

Section 2

Understanding Structures and Mechanisms

EXPLORATION 1

Force and Distance

Investigate the relationship between force and distance on inclined planes.

Simple machines, such as inclined planes, make work easier by reducing the amount of force needed to get work done. With the help of an inclined plane, we can move a heavy load up with less force than if we lift it up vertically. But, does the length of an inclined plane affect the force needed to move an object?



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EXPLORATION
1

Force and Distance

In this experiment, you will investigate the relationship between distance and force on inclined planes.

Level of Difficulty:

moderate

Time Needed:

40 minutes

Hypothesis:

Circle the word to show your hypothesis.

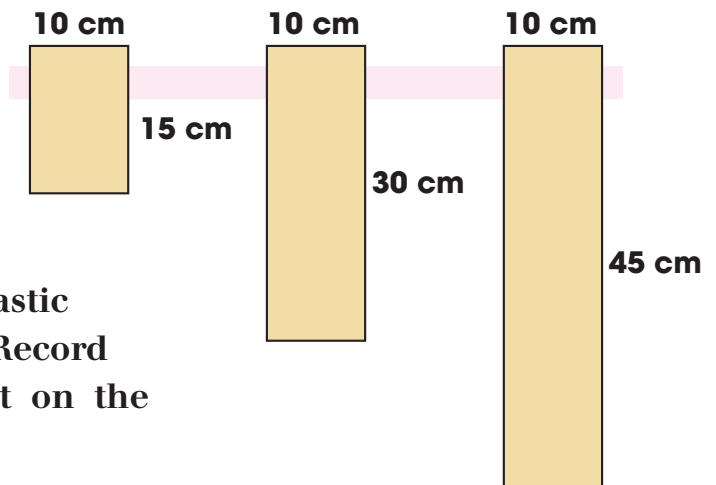
The longer the inclined plane is, the **less / greater** force is required to move a load up the plane.

Materials:

- books
- thick cardboard
- a heavy load (e.g. a set of keys)
- a ruler
- scissors
- an elastic band

Steps:

1. Cut out three ramps from the cardboard with the measurements as shown.
2. Tie the elastic band to the set of keys.
3. Measure the length of the elastic band without stretching it. Record the measurement in the chart on the next page.



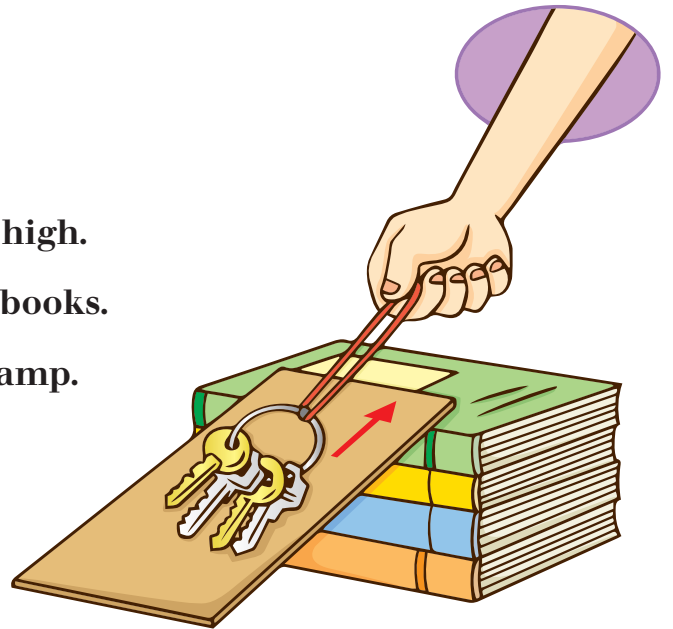
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- Stack some books to about 10 cm high.
- Lean the 15-cm ramp against the books.
- Place the keys at the base of the ramp.
- Pull the elastic band to drag the keys up the ramp. When the keys start moving, measure and record the length of the stretched elastic band.
- Repeat Steps 5 to 7 with the other two ramps. Record your results.



Length of the Ramp	Length of the Elastic Band		Force Needed (1 - least; 3 - most)
	before the experiment	during the experiment	
15 cm			
30 cm			
45 cm			

Conclusion:

Circle the correct words after conducting the experiment.

The greater the force required to move the keys up is, the more the elastic band stretches. The elastic band stretched the most on the **shortest / longest** ramp.

My hypothesis was **correct / incorrect** .

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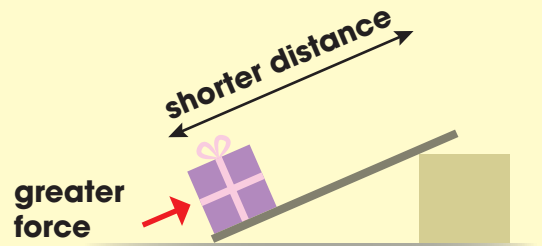
EXPLORATION 1

Force and Distance

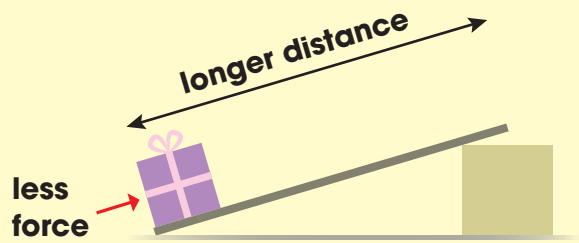
Explanation:

The elastic band stretched the most on the shortest ramp, implying that the most force was needed to move the keys up that ramp among the three ramps. As for the longest ramp, the elastic band stretched the least, meaning that the least force was needed. This shows that the longer the inclined plane is, the less force is required to move objects up the plane. An inclined plane is able to trade increased distance for decreased force.

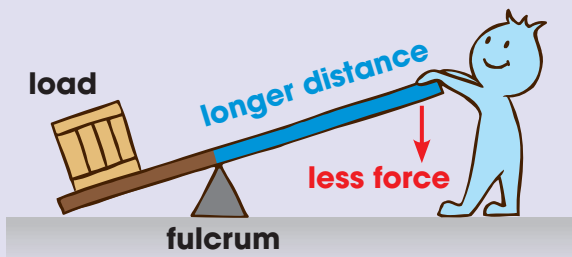
Shorter Inclined Plane



Longer Inclined Plane



Lever



The relationship between distance and force holds true for other simple machines as well. For example, a lever is able to reduce the force needed when the distance between the fulcrum and where the force is applied increases.