Simple Machines

Inclined Plane, Wedge, and Screw
Inclined Plane

Have you ever had to lift something from a lower level to a higher level?

• The job is much easier if you have a ramp.
• For example, a ramp makes it much easier to push a motorcycle onto a pickup truck.
• A ramp is an example of a simple machine called an inclined plane.

• An inclined plane is a flat, sloped surface.
How It Works

• An inclined plane allows you to **exert your input force** over a longer distance.

• As a result, the input force needed is less than the output force.

• The input force that you use on an inclined plane is the force with which you push or pull an object.

• The **output force** is the force that you would need to lift the object without the inclined plane.

• Recall that this force **is equal to the weight of the object**.
Mechanical Advantage

- You can determine the ideal mechanical advantage of an inclined plane by dividing the length of the incline by its height.

Length of Incline ÷ Height of Incline

THE INCLINED PLANE

Length or effort distance

IMA = length ÷ height

Height or resistance distance
• For example, if you are loading a truck that is 1 meter high using a ramp that is 3 meters long, the ideal mechanical advantage of the ramp is 3 meters ÷ 1 meter, or 3.

• The inclined plane increases the force you exerted three times.

• If the height of the incline does not change, increasing the length of the incline will increase the mechanical advantage.

• The longer the incline, the less input force you need to push or pull an object.
Mental Quiz

• Although the amount of work is the same whether you lift the boxes or push them up the ramp to the truck, you need less force when you use an inclined plane.

• When you use a ramp, what happens to the distance over which you exert your force?
If you’ve ever sliced an apple with a knife, pulled up a zipper, or seen someone chop wood with an ax, you are familiar with another simple machine known as a wedge.

A **wedge** is a device that is thick at one end and tapers to a thin edge at the other end.

It might be helpful to think of a **wedge**, like the one shown below, as an inclined plane (or sometimes two inclined planes back to back) that can move.
How It Works

• When you use a wedge, instead of moving an object along the inclined plane, you move the inclined plane itself.

• For example, when an axe is used to split wood, the axe handle exerts a force on the blade of the axe, which is the wedge.

• That force pushes the wedge down into the wood.

• The wedge in turn exerts an output force at a 90° angle to its slope, splitting the wood in two.
• Wedges are a part of your everyday life. For example, a zipper depends on wedges to push the two sides apart.
• A pencil sharpener, a cheese grater, and a shovel all make use of wedges.
Mechanical Advantage

• The mechanical advantage of the wedge and the inclined plane are similar.
• The ideal mechanical advantage of a wedge is determined by dividing the length of the wedge by its width.
• The longer and thinner a wedge is, the greater its mechanical advantage.
• For example, the cutting edge of a steel carving knife is a wedge.
• When you sharpen a knife, you make the wedge thinner and increase its mechanical advantage.
• That is why sharp knives cut better than dull knives.
Screws

- Like a wedge, a screw is a simple machine that is related to the inclined plane.
- A screw can be thought of as an inclined plane wrapped around a cylinder.
- This spiral inclined plane forms the threads of the screw.
How It Works

• When you **twist a screw** into a piece of wood, you **exert an input force** on the screw.

• The **threads** of a screw act like an **inclined plane** to increase the distance over which you exert the input force.

• As the **threads** of the screw turn, they **exert an output force** on the wood, pulling the screw into the wood.

• **Friction** between the screw and the wood holds the screw in place.
Many devices act like screws. Examples include bolts, light bulbs, and jar lids.

Look at the jar lid.

When you turn the lid, your small input force is greatly increased because of the screw threads on the lid.

The threads on the lid are pulled against the matching threads on the jar with a strong enough force to make a tight seal.
Mechanical Advantage

• The closer together the threads of a screw are, the greater the mechanical advantage.
• This is because the closer the threads are, the more times you must turn the screw to fasten it into a piece of wood.
• Your input force is applied over a longer distance.
• The longer input distance results in an increased output force.

• The ideal mechanical advantage of a screw is the length around the threads divided by the length of the screw.

• Think of the length around the threads as the length of the inclined plane, and the length of the screw as the height of the inclined plane.
Mental Quiz

• The length around the threads of a screw is the same as the
  - height of an incline plane.
  - width of an incline plane.
  - length of an incline plane.
  - output distance of an incline plane
### Organizing Information: Comparing and Contrasting

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