Name _____Teacher _____ Period_____ Date _____

# Angling for Access

**Problem (Question):** How does the steepness of a wheelchair-access ramp affect its usefulness?

**Materials:** meterstick ramp, water bottle filled with sand, spring scale, pencil, calculator

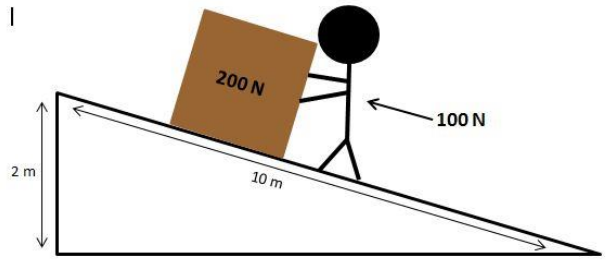
**Hypothesis:** Write a hypothesis based on the question we are trying to solve.

If the angle of an inclined plane (ramp) is steep, then it will be more _____ for a wheelchair to go up the ramp.

**Experiment:**

1. The output force with an inclined plane is equal to the weight of the object. Lift the bottle with the spring scale to measure its weight. Record this value (N) in the data table under "Output Force." This will be the same number for all of your tests today.
2. Find your meterstick ramp. You will prop this ramp up against the desk at three different heights today, so the manipulated variable is the height of the ramp. The variable you need to keep constant will be the length of the ramp. You will prop the ramp against the desk each time today at the 95-cm mark. Record this number in the data table under "Length of Incline." Use the same length for each test today.
3. Using the ramp, measure the vertical distance (up and down) in centimeters from the top of a desk to the ground. Measure to the nearest whole centimeter. Record this value in the data table as "Height of Incline." This height is the manipulated variable.
4. One partner should hold the inclined plane so that it doesn't move.
5. Another should lay the bottle on its side and hook the spring scale on the string. Use the spring scale to pull the bottle up the incline at a slow, steady speed, so that the bottle doesn't roll off the inclined plane. Do not lift the front of the bottle off the board when you are pulling on it. Be sure to hold the spring scale parallel to the incline. Measure the force (N) needed and record in the data table under "Input Force." **Make sure all members of your group do this so that each of you can feel the drag of the bottle up the ramp for each test today.**
6. Repeat steps 3-5 using the heights for the seat and the wire book rack under the seat. Make sure each group member has a chance to move the bottle up the ramp.
7. After you have finished the input force for all of the Trials, return all the materials to the counter and go back to your desk to complete the ideal and actual mechanical advantages and differences
8. For each test, calculate the ideal mechanical advantage and the actual mechanical advantage. Record the calculations in the data table under the correct heading.

**Ideal mechanical advantage** = $\frac{\text{Length of incline}}{\text{Height of incline}}$ **Actual Mechanical Advantage** = $\frac{\text{Output Force}}{\text{Input Force}}$




*The greater the difference between the ideal mechanical advantage and the actual mechanical advantage, the less input force needed by people using the inclined plane for access into a building.

**Data**

## Angling for Access

| | Output Force (N) | Length of Incline (cm) | Height of Incline (cm) | Input Force (N) | Ideal Mechanical Advantage | Actual Mechanical Advantage | *Difference = IMA - AMA |
|---|---|---|---|---|---|---|---|
| **Desktop** | 15N | 100cm | 80cm | 14N | 1.3 | 1.1 | .2 |
| **Deskseat** | 15N | 100cm | 50cm | 11N | 2.0 | 1.4 | .6 |
| **Wire rack** | 15N | 100cm | 25cm | 7N | 4.0 | 2.1 | 1.9 |

**Conclusion Questions:**

**1. How did the ideal mechanical advantage and the actual mechanical advantage compare each time you repeated the experiment?**

**The actual mechanical advantage (MA) was less than the ideal mechanical advantage (IMA)**

**2. What happens to the mechanical advantage as the inclined plane gets steeper?**

**The steeper the inclined plane the smaller the MA.**

**3. On the basis of this fact alone, which of the three inclined planes models the best steepness for a wheelchair-access ramp?**

**The wire rack (smallest slope) gave the best MA and best wheelchair access.**

**4. What other factors, besides mechanical advantage, should you consider when deciding on the steepness of the wheelchair access ramp?**

**Other factors that should be considered when deciding on the steepness of the wheelchair access ramp may include wheelchair safety, the texture or friction of the ramp surface, and space available for the ramp.**

*Before deciding to build a ramp, remember that the steeper the ramp is, the more dangerous it becomes to anyone using it. Ramp project builders have replaced steep ramps that have caused falls resulting in serious injuries and ramps that were so steep that the person needing it could not use it independently.

**5. Log in to Google Classroom and select the "Nearpod Simple Machines Inclined Plane" assignment to review Inclined Planes.**

Now you will go around the school and find the ideal mechanical advantage of different inclined planes.

$$\text{Ideal Mechanical Advantage} = \frac{\text{Length of Incline}}{\text{Height of Incline}}$$

| Where the ramp is located | Length of Incline (meters) | Height of Incline(meters) | Ideal Mechanical Advantage |
|---|---|---|---|
| **Inclined plane outside** | | | |
| **Ramp in stairwell (the bottom half of the stairs)** | | | |
| **Ramp at a curb** | | | |

After you have found an inclined plane (ramp), take a picture of it. Get the measurements of its length and height and write it in the chart. Go back to the classroom and calculate the IMA. Then using an appropriate app on your iPad, bring in the picture, label the length and height and show the work for IMA.