

Angling for Access

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

Materials: long board, water bottle filled with sand, spring scale, 5 books, metric ruler, pencil, calculator

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

If the wheelchair access ramp is too steep, then too much force will be required 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”
2. Look at the black line on the side of the board about 3 cm from one end. Measure (cm) the length from the longer side of the board to the mark and record it in the data table under “Length of Incline.” Measure to the nearest whole centimeter. Use the same length each trial today.
3. Place the end of the board (the side with the mark) on top of one textbook. The mark should be even with the edge of the book through each trial today. (See picture on other side.)
4. Measure the vertical distance (up and down) in centimeters from the top of the table (or ground) to where the underside of the incline touches the book. Measure to the nearest whole centimeter. Record this value in the data table as “Height of Incline.” This height is the manipulated variable.
5. 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.”
6. Predict how your results will change if you repeat the investigation using three and five books.

When more books are added, the input force will increase.

7. Test your predictions for 3 books and then 5 books and record the Output Force, Length of Incline, Height of Incline, and Input force for each trial.
8. 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
9. For each trial (number of books), 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 = $\frac{\text{Output Force}}{\text{Input Force}}$

Data

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Number of books	Output Force (N)	Length of Incline (cm)	Height of Incline (cm)	Input Force (N)	Ideal Mechanical Advantage	Actual Mechanical Advantage	*Difference = IMA - AMA
1	6N	57cm	3.5cm	1.5N	$57\text{cm}/3.5\text{cm}=16.3$	$6\text{N}/1.5\text{N}=4$	12.3
3	6N	57cm	10cm	2N	$57\text{cm}/10\text{cm}=5.7$	$6\text{N}/2\text{N}=3$	2.7
5	6N	57cm	16cm	2.5N	$57\text{cm}/16\text{cm}=3.6$	$6\text{N}/2.5\text{N}=2.4$	1.2

***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.**

Conclusion Questions:

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

The numbers decreased.

2. Why do you write ideal and actual mechanical advantage without units?

You write the IMA and AMA without units because when dividing, if you have the same units in the numerator as the denominator then they will cancel each other out.

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

It became less.

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

The one book setup models the best steepness for the ramp.

5. What other factors, besides mechanical advantage, should you consider when deciding on the steepness of the ramp?

What is using the ramp, material of ramp, material of object using the ramp, indoors or outdoors, railings, weight of object, space needed to make 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.

