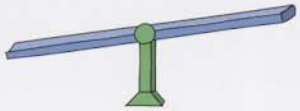
Getting Started with Levers



What is a lever?

- It's a stiff bar, often made of metal, plastic or wood.
- When you use a lever, you move the bar up and down or side to side.
- To use a lever, you provide the **effort.** The effort might be a push, pull, squeeze or lift.
- The lever might help you lift a weight, cut some paper or crack a nut. These objects provide **resistance.** The object resists, or works against, your effort. You push one way and the resistance pushes back against you.
- The **fulcrum** is the spot on the bar that is still as the rest of the bar rotates around it.
- Levers come in many shapes and sizes, but they all help do work.

How does a lever help you?

A lever is a simple machine that can make work easier. You still have to do the same *amount* of work, but with a lever, you need less force to do the job.

Here's an example of how levers can help.

Imagine trying to lift an elephant, and then hold it five centimeters off the floor. Five centimeters isn't much but an elephant is HEAVY! Sounds impossible, but not if you have a lever!

Picture this.

Place a lever under the elephant. When you push down on one end of the lever, up goes the elephant on the other side. You have to reach up high and push down a *long* way–much farther than the five centimeters the elephant is lifted. But the lever is pretty easy to push down. The lever makes work easier since you need to use *less force,* but you have to use that force over a *greater distance.* **Increasing the distance between the effort and the fulcrum reduces the effort needed.**

A Bright Idea!

Archimedes was a scientist and mathematician who lived in Greece more than 2,000 years ago. He was the first known person to describe how levers work using math. Learn more about Archimedes and his famous statement about levers. Would his idea work? Why or why not?

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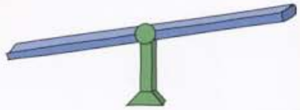
What's the Mechanical Advantage?



How much does a lever help you?

Find out by doing a little math.

1. Measure the distance from the **fulcrum** to the **effort.** This length is called the **effort arm (EA).**

2. Measure the distance from the **fulcrum** to the **resistance**. This distance is called the **resistance arm (RA).**

3. Divide the length of the effort arm by the length of the resistance arm to find the **Mechanical Advantage (MA).**

$$MA = EA \div RA$$

The Mechanical Advantage tells you how many times easier your job is when you use the lever.

Try It Out!

Imagine you are using a lever to lift a box.

The effort arm of your lever is six meters long (EA = 6). The resistance arm is two meters long (RA = 2).

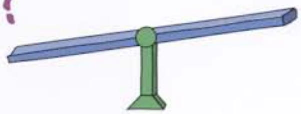
Divide to get the Mechanical Advantage.

$$MA = 6 \div 2$$
$$MA = 3$$

The Mechanical Advantage is 3, which means that this lever makes your job three times easier. Without the lever, you would need three times as much force to lift the box.

Remember:
When the effort arm is longer than the resistance arm, there will be a Mechanical Advantage. The longer the effort arm, the greater the Mechanical Advantage.

Which class is your lever?



To find out about your lever:

- Find the fulcrum, resistance and effort.
- Look for which one is in the middle.

1st-class

R F E

Fulcrum
in the middle

2nd-class

F R E

Resistance
in the middle

3rd-class

F E R

Effort
in the middle

What is a double lever?

A double lever is two levers attached to each other at the fulcrum. They might be a pair of 1st-class, 2nd-class or 3rd-class levers. The two levers work together to do one job.

1st-class: Pruning Shears

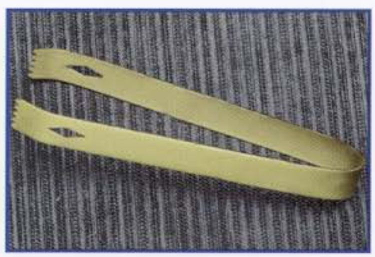
This double lever helps you trim your hedges.

2nd-class: Nutcracker

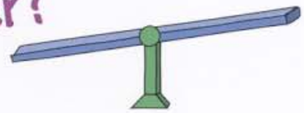
Put a walnut between these two levers and CRUNCH!

3rd-class: Ice tongs

Pinch the tongs and you can pick up a slippery ice cube.



What is a 1st-class lever?



A 1st-class lever has the FULCRUM in the middle. The **Resistance** and **Effort** are at opposite ends.

Here's an example.

Imagine you're a circus clown, ready to jump down on a springboard to launch an acrobat into the air. The effort is the force provided when you jump and push down on the end of the board. The acrobat is the resistance since she is the weight you are trying to lift. The fulcrum is in the middle.

Which way does a 1st-class lever move?

When you **push down** on the board, the acrobat will **go up.** All 1st-class levers are like that, with effort and resistance moving in *opposite directions*. That's great, because pushing down is easy. You have the weight of your body and gravity to help you.

How does a 1st-class lever help you?

Many 1st-class levers make work easier, but not all do. It depends on which is closer to the fulcrum, the resistance or the effort. When the resistance is closer to the fulcrum, work is easier. When the effort is closer to the fulcrum, work is harder. Just picture yourself on a see-saw. It's not so easy to lift an adult if you're sitting too close to the fulcrum. But if your sitting all the way at the end, the lever is helping you lift that weight.

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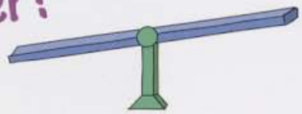
What is a 2nd-class lever?



A 2nd-class lever has the RESISTANCE in the middle. The **Fulcrum** and **Effort** are at opposite ends.

Here's an example.

Picture a wheelbarrow full of sand. Your hands on the handles provide the effort, the sand is the resistance (what you are trying to lift) and the wheel is the fulcrum.

Which way does a 2nd-class lever move?

When you **lift up** on the handles, your load of sand **goes up** too. A 2nd-class lever has its effort and resistance moving in the *same direction*.

How does a 2nd-class lever help you?

Like all 2nd-class levers, the wheelbarrow always makes work easier. Remember, increasing the distance reduces the effort needed. This lever reduces the force you need to do the job.
That's because the effort is always farther from the fulcrum than the resistance. With a 2nd-class lever, you can move a large load with a small effort.

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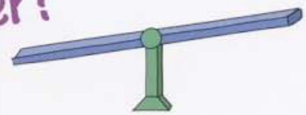
What is a 3rd-class lever?



A 3rd-class lever has the EFFORT in the middle.
The **Fulcrum** and **Resistance** are at opposite ends.

F   E ↑   R ↑
^

Here's an example

You're holding a baseball bat, ready to swing. Your hands provide the effort, the ball is the resistance (the thing you are trying to move) and the fulcrum is at the bat's knob, below your hands.

Which way does a 3rd-class lever move?

Swing the bat **forward** to hit the ball. Bam! The ball goes **forward** too. A 3rd class lever has its effort and resistance moving in the *same direction.*

How does a 3rd-class lever help you?

In a 3rd-class lever, the effort arm is always shorter than the resistance arm. That means that the lever actually makes work harder. You have to apply more effort to move less resistance.

But 3rd class levers can still be helpful. When you swing the bat, you only have to move your hands a short distance. In the same amount of time, the end of the bat moves a much farther distance. It also moves faster than your hands. The fast-moving bat hits the ball and makes it go fast too.

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