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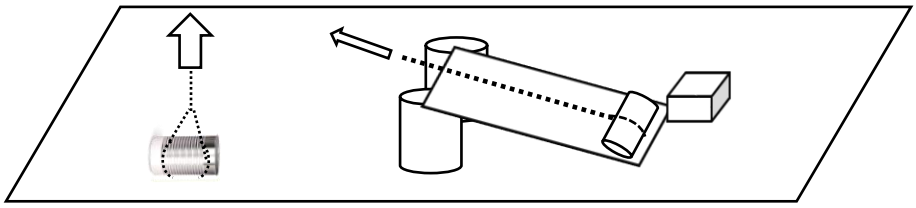
RESOURCE AREA FOR TEACHING

STEAM
SCIENCE TECHNOLOGY ENGINEERING ARTS MATHEMATICS

LEARNING ACTIVITY

The Inclined Plane

The Simplest Simple Machine!



The word "machine" usually refers to a device that has many moving parts. The scientific definition of a "**machine**" is a device that can change the direction or amount (**magnitude**) of a push or pull (a **force**). A **simple machine** will have just one, or only a couple of parts. The simplest simple machine is a flat surface (called a **plane**) that is tilted (**inclined**) and is called an **inclined plane.**

Activity Challenge

How can a full container be moved upward to a height of at least 1 foot (30 centimeters) above the starting surface using less force than lifting the container straight up?

Preparation

1. Find a flat, horizontal work surface like a tabletop, desk, chair seat or floor that can be used for the challenge.
2. Collect the materials listed in the Materials Needed list.

To Do

1. Place the flat sheet onto the horizontal work surface.
2. Place books, cans, blocks or other items under one end of the flat sheet to elevate and support that end at least one foot (30 cm) above the work surface to create an **inclined plane**.
3. Place a book, can or other item at the lower edge of the sheet, (see top illustration), if needed to keep the flat sheet from sliding off the top supports. This arrangement can also be referred to as a **ramp**.
4. Tie a string around the center of the water bottle or food can.
5. Lay the bottle or can across the bottom of the **inclined plane**, see top illustration.
6. Pull on the string to move the object, rolling or dragging, up the inclined plane. If the object starts moving off the ramp, then reposition the string around the item. Alternately tie two strings around the can or bottle and join both to form a "Y" shape, as shown above on the left.
7. Note the amount of **force,** (pull) that needed to move the object up to the top of the **inclined plane**.
8. Place the object back on the flat work surface.
9. Lift the object straight up to the same height when the item was at the top of the **inclined plane**. Note the **magnitude** (amount) of force needed to lift the item.

Materials Needed

- Flat sheet of stiff cardboard, a clipboard or flat piece of wood, 1 to 2 feet long (30-60 cm) and wider than the object listed next
- Round bottle of water, can of food or an empty can that is filled with heavy items and sealed
- String
- Items to support (prop up) one end of the flat sheet and block the other end. Could be books, blocks, or cans

Grade Range

K-2
3-5
6-8

Topics/Skills

Science: Simple machines, Forces & Motion

Learning Standards

NGSS: Physical Science

Duration

15-30 minutes

Prep Time

5-10 minutes

Observations

- How does the **magnitude** (amount) of force required to move the object up the inclined plane compare with the force needed to lift the object straight up?
- How far does the object travel from the starting point when moving to the top of the inclined plane? How does that distance compare with the distance the object travels when lifted straight up?

Extensions

- Does an inclined plane of the same height but longer length, require less force to move the object to the same height?
- Is there a relationship between the force needed and the distance the objects travels?
- What are other names for and examples of inclined planes?
- What inclined plane is found in buildings with more than one floor?

The Science behind the Activity

There are 6 types of simple machines. An **inclined plane** is considered the simplest simple machine because the inclined plane does not move when an object is moved along the top surface. Some of the other simple machines involve moving the machine as in the turning of a **screw**, inserting a **wedge** or tilting a **lever**. The other 2 simple machines, a **pulley** and a **wheel/axle**, contain parts that move.

Using a simple machine to do a task will require less force (effort) than doing the task without the machine. An inclined plane, often called a ramp, is a good example. It takes less effort to move an object up a ramp than the effort required to lift the object straight up to same height. To gain the benefit of less effort, you must move the object a greater distance. This is called a **tradeoff**—less effort is required at the cost of moving the object further.

A wheelchair ramp is much longer than a staircase that is needed to reach the same height. A wheelchair user needs a ramp that gradually rises to be able to use the limited strength of their arms to move themselves to the top. Ramps are defined by how much the height increases for each foot of horizontal distance along the ramp. The requirement for wheelchair ramps is 1 inch of **rise** (elevation) for each horizontal foot travelled, a 1 to 12 ratio (1:12). Another way an inclined plane can be defined is by the angle created by the top surface and an intersecting horizontal line. For a wheelchair ramp with a 1:12 ratio, the angle would 4.8 degrees, which can be calculated using trigonometry.