SCIENCE

NAME: PERIOD: DATE:

SIMPLE MACHINES NOTES

Machine – a device that makes work easier by increasing, decreasing, or changing the direction of your force.

Work –applying a force over a distance. Ex. pushing a box for ten feet

Formula: **Work = Force x Distance**

Machines change the work you do on them by either:
1. trading your extra distance on the machine for extra force out of the machine
2. trading your extra force on the machine for extra distance out of the machine

A machine does the exact same amount of work that you do just in a different way.

Simple machine – device that makes work easier with only one movement

Compound machine – a device that makes work easier that is made up of 2 or more simple machines

Effort Force – the force applied to the machine
Ex. you twist the screwdriver, you make the hammer swing, you pull back on the crowbar

Resistance Force – the force applied by the machine. The force that does what you want done.
Ex. the screw's threads dig into the wood, the nail drives into the wood, the crowbar pries upward

Mechanical Advantage – calculates how much the machine multiplies your force

Formula: **Mechanical Advantage = Resistance force ÷ Effort force**

Mechanical advantage is what makes most machines worthwhile. Most of the time you want more force from the machine than you could exert yourself.

If you put in a force of 50 and get out a force of 500, then the mechanical advantage is 10.
You got 10 times more force out of the machine.

If a machine has a mechanical advantage of 3 and you put in a force of 10, you will get a force of 30 out of it.

Ideal Machine – a machine in which no force is lost and work output is equal to work input.

All machines lose energy through friction, so you never get 100% out of the force you put into it.
There are no ideal machines in the real world

Perpetual Motion Machine – a machine that continues to run forever once it is started. A perpetual motion machine would be a type of ideal machine that would use the energy it generates to run itself.

EXAMPLES OF SIMPLE MACHINES

1. Lever – a bar that is free to pivot or turn on a fixed point
Ex. crowbar, hockey stick, oar for a boat

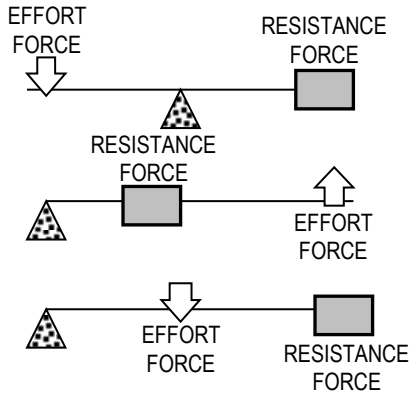
Why use one?
By putting an "effort force" on the lever and causing it to pivot on the fulcrum, more force or greater movement on the other end can be achieved.

PARTS OF A LEVER:

Fulcrum – the fixed point on which a lever pivots or turns

Resistance arm – the part of the lever that exerts the "resistance force"

There are 3 types of levers. The only difference between them is where the fulcrum and the effort force is applied.



1st Class lever: In this lever, the fulcrum (triangle) is in between the "effort force" (arrow) and "resistance force" (box)
Ex. 'see saw'

2nd Class lever: the "resistance force" is in the middle
Ex. wheelbarrow

3rd Class lever: the "effort force" is in the middle
Ex. stapler or hockey stick

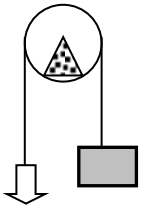
The mechanical advantage of a lever is:

Mechanical Advantage (lever) = effort arm (length of) ÷ resistance arm (length of)

A SPECIAL "LEVER":

Pulley – a grooved wheel with a rope or chain running through the groove

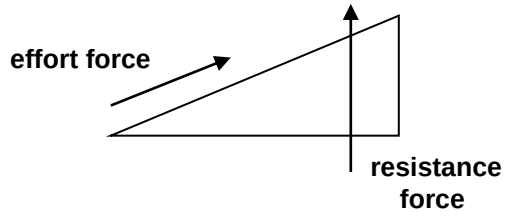
- works similar to a lever
- instead of a lever, the pulley uses a rope
- the wheel part of a pulley is the fulcrum
- the effort is on one side of the pulley, and the resistance is on the other side
- the more pulleys used, the better the mechanical advantage
- a single pulley only changes the direction of the effort force, force is not increased



The mechanical advantage of a single pulley is one.

The mechanical advantage of multiple pulleys:
equals the number of ropes between the pulleys
+1 for each rope that is supporting the weight of load.
+0 for ropes that don't support the weight of the load. (like the pull rope)

2. Inclined plane – use a sloped surface to increase or decrease the distance a force will be applied over.
Ex. ramp, axe head, screws



Why Use One?
The inclined plane's slope means that little "effort force" is needed to get a large resistance force. The "effort force" also goes in a different direction than the "resistance force" which is often desirable.

The length of the slope of an inclined plane divided by its height is its mechanical advantage.

The mechanical advantage of an inclined plane is:

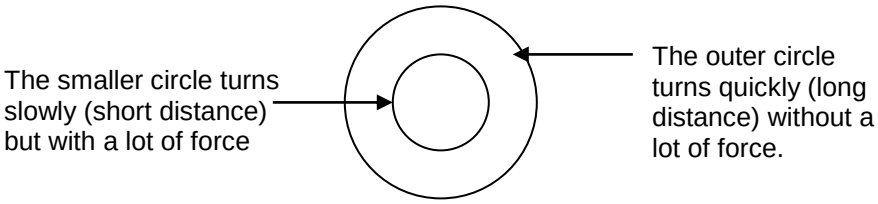
Mechanical Advantage (inclined plane) = slope (ramp length) ÷ ramp height

The longer and less steep the ramp, the easier it is to push or pull an object up, however, you have to exert your small force over a much longer distance.

3. **Wheel and Axle –** A combination of a large circular object and a smaller one. One of the circular objects is used to turn the other, giving a mechanical advantage.

Ex. doorknobs, wheels and axles of vehicles, screwdriver

- If the bigger circle is turning the smaller circle, then you are trading distance for force.
- If the smaller circle is turning the bigger circle, then you are trading force for distance (i.e. a fast turning large wheel.)



The mechanical advantage of a wheel and axle is because of the fact that both circular parts are attached to each other. If one is turned, the other must turn also. When either circle makes a complete turn, so must the other, therefore, the larger wheel must turn farther than the inner circle in order to keep up. (Think of it as lanes in a track meet. The inside lane is shorter, so a person running in the outer lane would actually have to run farther!)

The mechanical advantage of a wheel and axle is:

Mechanical Advantage (wheel and axle) = radius of wheel ÷ radius of axle

The bottom line on ALL simple machines:

- You use them to trade force for distance. If you can't provide a powerful enough force, then you give up the extra distance. If you can't get the distance (usually speed) that you want, you give up the extra force.

- Simple Machines DO NOT GIVE YOU SOMETHING FOR NOTHING, and in the real world, you ALWAYS lose some energy due to friction.