through a greater distance.



A shovel would not be a good machine for digging if it only had a handle. In order for a shovel to help you dig up dirt, it also needs a second simple machine. The second simple machine on a shovel is a wedge. The bottom of the shovel scoop is shaped like a wedge. The wedge helps to push the scoop into the ground, so it can go under the dirt that you want to lift up. When you apply a downward force to the scoop, it pushes down on the top of the wedge. The wedge then changes the direction of the force from a downward direction to a sideways direction. The force pushing sideways pushes the dirt out of the way so the scoop can move through the dirt. The mechanical advantage of using the wedge on the bottom of the scoop is that it changes the direction of the force you apply.

MBT 102

Project-Based Inquiry Science

△ Guide

Discuss how a crane is composed of pulleys and levers. A backhoe is composed of levers and wedges, a screwdriver is a wheel and axle but can also be used as a wedge or lever (like when opening a can of paint), the drill shown on page 101 is composed of a wheel and axle and a wedge, and the pencil sharpener is composed of a wheel and axle and a wedge. Also, note that a wheel and axle is basically a lever that rotates around its fulcrum or pivot point.

Describe how combining simple machines together such as in the case of the screwdriver or a pocket knife does not mean that it is a complex machine. To be a complex machine the simple machines need to work together to move an object.

TEACHER TALK

“The screwdriver acts as a wheel and axle when it is being used to move a screw. It acts as a lever when it is being used to remove the lid from a can of paint. It acts as a wedge if it is being used to separate two items. In each case it is used as a single simple machine, not a combination of machines.”

Then ask students what they think a shovel is composed of and how it works. After eliciting students ideas describe the shovel using the student text. Consider having students read the text, which has a detailed explanation.

TEACHER TALK

“The shovel is a complex machine composed of a lever (the handle) and a wedge (the blade). The lever and wedge work together as you are trying to move the dirt. The wedge helps you to push the shovel into the ground so it can go under the dirt you want to lift up. And the lever helps you to lift it.”

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Stop and Think

20 min.

Discuss groups' answers to the questions.

4.2 Read

A shovel shows how two simple machines, the lever and the wedge, work together to make it easier to lift and move dirt. You gain the mechanical advantage of both simple machines. The lever and the wedge work together in a shovel to both reduce the amount of applied force needed and change the direction of the applied force. Together, this makes it easier to dig dirt than if you were just using your hands. Other complex machines work in the same way. Every complex machine has two or more simple machines working together to make getting the job they were designed for easier. By looking at what each simple machine does, you can figure out how they work together to make the complex machine work.



Stop and Think

1. Draw one complex machine you use everyday. Show the simple machines that make it up.
2. What is the mechanical advantage of each simple machine that makes up the complex machine in your drawing?
3. What is the mechanical advantage of the complex machine in your drawing? How do the simple machines that make it up work together?
4. How can you tell if a machine is a complex machine or not?



What's the Point?

Machines with few, if any, moving parts are called simple machines. These machines can be combined to create a complex machine. A complex machine can be a heavy-duty backhoe or hand shovel. Both of these are at least two simple machines combined into one machine. Simple machines and complex machines all have mechanical advantage. For example, when you use a shovel, you trade force for distance. Mechanical advantage makes the moving or lifting of heavy things easier.



MBT 103

MOVING BIG THINGS

△ Guide and Assess

Monitor students' progress. Refer students as needed back to the example of the shovel in the student text, and to their previous investigations of simple machines.

After groups have answered the questions, hold a discussion on their responses. Ask groups to label their drawings and be prepared to describe them in detail. Consider projecting student drawings as the class discusses the groups' responses.

1. Responses should describe and label a common item composed of at least two simple machines that combined help to move an object.
2. Responses should describe the mechanical advantage of each simple machine. The mechanical advantage should at least be described as increasing or decreasing the force needed to move an object, and if the direction of the force is changed. Consider including in the discussion how the distance the force needs to be applied is affected. If students have difficulty with this, refer them to the example of the shovel in the student text.
3. Students should describe the overall mechanical advantage of the complex machine in terms of an increase or decrease in force and a change in direction of force. They should also describe how the simple machines work together. If students have difficulty with this, refer them to the example of the shovel in the student text.
4. Students should describe that a complex machine is composed of at least two simple machines that work together.

After discussing the questions, ask students to summarize the idea of mechanical advantage and the tradeoff that occurs.

◆ Evaluate


Make sure students understand that all machines have a mechanical advantage and that there is a tradeoff that occurs between force and distance unless the mechanical advantage is one (as it is for the fixed pulley).

up the _____ machine in your drawing.

3. What is the mechanical advantage of the complex machine in your drawing? How do the simple machines that make it up work together?
4. How can you tell if a machine is a complex machine or not?

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MBT 103

MOVING BIG THINGS

What's the Point?

5 min.

If needed, summarize that complex machines are composed of at least two simple machines that work together.

