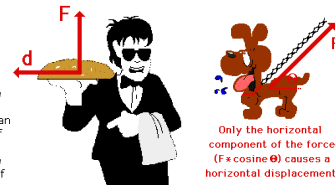


# Work

## Daily def



**Science Def** Apply a force object move a distance



Mathematically, work can be expressed by the following equation.

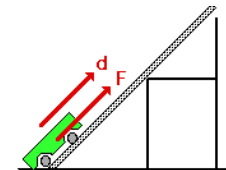
$$W = F * d * \cos \theta$$



where F = force, d = displacement, and the angle (theta) is defined as the angle between the force and the displacement vector. Perhaps

$$N = \frac{kg \cdot m}{s^2}$$

$$J = \frac{kg \cdot m^2}{s^2}$$



Whenever F and d are in the same direction,  $\theta = 0$  degrees.

The Joule is the unit of work.  
 1 Joule = 1 Newton \* 1 meter  
 1J = 1 N \* m

## Non-standard units of work

$$ft * pound \quad kg * \frac{m}{s^2} * m \quad kg * \frac{m^2}{s^2}$$



$$\text{Power} = \frac{\text{Work}}{\text{time}}$$



Rock climbers do a lot of work at a slow rate; their power is small.

# Power

RATE AT WHICH WORK IS DONE

$$\text{unit - watt} = \frac{\text{J}}{\text{s}}$$

$$\text{horsepower} \approx 746 \text{ watts}$$

# Machines

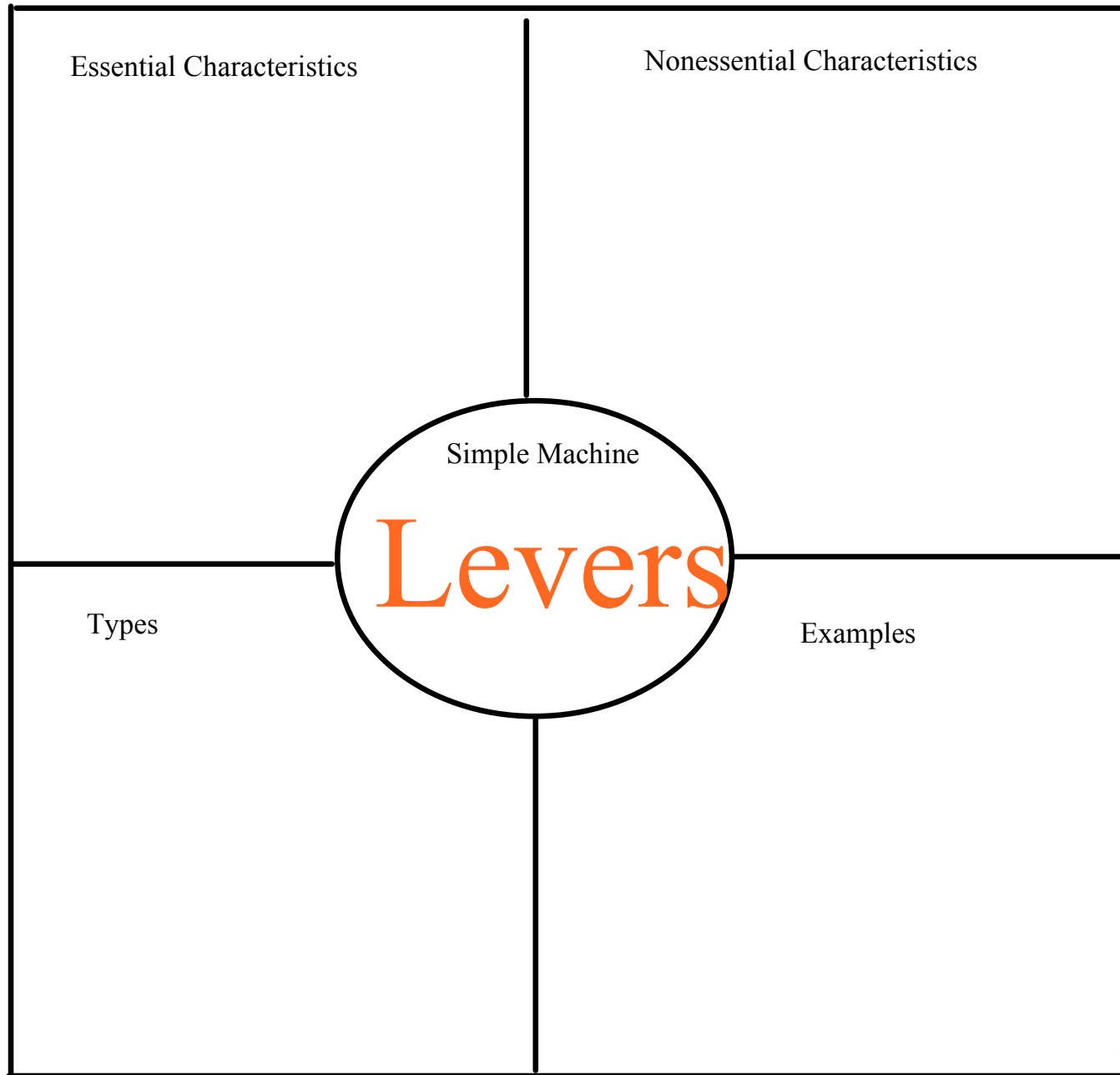
What do they do for us?

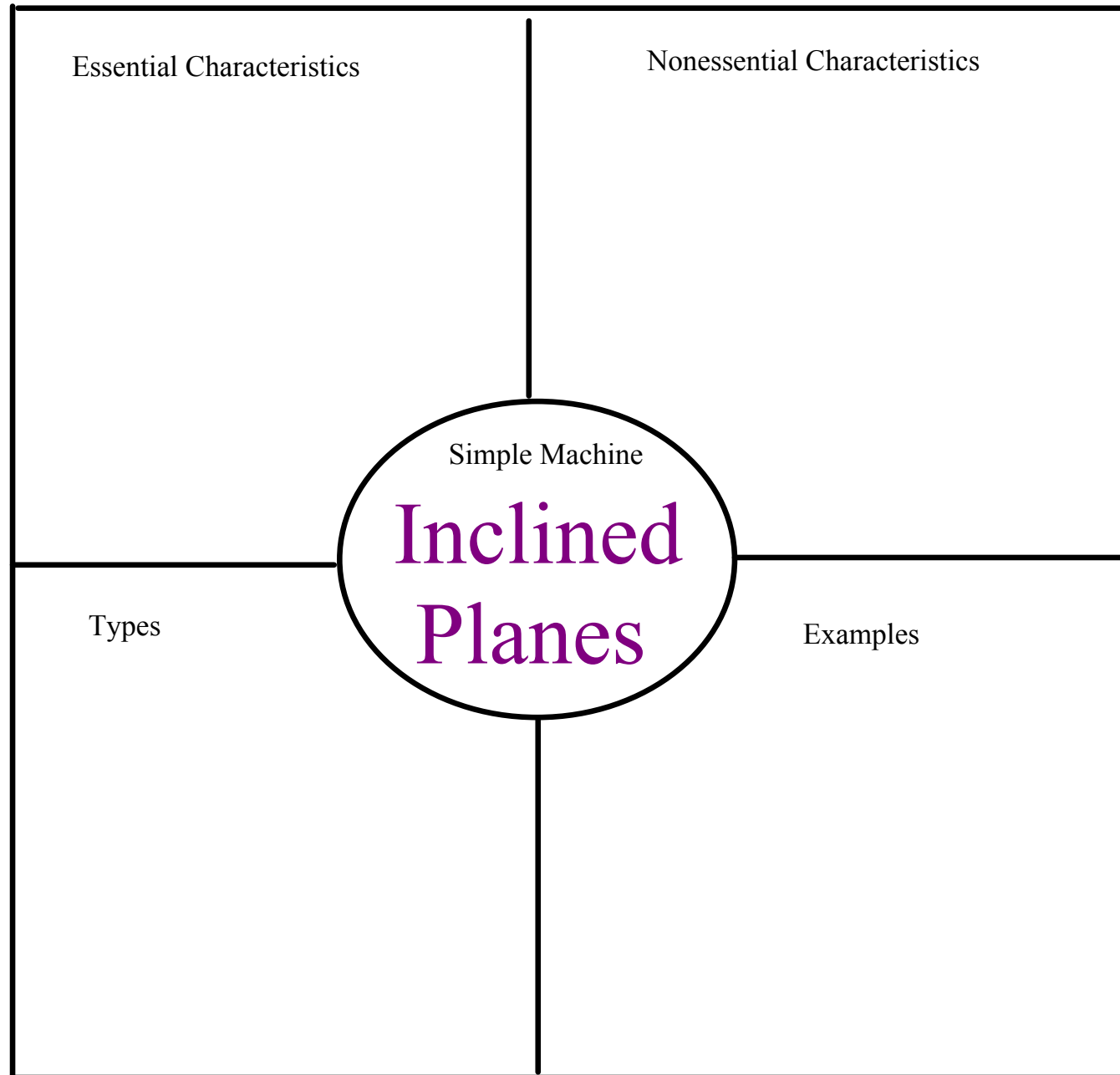
make work easier

<http://science.howstuffworks.com/pulley1.htm>

How do they do it?  $W = F \times d$

1. Increase Force  
you apply force over a greater distance
2. Increase distance (speed)  
you apply a greater force
3. Change direction of Force





# Simple Machines

## Lever

## Inclined plane

Lever

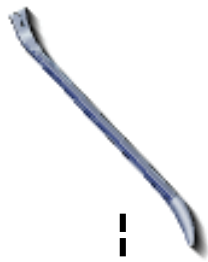
Pulley

Wheel and axle

Inclined plane

Wedge

Screw



IMA

$$\frac{L_e}{L_R}$$

#supporting strands

$$\frac{\text{Radius W}}{\text{Radius A}}$$

$$\frac{L}{H}$$



$$\frac{L}{H}$$

$$\frac{L}{H}$$

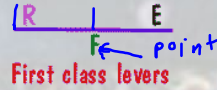
Wheel - APPLY F



Lever - bar that rotates around a pt.

1st class

In all first class lever the Fulcrum is between the Effort and Resistance (EFR).

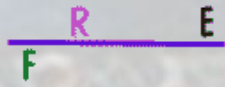


First class levers

Change direction  
Increase F  
Increase D

2nd class

R arm - fulcrum to the resistance force  
E arm - " " " effort force

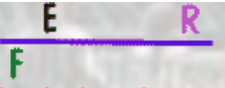


Second class levers



Always Increase Force

3rd class



Third class levers



Always Increase Speed (d)

LEVERS

How much effort is needed to lift a load?

ClickScience

START

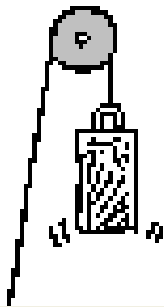
Lever - ClickScience.swf

# Pulley

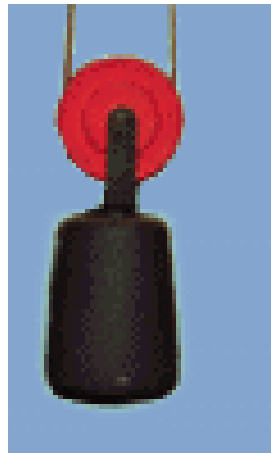
<http://science.howstuffworks.com/pulley.htm>



## Fixed



## Movable



## Block and Tackle





# ***Mechanical advantage***

***Actual***

***Ideal***

$$\text{AMA} = \frac{\text{output Force } F_R}{\text{input Force } F_E}$$

Based on  
machine

or

$$\frac{\text{input distance}}{\text{output distance}}$$

Greater than 1

Equal to 1

Less than 1

# ***practice***

***p384 1-8***

***p390 1-8***