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Simple Machines

What are Simple Machines?

We use **machines** to make our work easier. Machines do this by maximizing **force**, or the push or pull on an object caused by another object. We exert force on things all the time. Movement requires force. Picking things up requires force. Writing and typing require force. Similarly, forces are applied to all the time, too. The force of gravity is the force Earth applies to everything on Earth and even things far away from Earth, like satellites, the International Space Station, and the moon.



Bicycles use simple machines

To do useful work, humans need to apply forces on objects to make them move. Machines help us move heavy objects and do other tasks by making the force that we exert larger. **Simple machines** are the most basic devices used for increasing force. They are simple so they do not usually have many (some have no) moving parts.

Simple machines help people do **work** and make up more complex machines, such as construction equipment. **Work** is the product (multiple) of force applied and distance moved.

$$W = F \times d$$

Ecobottle Sample



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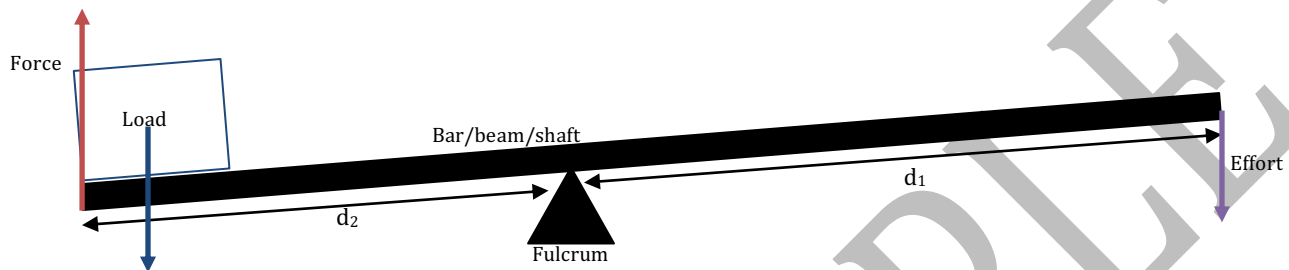
There are six types of simple machine: the **lever**, the **inclined plane**, the **wheel and axle**, the **pulley**, the **screw**, and the **wedge**.

Lever

A **lever** adds force by increasing distance. Levers are **bars**, **beams**, or **shafts** that sit on top a support known as a **fulcrum**. By applying a downward force on one end of the lever, a stronger upward force is felt on the other end. The farther the fulcrum is from the initial force (meaning the smaller the distance between the fulcrum and the object to be moved),

the greater the magnification of force. The initial force is called the **effort** and the object to be moved is called the **load**. The greater d_1 becomes (and smaller d_2), the lower the effort required to do the workload.

Examples of levers include seesaws (teeter-totters), crowbars, nutcrackers, bottle openers, and fishing poles.



Inclined Plane

An **inclined plane** is simply a ramp, or a flat surface placed at an angle. Inclined planes make it easier to lift heavy objects by increasing the distance the object is moved.



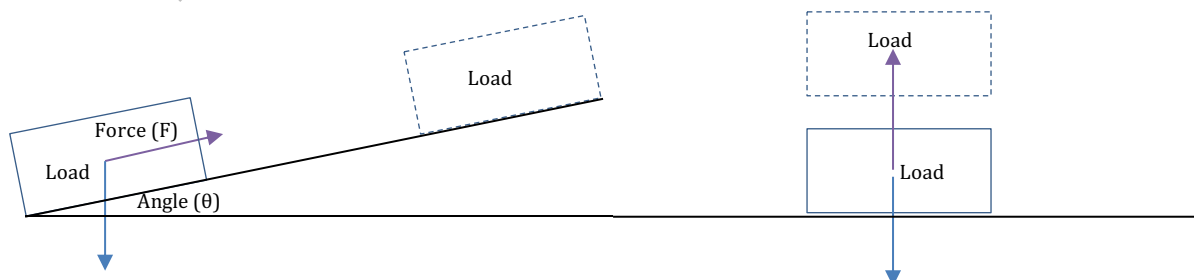
Inclined planes make lifting easier.

Ecobottle Sample



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Examples of inclined planes include switchback roads/trails, boat ramps, stairs, and wheelchair ramps.



Wheel and Axle

A **wheel** is a round frame and an **axle** is the shaft/rod that it turns around. It is considered one of the greatest inventions in human history. It minimizes the force required by reducing friction (the force that causes things to slow down). The part of the wheel touching the ground is small and instead of sliding along on the ground, the wheel rolls. A rolling wheel has less friction than a sliding object. Imagine pushing a heavy box along the ground. Friction between the box and the ground makes it difficult to move the box. Now imagine putting that box on a wheeled cart. Friction is greatly reduced making it much easier to move the box.



Examples of wheel and axle systems include automobiles, bicycles, shopping carts, strollers, wheelchairs, skateboards, and roller skates.

Pulley

Ecobottle Sample

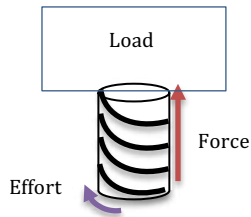


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Screw

A **screw** is a shaft with a small inclined plane wrapped in a continuous spiral around it from bottom to top. We are most familiar with the use of a screw for connecting things like wood and metal together. However, screws can also be used to magnify force or transform motion. A device called a **water screw** is thought to have been invented by Archimedes in the 200s BC. It was a large screw inside a pipe. When the screw was turned, the plane collected water and transported it up the screw until it poured out the top.

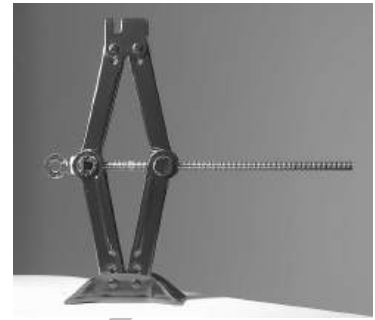
A screw works to hold things together because the plane is wound into the materials instead of being pushed in. The only way to get it out again is to wind it the opposite way. The inclined plane prevents it from being pulled straight out. This



property of screws also allows it to be used for lifting loads. A large screw with a platform at its top can be turned so that it rises. Such a system converts torque (twisting force) to pushing force. If a long shaft is used to turn the screw, only a small force is needed to

generate a large upward force.

Examples of screws include screws/bolts, spiral staircases, and jar lids.



Screws are used in car jacks.

Wedge

Ecobottle Sample



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Compound Machines

Some machines combine two or more simple machines. These machines are called **compound machines**. Examples include wheelbarrows (lever + wheel and axle), can openers (lever + wedge), shovels (lever + wedge), wood screws (wedge + screw), car jacks (lever + screw), cranes (lever + pulley), and bicycles (wheel and axle + pulley).



A wheelbarrow

Reading Comprehension Questions:

1. What
2. What are simple machines?
3. What is
4. If you
5. Regarding question #4, if you were to double the distance, how much force would be needed?
6. Regarding question #4, if you were to quadruple (4X) the distance, what force (as a fraction) would you need to apply?
7. What
8. How does a lever work? Give 3 examples.
9. Using what you've learned about levers, explain why the lighter mass is able to balance the heavier one is shown in the picture.
10. How
11. How
12. How do pulleys work? Give 3 examples.
13. How do
14. How do
15. What are compound machines? Give 3 examples.



Extension Questions:

16. What types of simple machines have you used?
17. Choose

Ecobottle Sample



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