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Simple Machines and Mechanical Advantage

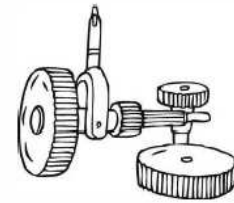
A **Machine** is anything that has moving parts and can perform a task (can do work).

Machines make work easier.

A **Simple Machine** is a device that accomplishes a task with one simple motion and without an engine.

Most devices you know are combinations of the six simple machines.

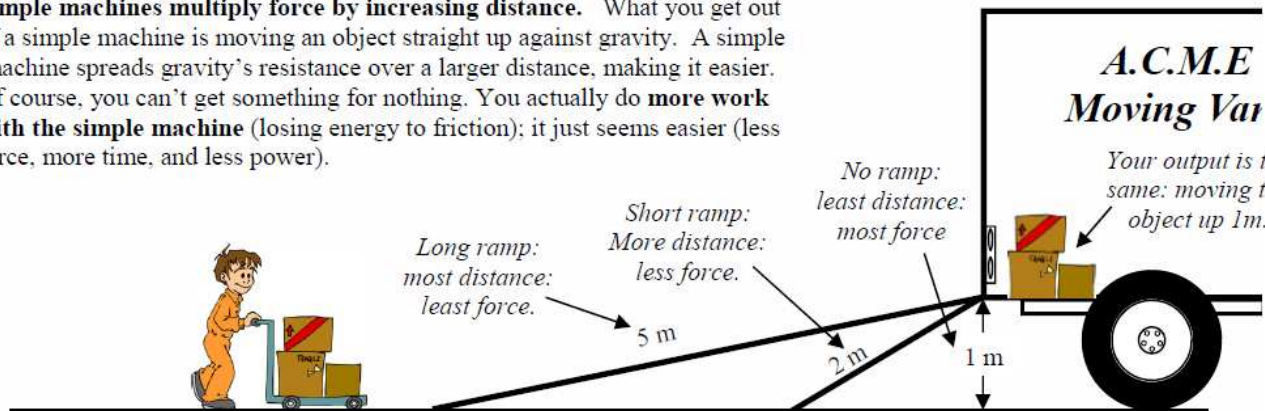
<i>The Six Simple Machines with Examples</i>	
<u>S</u> crew	Screw; corkscrew
Wheel and <u>A</u> xle	Crank; tires; screwdrivers
<u>W</u> edge	Nail; arrow; knife
<u>L</u> ever	Scissors; nutcracker; arm
Ramp or <u>I</u> ncline Plane	Wheelchair ramp; stairs
<u>P</u> ulley	Block and tackle



Some people consider "gears" to be a seventh simple machine, but gears are actually just levers on wheels.

Increasing Distance, Decreases Force

Simple machines multiply force by increasing distance. What you get out of a simple machine is moving an object straight up against gravity. A simple machine spreads gravity's resistance over a larger distance, making it easier. Of course, you can't get something for nothing. You actually do **more work with the simple machine** (losing energy to friction); it just seems easier (less force, more time, and less power).



Mechanical Advantage (MA)

An advantage is something that helps you (like a head start)

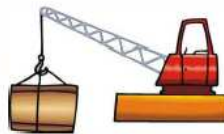
A mechanical advantage is how much a machine helps.

More help = more MA

Forces

A simple machine has a greater mechanical advantage if it multiplies your force OR if it makes the object feel lighter.

A crane gives a huge mechanical advantage!



Time

A simple machine could even multiply your time, by making a job faster.

A vacuum cleaner gives MA by making it easier to pick up things.



Input vs. Output

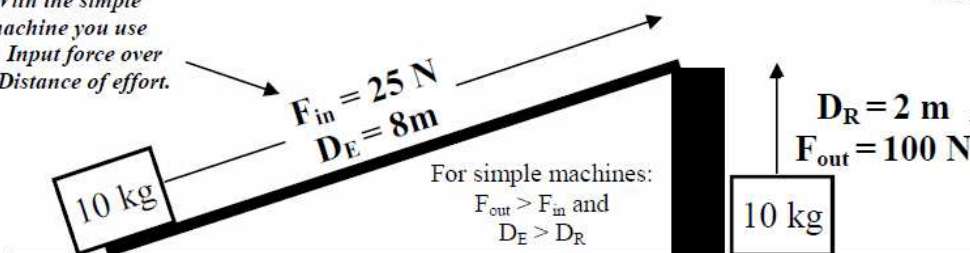
The input is you putting force (and energy) into moving the object with the simple machine. The output is always lifting the object against gravity OR what you would have to do without the simple machine.

Input—With the simple machine:

Force in (F_{in}) and Distance of effort (D_E).

By using 4 times the distance you only need 1/4th the force. This ramp has an MA of 4.

With the simple machine you use an Input force over the Distance of effort.

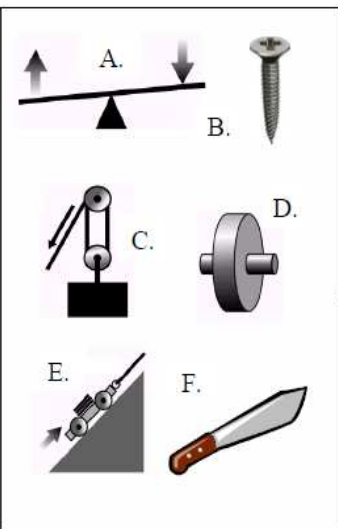


Output—Without the simple machine:

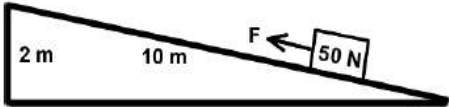
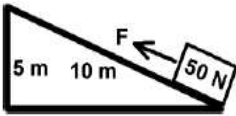
Force in (F_{in}) and Distance of resistance (D_R).

Without the simple machine you use an Output force over the Distance of resistance to resist gravity.

The output force (F_{out}) is always the weight of the object you are lifting.
 $F_{out} = F_w = mg$

Identify these simple machines: A. _____ B. _____ C. _____ D. _____ E. _____ F. _____		1. Mechanical Advantage 2. None 3. D_E 4. D_R	A. How much a machine amplifies or reduces your force. B. The units for mechanical advantage. C. How far the object would move without the simple machine. D. How far the object moves with the simple machine.
		1. Machine 2. F_{in} 3. F_{out} 4. Pulley	A. The force you put into a machine. B. A device that has moving parts and can do work. C. A block and tackle is another name for this. D. The force you get out of a machine.

<u>Input Force (F_{in}) or Output Force (F_{out})?</u> ____ You lift a 200 N object. ____ How hard you push with the simple machine. ____ A wedge applies 400 N of force to a piece of wood. ____ You push 240 N on a lever. ____ You turn a screw with 30 N of force. ____ A pulley applies 48 N of force up. ____ The weight of the object you are lifting.	<u>Distance of Effort (D_E) or Distance of Resistance (D_R)?</u> ____ You use an incline plane to lift a car up 4 meters. ____ You use a 10 meter long ramp to raise up a car. ____ You lift a 200 kg object up 2 meters to the back of a pickup truck. ____ The distance <i>you</i> push down on a lever. ____ The distance the object moves <i>up</i> with a lever. ____ Vertical distance you lift against gravity.
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What is the difference between a machine and a simple machine? How can time be used to measure mechanical advantage? In a simple machine which is bigger: D_E or D_R ? In a simple machine which is bigger: F_{in} or F_{out} ?	For both ramps, label D_E , D_R , F_{in} , and F_{out} . Ramp A  Ramp B 
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You have to lift a 15 kg object. What is your output force? Using a lever, you push down 20 N to lift a 10 kg object. A) Find the output force. B) What is the input force? C) How much does the ramp multiply your force? You push with 10 N up a ramp to move a 40 N object to the top of a table. By how much does the ramp multiply your force?	Which ramp has the greatest mechanical advantage? To give a greater MA, what would you have to do? Give three examples of simple machines you have at home (be sure to specify which simple machine it is). Give three examples of simple machines in your body (and specify which simple machine they are).
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