Inclined plane

An inclined plane is one of the six types of **simple machines**.

A machine is a device that does a physical task. **Simple machines** are the most basic devices that allow work to be done with less effort. A simple machine can change the direction or the magnitude of a force, or the point where the force is applied.

What is an inclined plane?

An inclined plane is a flat surface that is raised at one end. It is a simple machine that reduces the force required to move an object over a vertical distance.

Common examples of inclined planes include:

- ramps
- slides
- screws

A **screw** is an inclined plane where the inclined plane is wrapped around a central point. This is sometimes called a winding inclined plane.

Why use an inclined plane?

One of the most common reasons to use an inclined plane is to help raise an object vertically.

✑ Here's an example

Imagine you have a rock as a pet. Your pet rock is pretty big: it has a mass of 10 kilograms.

If you want to give your pet rock a bath, you will need to get the rock up and over the edge of the bathtub. This will take a certain amount of work to accomplish.
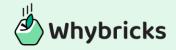
One way to do this is to pick the rock up and lift it over the edge. Another way is to use an inclined plane, pushing the rock along a ramp over a longer distance.

The two options require the same amount of work, but the inclined plane changes *how* you do the work. The inclined plane reduces the effort needed to raise the rock by increasing the distance that it moves.

Using the inclined plane takes less force, but needs that force for a greater distance.

You can understand the trade-off between effort and distance with another example: walking trails up a mountain. Imagine two paths: a shorter path with a steep incline and a longer path with a gentler incline. Both will get you to the top. The effort of each step you have to take on the short, steep path will be greater than on the long, gentler path. However, the longer path means more steps are needed to get to the top.

Mechanical advantage of an inclined plane

The ideal **mechanical advantage** (MA) for the inclined plane is equal to the length of the slope (L) divided by the height of the plane (H).

$$MA = \frac{L}{H}$$

🗨 Here's an example

Think back to your pet rock's bath time.

Let's say the bathtub is 45cm tall (H) and the board you are using as a ramp is 135cm long (L). That means the mechanical advantage of using the inclined plane is:

$$\frac{135cm}{45cm} = 3$$

What does that '3' mean? It means that the inclined plane multiplies your input force by 3 times.

You can think of it the opposite way too: however hard you work to push your pet rock up the ramp, you would have to work 3 times harder to lift it straight up!

Want to see the maths? Your pet rock has a mass of 10 kilograms and is being accelerated by gravity at a rate of $9.8\frac{m}{s^2}$. **Newton's second law** tells us that **F**=m**a** which means you will need to exert a force of ($10kg \times 9.8\frac{m}{s^2}$) = 98 newtons to lift up the rock.

But the inclined plane is giving you a mechanical advantage of 3, so that's (98÷3) = 32.7 newtons. A lot less!