All Work and no Play

Work, work, work. You might head off to your job one day, sit at a computer, and type away at the keys.

Is that work?

To a physicist, only parts of it are.

Work is done when a **force** that is applied to an object **moves** that object.

Answer #2 on your notes before moving on!

Sitting and looking at a computer screen is NOT WORK because nothing is moving.

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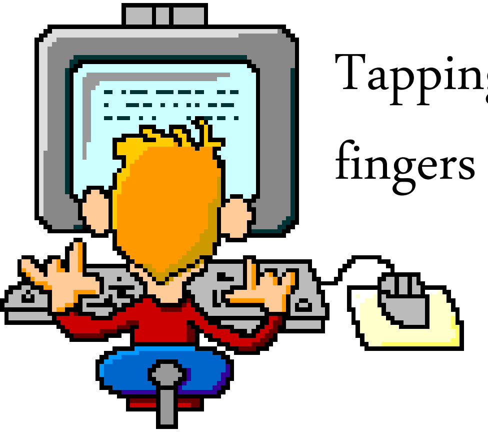
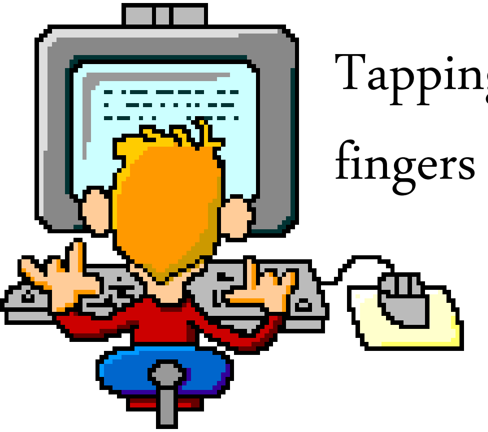


Tapping on the keyboard and making the keys move is work. Your fingers are applying a force and moving the keys.

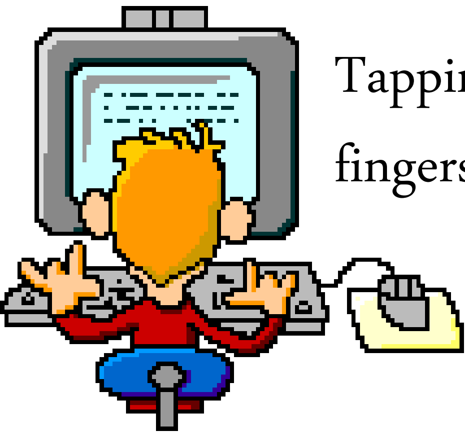
Sitting and looking at a computer screen is NOT WORK because nothing is moving.



Tapping on the keyboard and making the keys move is work. Your fingers are applying a force and moving the keys.

Sitting in the car on the way to school is NOT WORK.

Sitting and looking at a computer screen is NOT WORK because nothing is moving.

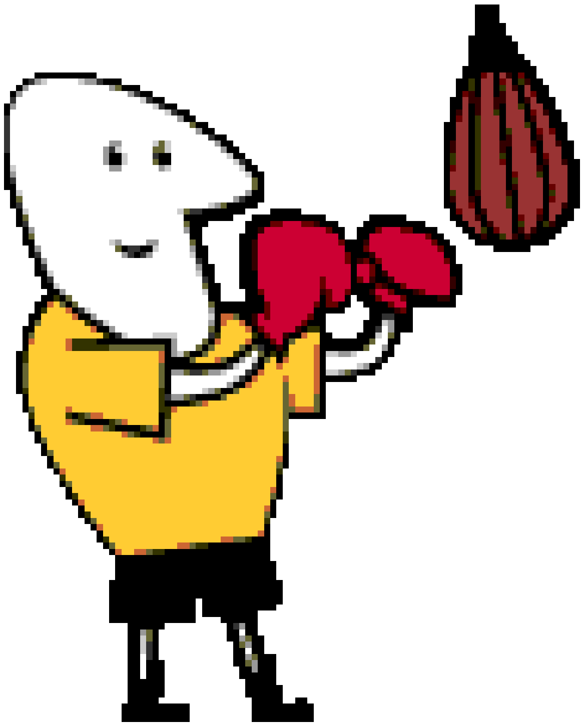


Tapping on the keyboard and making the keys move is work. Your fingers are applying a force and moving the keys.

Sitting in the car on the way to school is NOT WORK.

...but the energy your car engine uses to move the car does work.

You have to exert a force AND move something in the same direction as the force to qualify as doing work.



The work is calculated by multiplying the force by the amount of movement of an object. The formula is:

(**Work = Force x Distance**)

The unit for work is the joule.

For example:

With the **work** formula, you can compare the amount of work you do to lift some trees you are planting. To lift one tree that has a weight of 100 Newtons, you would have to exert a force over **100 Newtons**. If you were to raise the tree **1 meter**, how much work would you do? Calculate this with your partner before moving on. (**W = F x D**)

For example:

With the **work** formula, you can compare the amount of work you do to lift some trees you are planting. To lift one tree that has a weight of 100 Newtons, you would have to exert a force over **100 Newtons**. If you were to raise the tree **1 meter**, you would do: **(W = F x D)**

100 newtons x 1 meter =

100 Joules (of work)

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To lift a tree that has twice as much weight, you would have to exert a force over **200 Newtons**. If you were to raise the tree **1 meter,** how much work would you do? Calculate this with your partner before moving on. **(W = F x D)**

For example:

With the **work** formula, you can compare the amount of work you do to lift some trees you are planting. To lift one tree that has a weight of 100 Newtons, you would have to exert a force over **100 Newtons**. If you were to raise the tree **1 meter**, you would do: **(W = F x D)**

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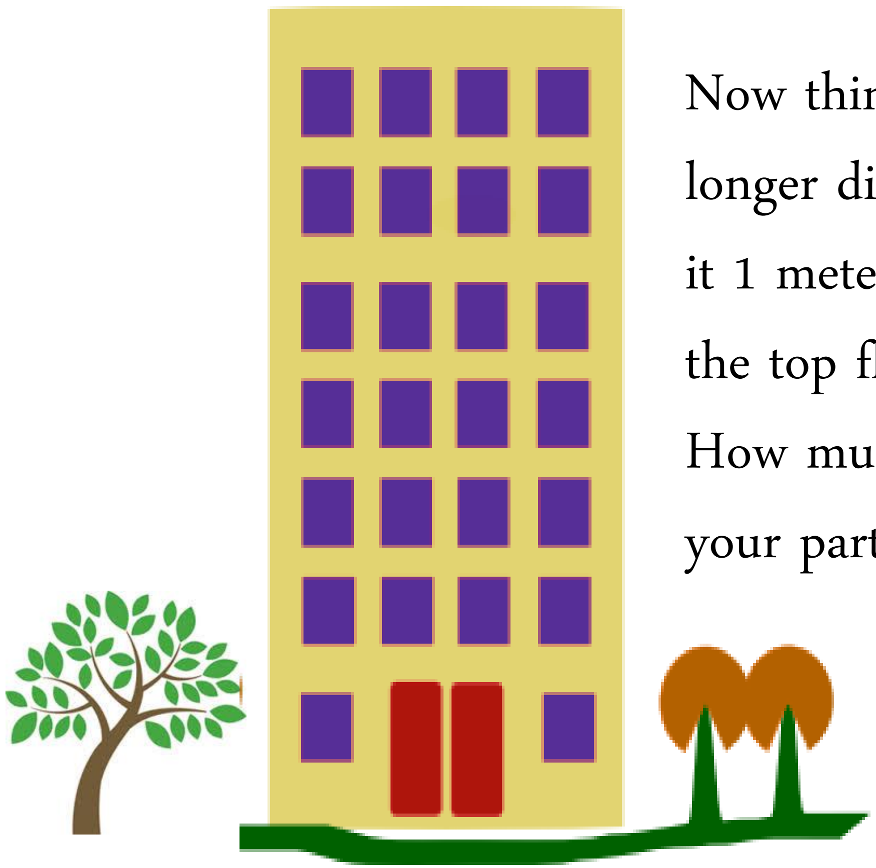
To lift a tree that has twice as much weight, you would have to exert a force over **200 Newtons**. If you were to raise the tree **1 meter**, you would do: **(W = F x D)**

200 newtons x 1 meter =

200 Joules (of work)

Therefore, the <u>heavier</u> the object, the more work needed to move the object the same distance! Seems logical, but now you know why!

Another example:



Now think about lifting the first tree (100N) up a longer distance. You did 100 joules of work lifting it 1 meter. Suppose you needed to lift the tree to the top floor of a building that is **<u>40 meters tall</u>**. How much work would you do? Calculate this with your partner before moving on. (**W = F x D**)

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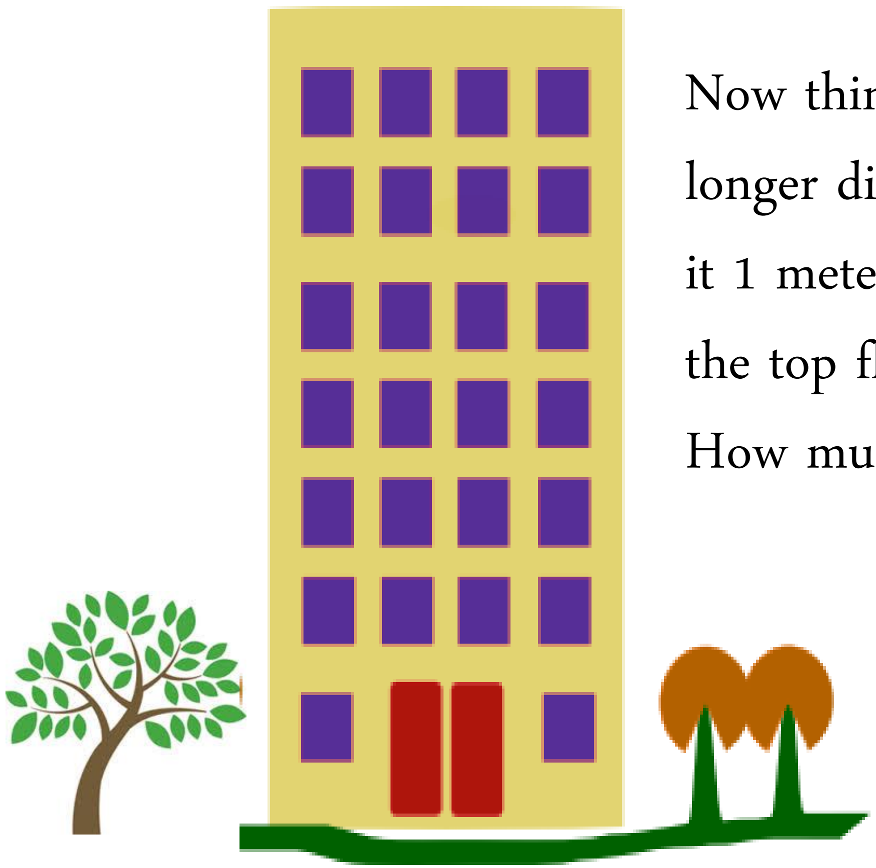


Now think about lifting the first tree (100N) up a longer distance. You did 100 joules of work lifting it 1 meter. Suppose you needed to lift the tree to the top floor of a building that is **40 meters tall**. How much work would you do?

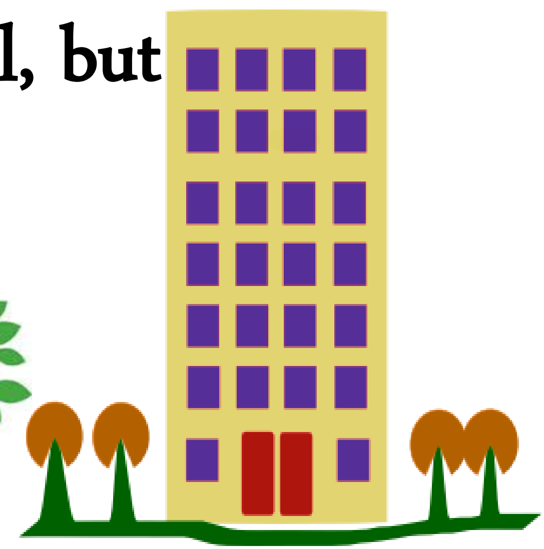
(W = F x D)

100 newtons x 40 meters =

4,000 Joules (of work)

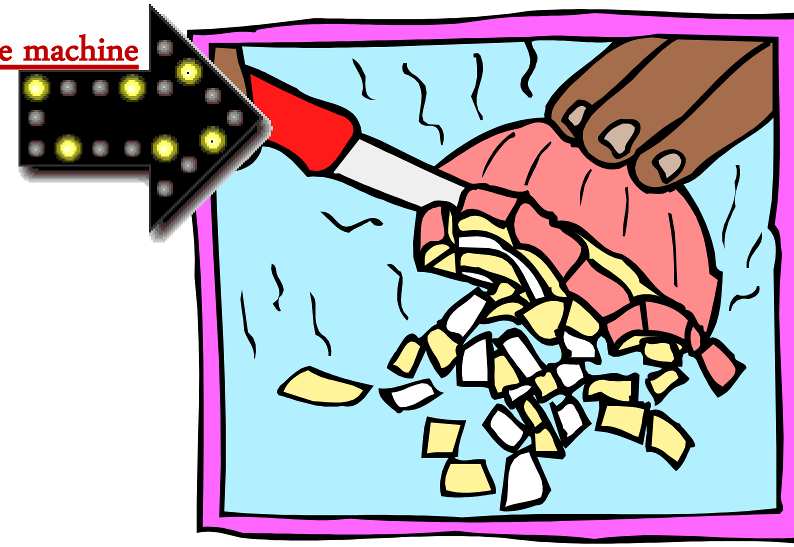
(40 times as much work as you did lifting it 1-meter!)

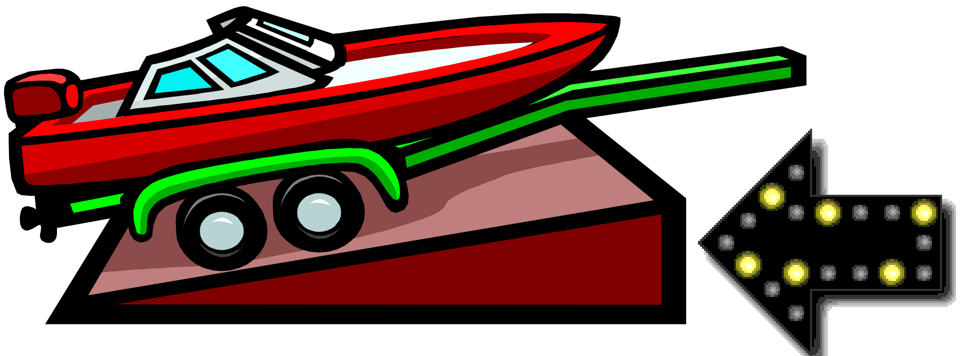
Therefore, if you try to move the same object a longer distance, more **work** is needed! Again, seems logical, but now you know why!



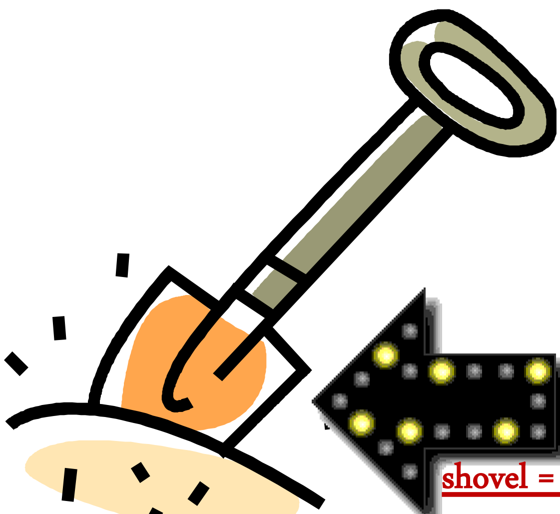
A **simple machine** is a device that has one or two parts which you can use to make **work** easier or more effective.

knife = simple machine

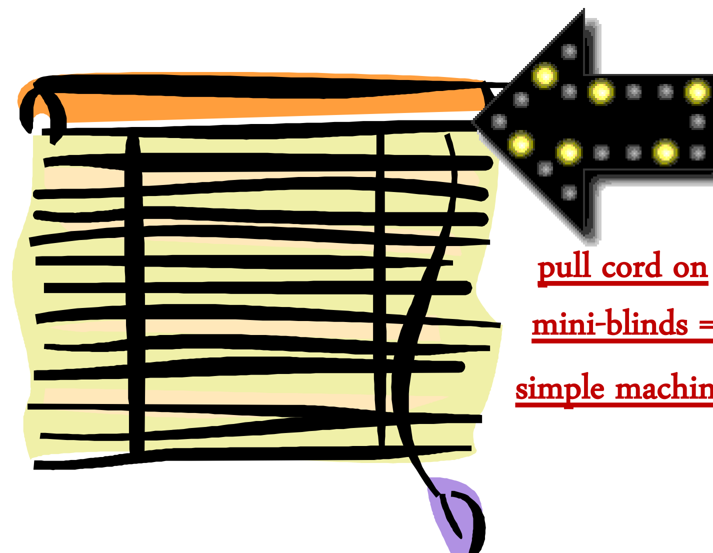




boat ramp = simple machine



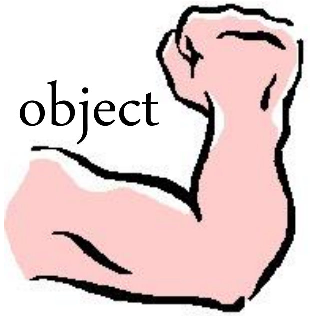
shovel = simple machine



pull cord on mini-blinds = simple machine

A **machine** does **NOT** decrease the amount of **work** that is done, but it makes the work easier by:

- Increasing the amount of **FORCE** exerted to move the object



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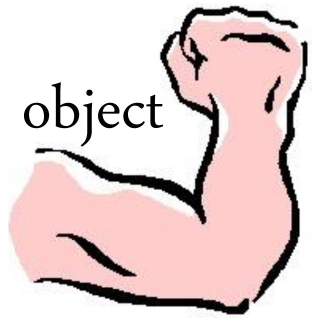
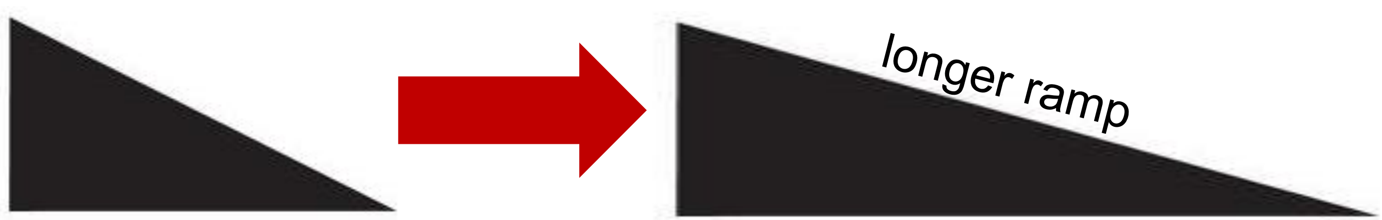


Increasing the **DISTANCE** over which you exert the force,



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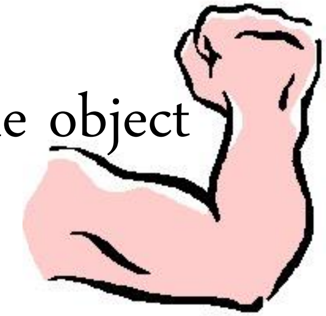

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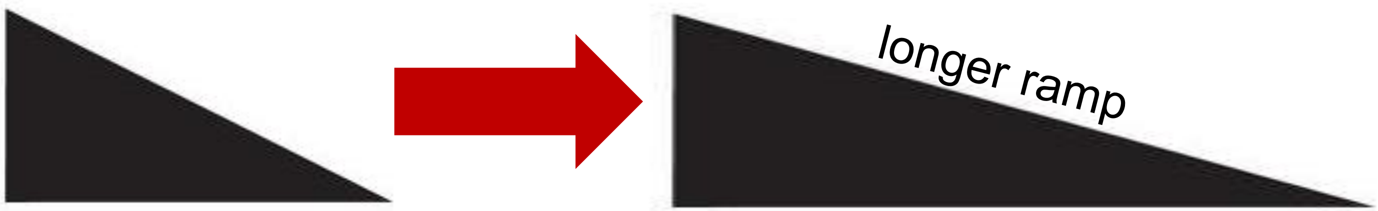
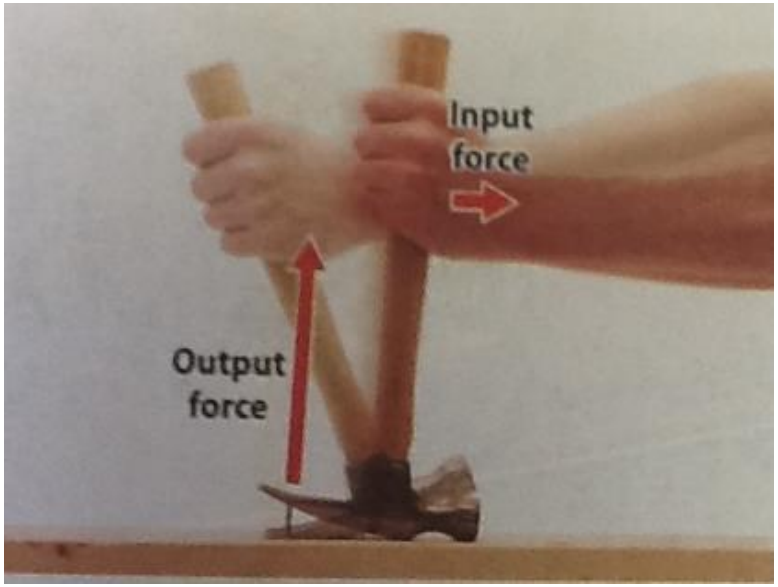


CHANGING the **DIRECTION** in which you exert your force.

The force you apply to the simple machine is called the **INPUT FORCE**.

The machine does work by exerting a force on the object over a distance. The force exerted by the machine on the object to be moved is the **OUTPUT FORCE**.



You move the hammer. (input force)

The hammer moves the nail.(output force)

MECHANICAL ADVANTAGE

A machine's mechanical advantage is a ratio of the output force to the input force. It indicates how much the simple machine changes the input force (the force you apply to it.)

$$\text{Mechanical Advantage} = \frac{\text{Output Force}}{\text{Input Force}}$$

A machine's mechanical advantage can be:

less than 1, equal to 1, or greater than 1

Mechanical Advantage of Increasing Force

For a simple machine that increases the force, the mechanical advantage is greater than 1.

So, the output force (the force the machine exerts) is GREATER than the input force (the force you put on the machine.)

For Example: If you exert a force of 20 Newtons on a can opener, and the opener exerts a force of 60 Newtons on the can, the mechanical advantage is:

$$\frac{\text{Output Force}}{\text{Input Force}} =$$

Calculate with your partner before you move on.

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$$\frac{\text{Output Force}}{\text{Input Force}} = \frac{60 \text{ Newtons}}{20 \text{ Newtons}} = \mathbf{3}$$

The can opener **TRIPLED** your force!

Mechanical Advantage of Increasing Distance

For a machine that increases distance, the mechanical advantage is **LESS** than 1, which means a **lesser force is exerted by the machine**, **but over a longer distance**.

For Example: If you exert a force of 20 Newtons on a high gear while riding your bicycle and the bicycle exerts a force of 10 Newtons on the moving parts , the mechanical advantage is:

$$\frac{\text{Output Force}}{\text{Input Force}} =$$

Calculate with your partner before you move on.

Mechanical Advantage of Increasing Distance

For a machine that increases distance, the mechanical advantage is **LESS** than 1, which means a **lesser force is exerted by the machine**, **but over a longer distance.**

For Example: If you exert a force of 20 Newtons on a high gear while riding your bicycle and the bicycle exerts a force of 10 Newtons on the moving parts , the mechanical advantage is:

$$\frac{\text{Output Force}}{\text{Input Force}} = \frac{10 \text{ Newtons}}{20 \text{ Newtons}} = .5$$

You are putting more force on the pedal but the bike exerts the force for a longer distance than you normally can.

Mechanical Advantage of Changing Direction

If only the direction changes, the input force will be the **SAME** as the output force. This means the mechanical advantage is **one**. You still exert a force, but because it is in a different direction, it is easier to do.

For example:

A sailor pulls on a rope to raise the sail. The pull changes the direction of the force, so it is easier to raise the sail.

So, some machines allow you to:

-use **less** force over a greater distance (can opener,)

-more force over a **shorter** distance (bike gears,)

-or the same force in a **different** direction (sail.)

In the end, you do as much work with the machine as you do without the machine, but the work is **easier**.

For example:

If you had to get a piano onto the stage in the cafeteria, you could LIFT it up to the stage or PUSH it up a RAMP.

If you use a ramp, the distance over which you must exert your force is longer than if you lifted the piano…

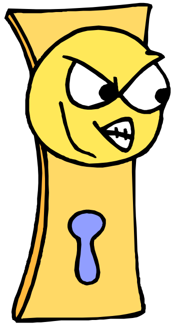
…but the advantage of the ramp is that it allows you to exert a smaller force to push the piano than to lift it.

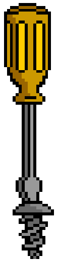
There are <u>SIX</u> types of machines which make work easier.

They are called <u>SIMPLE MACHINES</u>!

The Wedge

The Wheel & Axle





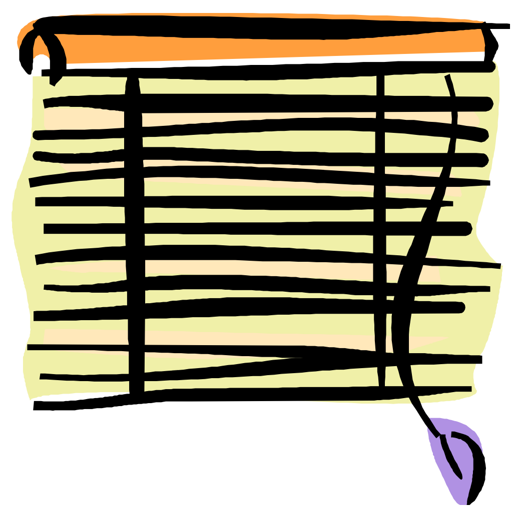
The Screw

The Lever

And the two we will focus on this year:

*The Inclined Plane

*The Pulley



Work together to complete page 198 in your textbook.