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How Ramps Change Force and Work

Purpose

To compare the amount of work it takes to lift an object straight up in the air to pushing it up a ramp.

Connections to What You Already Know About in Life

You've probably heard about ramps being simple machines, but what does that actually mean? You have probably seen wheelchair ramps and ramps to load supplies into and out of trucks and airplanes. Why use a ramp instead of the stairs or just lifting an object straight up or down? What are the advantages and disadvantages to each?

Vocabulary

Force, weight, work

Background

The Egyptians were able to build their enormous pyramids due to their understanding of the potential of the inclined plane. Since the Egyptians were limited to just the amount of man-power force they had to haul the blocks of cement to the necessary heights for the structures, they needed to use ramps as machines to achieve their immense task.

Remember the equations: $Work = force \times distance, Weight = mass \times g$

The value of acceleration due to gravity, $g = 9.8\text{m/s}^2$.

In this activity, you will learn about the relationship between work and force and why it is important to study engineering and improve our understanding of machines.

Pre-Lab Questions

1. The mass of the block you will be lifting in the activity is 50 kg. What is the weight of the block?

2. In the activity you will be pushing a block up a ramp. When the angle of the ramp is changed, what else must you change in order to have the block reach the same height as before? Explain.

Procedure

1. Start *Virtual Physical Science* and select *How Ramps Change Force and Work* from the list of assignments. The lab will open in the Mechanics laboratory.
2. The laboratory will be set up with a block at the bottom of the screen and attached to the block will be a rocket used to push the block up in the air. You will first push the block straight up in the air and

measure the force that it takes to lift it up, then you will push it up a ramp and measure the different forces that it takes to go up ramps of different angles.

3. Determine the least amount of force necessary to lift the block 50m in the air. Change the amount of force until you have the smallest force necessary to push the block to the top of the screen, which is 50m high. Click the *Force* button to start the rocket for each trial. Watch the Y display at the bottom and Pause when the block reaches 50m. If you have too much or too little force then use the *Reset* button to reset and use the *Parameters* Palette to increase or decrease the force for the next trial. Record the approximate time it took the block to reach the top. You may want to use the *Time* Acceleration buttons to speed up time to make it to the top sooner. Click the *+* or – buttons in the Time display.

Minimum Pushing Force	Time to Reach Top

4. Now find the least amount of force necessary to push the block to the same height using ramps of different angles. You will push the block with different amounts of force and watch it slide up the ramp.
5. Drag the Ramp icon on the tray at the top of the screen down into the experiment area. Also pull down the friction icon (the ramp with a block icon on it). Notice that the table is made of cement and the block is made of cement. Use the *Ramp* section in *Parameters* to change the angle of the ramp and the length as indicated in the table below. You already completed the first row in the experiment. To find the force necessary to push the block to the top, pick up the block and drag it to the bottom of the ramp, where Y=0. After each attempt use *Reset* button and then make the necessary changes, before you begin your next trial. Complete the following table using the same technique as from step 3.
6. Compute the work required for each ramp.

Ramp Angle (°)	Ramp Length (m)	Force (N)	Work (J)
90	50		
60	57.74		
45	70.71		
30	100		
10	287.94		

Questions

1. Why did the length of the ramp need to change for the ramps of different angles?

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2. How did the pushing force change when the ramp angle changed?

3. If you had to help the early Egyptians build a pyramid, explain which ramp you would use and why you would want them to use it?

