

Compound Machines

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Printed: October 22, 2016

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CHAPTER 1

Compound Machines

Lesson Objectives

- Give examples of compound machines.
- Describe the efficiency and mechanical advantage of compound machines.

Lesson Vocabulary

- compound machine

Introduction

Did you ever look closely at the moving parts of a bicycle, like the mountain bike gears in **Figure 1.1**? If you did, then you observed several simple machines, including wheels and axles, pulleys, and levers. A bicycle is an example of a compound machine.



FIGURE 1.1

What simple machines do you see in this photo of bicycle gears?

What Is a Compound Machine?

A **compound machine** is a machine that consists of more than one simple machine. Some compound machines consist of just two simple machines. For example, a wheelbarrow consists of a lever, as you read earlier in the lesson "Simple Machines," and also a wheel and axle. Other compound machines, such as cars, consist of hundreds or even thousands of simple machines. Two common examples of compound machines are scissors and fishing rods with reels. To view a young student's compound machine invention that includes several simple machines, watch the video at this link: http://www.youtube.com/watch?v=e4LUaAwuh_U . To see if you can identify the simple machines in a lawn mower, go to the URL below and click on "Find the Simple Machines."

<http://www.cosi.org/files/Flash/simpMach/sm2.html>

Scissors

Look at the scissors in **Figure 1.2**. As you can see from the figure, scissors consist of two levers and two wedges. You apply force to the handle ends of the levers, and the output force is exerted by the blade ends of the levers. The fulcrum of both levers is where they are joined together. Notice that the fulcrum lies between the input and output points, so the levers are first-class levers. They change the direction of force. They may or may not also increase force, depending on the relative lengths of the handles and blades. The blades themselves are wedges, with a sharp cutting edge and a thicker dull edge.

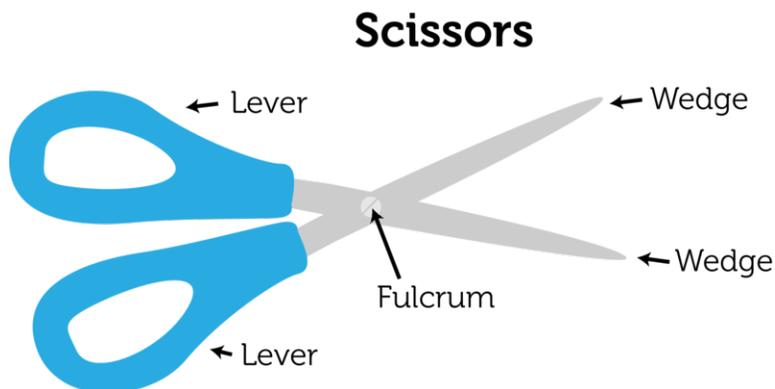


FIGURE 1.2

A pair of scissors is a compound machine consisting of levers and wedges.

Fishing Rod with Reel

The fishing rod with reel shown in **Figure 1.3** is another compound machine. The rod is a third-class lever, with the fulcrum on one end of the rod, the input force close to the fulcrum, and the output force at the other end of the rod. The output distance is greater than the input distance, so the angler can fling the fishing line far out into the water with just a flick of the wrist. The reel is a wheel and axle that works as a pulley. The fishing line is wrapped around the wheel. Using the handle to turn the axle of the wheel winds or unwinds the line.

Fishing Rod with Reel

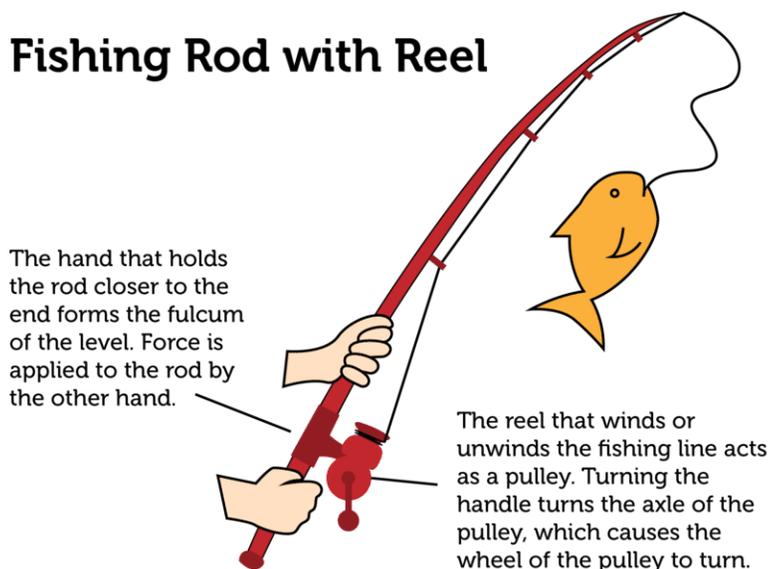


FIGURE 1.3

As a third-class lever, how does a fishing rod change the force applied to the rod? How does the reel help land the fish?

KQED: The Science of Riding a Bicycle

Riding a bicycle might be easy. But the forces that allow humans to balance atop a bicycle are complex. QUEST visits Davis – a city that loves its bicycles – to take a ride on a research bicycle and explore a collection of antique bicycles. Scientists say studying the complicated physics of bicycling can lead to the design of safer, and more efficient bikes. For more information on the science of riding a bicycle, see <http://www.kqed.org/quest/television/cool-critters-dwarf-cuttlefish> .



MEDIA

Click image to the left or use the URL below.

URL: <https://www.ck12.org/flx/render/embeddedobject/129628>

Efficiency and Mechanical Advantage of Compound Machines

Because compound machines have more moving parts than simple machines, they generally have more friction to overcome. As a result, compound machines tend to have lower efficiency than simple machines. When a compound machine consists of a large number of simple machines, friction may become a serious problem, and it may produce a lot of heat. Lubricants such as oil or grease may be used to coat the moving parts so they slide over each other more easily. This is how a car's friction is reduced.

Compound machines have a greater mechanical advantage than simple machines. That's because the mechanical advantage of a compound machine equals the product of the mechanical advantages of all its component simple machines. The greater the number of simple machines it contains, the greater is its mechanical advantage.

Lesson Summary

- A compound machine consists of two or more simple machines. Examples of compound machines include bicycles, cars, scissors, and fishing rods with reels.
- Compound machines generally have lower efficiency but greater mechanical advantage than simple machines.

Lesson Review Questions

Recall

1. What is a compound machine?
2. Give two examples of compound machines.
3. How is the mechanical advantage of a compound machine calculated?

Apply Concepts

4. The can opener in the picture below is a compound machine. Identify two simple machines it contains.



Think Critically

5. Explain why the efficiency of compound machines is generally less than the efficiency of simple machines.

Points to Consider

Some of the machines you read about in this chapter require electricity in order to work. Electricity is a form of energy.

- What is energy?
- Besides electricity, what might be other forms of energy?

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References

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