

Mechanical Advantage

Use the equation for mechanical advantage to see how machines multiply force.

The mechanical advantage of a machine is the factor by which the machine multiplies force. The mechanical advantage of a machine can be used to determine how well a machine works and whether it can perform a particular job.

EQUATION: mechanical advantage (MA) = $\frac{\text{output force}}{\text{input force}}$

SAMPLE PROBLEM: What is the mechanical advantage of a lever that requires an input force of 20 N and lifts an object that weighs 60 N?

$$\text{mechanical advantage (MA)} = \frac{60 \text{ N}}{20 \text{ N}}$$

$$MA = 3$$

Practice Your Skills!

Use the equation for mechanical advantage to answer the following questions:

1. Amanda uses a wheelbarrow to lift a load of bricks. The bricks weigh 600 N, which is more than Amanda could normally carry. However, with the wheelbarrow, Amanda can lift the bricks with as little as 120 N. What is the mechanical advantage of the wheelbarrow?

2. Marshall wants to remove a tree stump from the ground. To do this, he puts one end of a long beam under the stump and puts all of his weight on the other end. His weight is just enough to lift the stump. The stump weighs 400 N. Marshall weighs 250 N. What is the mechanical advantage of the lever Marshall is using?

3. A system of pulleys allows a mechanic to lift an 1800 N engine.
 - a. If the mechanic exerts a force of 600 N on the pulley system, what is the mechanical advantage of the machine?

 - b. What is the mechanical advantage of the pulley system if the mechanic must exert 800 N of force to lift the engine?

 - c. After improving the design of his pulley system, the mechanic can now lift the engine with a MA of 4. How much force is now required to lift the engine?

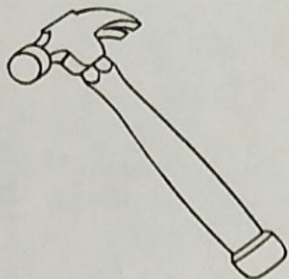
CHAPTER

8

REINFORCEMENT WORKSHEET

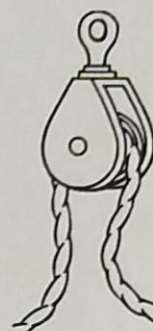
Mechanical Advantage and Efficiency

Complete this worksheet after you have finished reading Chapter 8, Section 3. Carlita, Tom, and Jamal are having a contest to see who can build the best pulley. After they finish constructing the pulleys, they measure the input and output forces as well as the input and output work. Below is a chart with the results. Help the three students calculate the mechanical advantage and the mechanical efficiency of each of the pulleys.



1. What is the output force of Tom's pulley? _____
2. What is the input force of Tom's pulley? _____
3. Divide the output force by the input force. _____
4. Your answer for item 3 is the mechanical advantage for Tom's pulley. Record this value on the chart below. Calculate the mechanical advantage of the other two pulleys in the same way, and record these values on the chart.

5. What is the output work of Carlita's pulley? _____
6. What is the input work of Carlita's pulley? _____
7. Divide the output work by the input work. _____
8. Multiply your answer for item 7 by 100%. _____
9. Your answer for item 8 is the mechanical efficiency for Carlita's pulley. Record this value on the chart. Calculate the mechanical efficiency of the other two pulleys in the same way, and fill in these values in the chart.



	Force (N)		Work (J)		Mechanical advantage	Mechanical efficiency
	Input	Output	Input	Output		
Carlita	4	8	4	3		
Tom	15	60	12	6		
Jamal	25	100	10	9		

10. Based on your calculations, whose pulley won the contest? Explain your reasoning.

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