Mechanical Advantage and Speed Ratio

pg 37-38



Right Side – Teacher Input

*Remember that all notes must be on the right side and this ENTIRE lesson must be on this page only

I Can...

- Analyze a mechanical device to determine mechanical advantage and speed ratio.
- Describe the difference between theoretical and actual values and provide explanations.

Mechanical Advantage

Machines can make work easier by increasing the amount of force that you exert on an object – for example a lever increases the amount of force that a person can exert on an object

- **Mechanical Advantage** of a machine is the amount by which a machine can multiply a force (AKA force ratio)
- The force applied to the machine is called the **input force**
- The force the machine applies to the object is called the **output force** or **resistance**



Calculating MA

- By knowing the input and output force of a machine you can determine the MA:

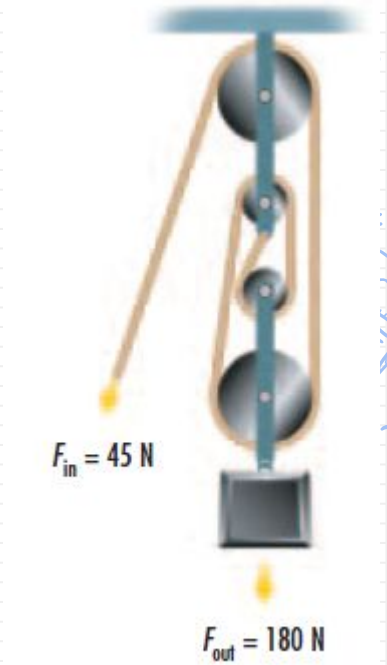
$$Mechanical\ Advantage = \frac{Output\ Force\ (N)}{Input\ Force\ (N)}$$

  - MA is actually a ratio of forces in a mechanical device – this is why it is also called a force ratio



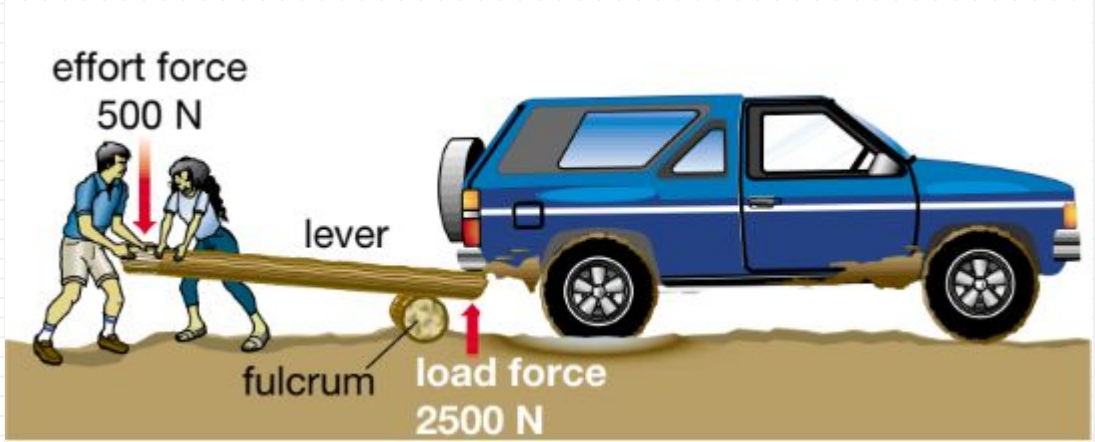
Examples

$$Mechanical\ Advantage = \frac{Output\ Force\ (N)}{Input\ Force\ (N)}$$



Examples

$$Mechanical\ Advantage = \frac{Output\ Force\ (N)}{Input\ Force\ (N)}$$



MA less than 1

In most examples, MA will be greater than 1 – this makes sense!

- ✘ Machines multiply the input force to create a larger output force

  What does it mean if a machine has a MA that is less than 1?

  - ✘ Does this mean the machine isn't useful? No! It means the machine is useful for tasks that don't require a large output force but instead often means it can magnify distance.
- ✘ Think about a bike – you need to put into a much greater force than what is put out by the bike, but it is much faster to ride a bike than walk...therefore the machine is useful!



MA equal to 1

- Some machines do not have any effect on the effort force that you exert. They simply change the direction of the effort force.

- For example, when you pull down on the cord of window blinds, the blinds go up. Only the direction of the force changes. The effort force and the load are equal, so the mechanical advantage is 1.

- Try to think of other mechanical devices that have a mechanical advantage of 1.



Speed Ratio

- Calculating the speed ratio is another way to analyze how machines work!
- Speed measures the distance an object travels in a given amount of time
- The **Speed Ratio** is the measurement of how the speed of an object is affected machine



Calculating SR

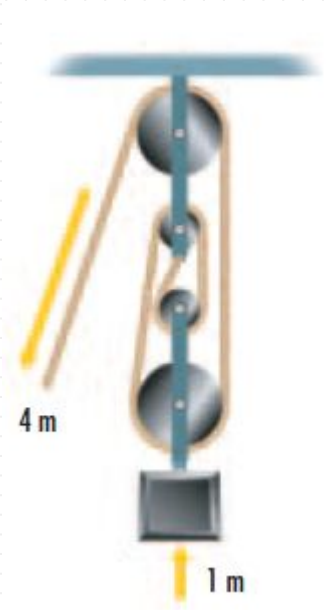
- By knowing the input and output distance of a machine you can determine the SR:

$$Speed\ Ratio = \frac{Input\ Distance}{Output\ Distance}$$



Examples

$$Speed\ Ratio = \frac{Input\ Distance}{Output\ Distance}$$

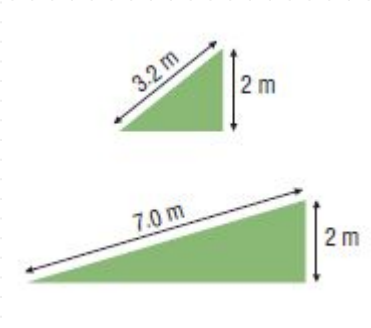


Less Force, Greater Distance

- ✘ Speed ratio calculations help determine that machines don't get "something for nothing"
- ✘ When we talked about simple machines we noted that each machine had a pro and a con – for example a pulley system multiplies the force you input but in using the pulley, you have to pull much farther than the load actually moves



Example



You can see the pros and cons with this example.

- ✘ Which ramp has the greater MA?
- ✘ Which ramp is longer (push the load farther)?
- ✘ What is the SR of the ramps?

Left Side – Student Input

Finding Mechanical Advantage

Glue one edge of the practice page to your left side.

Complete the questions with a partner or independently.

Questions are on the following slide if you are missing the handout.



Finding Mechanical Advantage

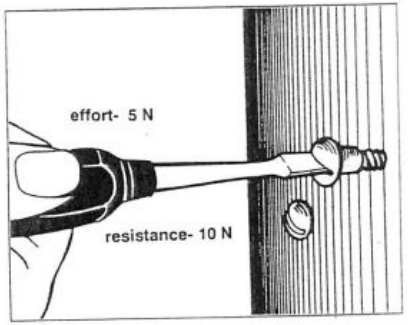


Figure D

1. The simple machine in Figure D is a _____.
2. The resistance is _____ N.
3. The effort is _____ N.
4. The effort is multiplied _____ times.
5. The M.A. is _____.

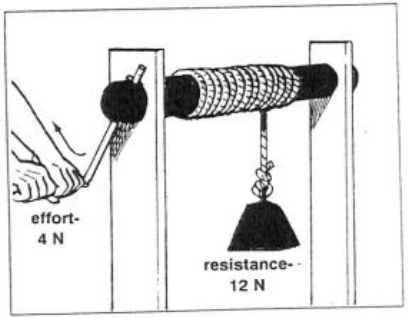


Figure E

6. The simple machine in Figure E is a _____.
7. The resistance is _____ N.
8. The effort is _____ N.
9. The effort is multiplied _____ times.
10. The M.A. is _____.

Remember M.A. = $\frac{\text{Resistance}}{\text{Effort}}$

	Effort	Resistance	M.A.
1.	30 N	300 N	10
2.	5 N	25 N	
3.	15 N	15 N	
4.	20 N		2
5.	2 N	100 N	
6.		200 N	4
7.	25 N	150 N	
8.		150 N	5
9.	50 N	50 N	
10.	30 N		6

1. A 200 N force moves an 800 N resistance. Find the M.A. _____
2. A pulley lifts a 100 N resistance with a force of 100 N. Find the M.A. _____
3. The M.A. of a certain machine is 2. How much force does it use to move a 200 N resistance? _____
4. The M.A. of a certain machine is 4. It lifts a resistance with 10 N. What is the weight of the resistance? _____