Motion and Machine Unit Notes   Name:
DO NOT LOSE!

Energy
- Ability to do work
- To cause something to change move or directions
- Energy cannot be created or destroyed, but transferred from one form to another.
- Energy quality is lost due to friction / force/ heat.
    - -From high quality energy to low quality energy.

Newton's 1st Law of Motion
- Every object in a state of uniform motion tends to remain in that state of motion unless an external force is applied to it.

- Inertia: The property of matter by which it retains its state of rest or its velocity along a straight line.
    - -So long as it is not acted upon by an external force.

- New mini area of focus: Friction

- Friction - The resistance encountered when one body is moved in contact with another.

The four types of friction
- Static friction- friction between two surfaces that are not moving past each other.
- Sliding friction- the force that opposes the motion of two surfaces sliding past each other.
- Rolling friction- the friction between a rolling object and the surface it rolls on.
- Fluid friction- when an object is moving in liquid or gas.

Friction
- Slows an object down until it stops
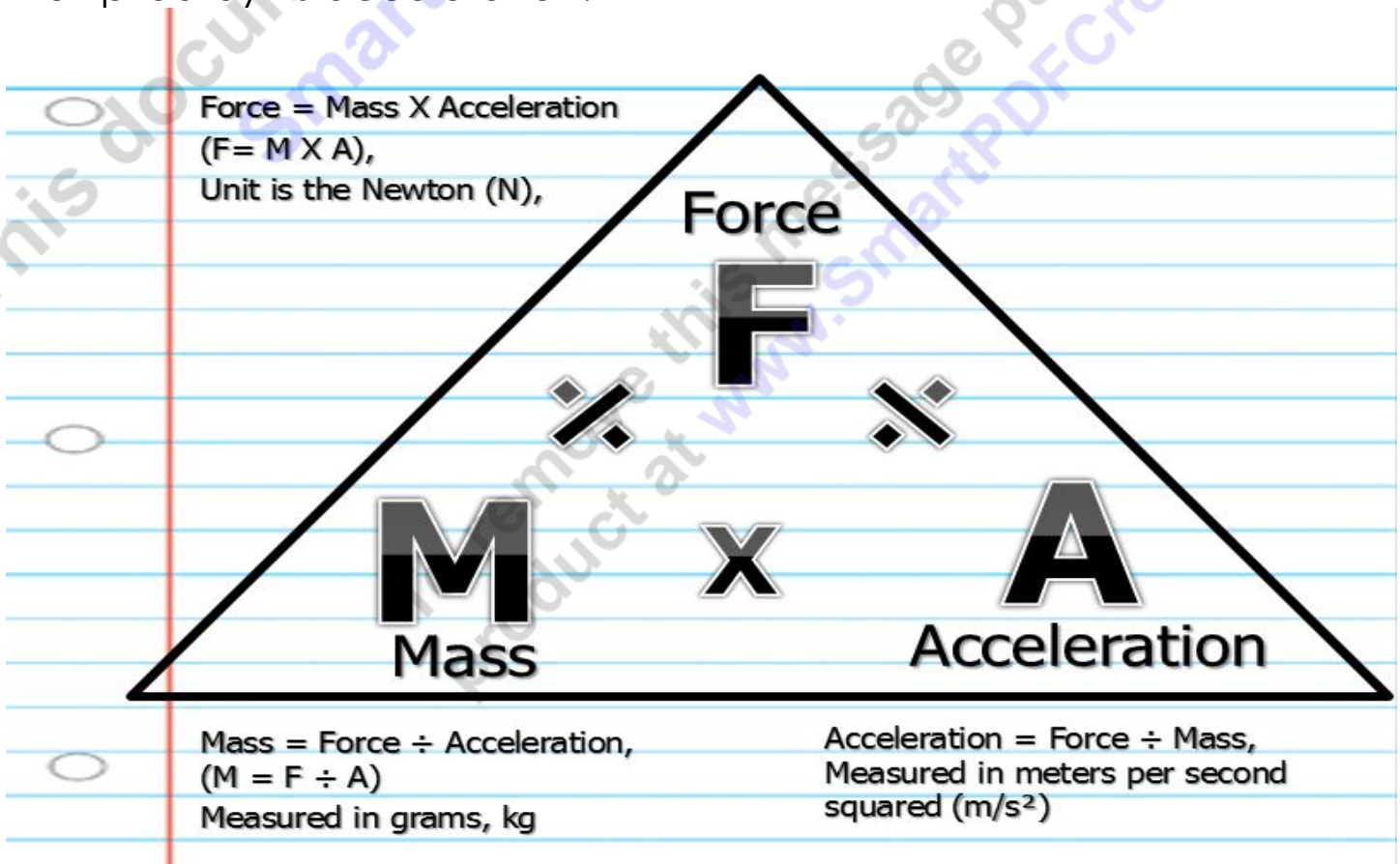- Produces heat
- Wears object down

- Aerodynamic: Designed or arranged to offer the least resistant to fluid flow.
- Hydrodynamic: A shape designed to move efficiently through the water.
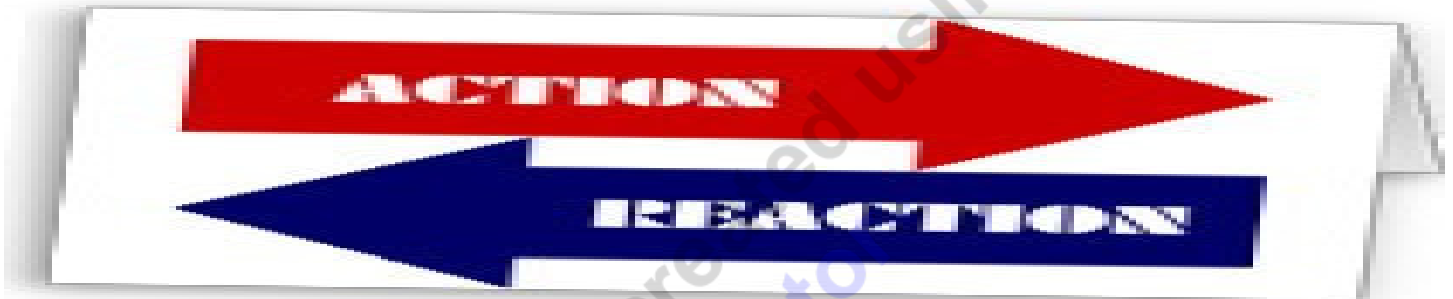
Newton's 2nd Law
- The relationship between an object's mass m, its acceleration a, and the applied force F is $F = ma$.

The net force on an object is equal to the mass of the object multiplied by its acceleration.

Force = Mass X Acceleration
(F= M X A),
Unit is the Newton (N),

Mass = Force ÷ Acceleration,
(M = F ÷ A)
Measured in grams, kg

Acceleration = Force ÷ Mass,
Measured in meters per second squared (m/s²)

3rd Law of Motion
- For every action there is an equal and opposite reaction.

Energy can either kinetic or potential.

Potential Energy: (PE) The energy stored by an object as a result of its position

- Potential Energy is the energy of position. Objects that are elevated have a high potential energy.
- Kinetic Energy is the energy of motion

PE = mgh
- PE = Energy (in Joules)
- m = mass (in kilograms)
- g = gravitational acceleration of the earth (9.8 m/s²)
- h = height above earth's surface (in meters)

- Gravity: The force of attraction between all masses in the universe.
  - The more mass an object has, the greater the force of attraction.
  - Law of Gravity $F = G M m / r^2$
  - Gravity is an attractive force between two bodies, which depends only on the mass of the two bodies (M and m) and inversely on the square of the separation between the two bodies.
    - Ex. (If you double the mass of the earth, its gravitational force will become twice as big; if you get 3 times further away from the earth, its gravitational force will be 3 times weaker.)

Kinetic Energy
- The energy that matter has because of its motion and mass.
- where m = mass of object
- v = speed of object
- KE = Energy in Joules

$$KE = \frac{1}{2} * m * v^2$$

- Don't forget your order of operations.
- PEMDAS
- For KE, you must do exponents (E) before multiplying (M). So square the velocity first, and multiply by half of the mass.

Kinetic energy
- Translational Energy: Motion from one location to another.
- Vibrational energy (sound)
- Electrical energy: Flow of electrons.
- Rotational energy.

Kinetic energy is a **scalar** quantity; as it does not have a direction.
- Velocity, acceleration, force, and momentum, are **vectors**. A quantity having direction as well as magnitude

- <u>Mechanical Energy</u> (ME) – Energy due to position and motion; sum of potential and kinetic energies. Includes heat and friction.
  - Just add Potential Energy + Kinetic Energy.

- Centrifugal Force: (Does not exist) The Force that makes feel that a force is acting outward on a body moving around a center, arising from the body's inertia.

- Centripetal Force: A force that makes a body follow a curved path.

- Hydropower – Potential to Kinetic energy

- Speed: A measure of motion, = distance divided by time. D/T

●
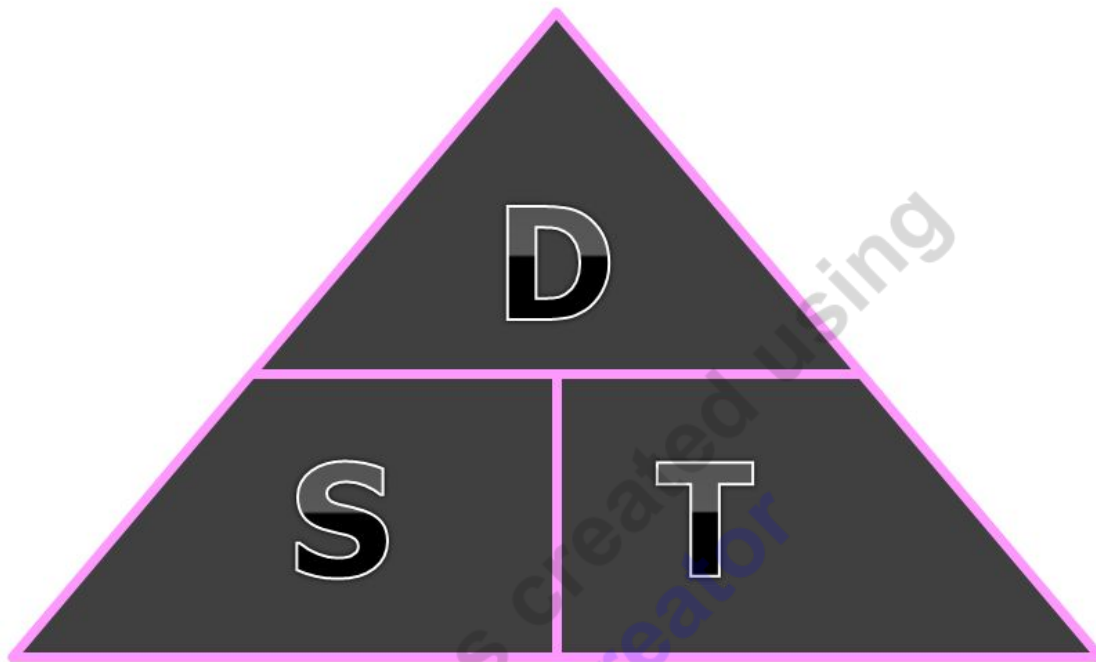
Distance = Speed * time (Multiply)
Speed = Distance divided by time
Time = Distance divided by Speed

- Velocity = Speed (distance / time) and direction.
-     velocity = Distance Divided by Time

- Acceleration = The rate of change in velocity. (m/s²)
  The final velocity – the starting velocity, divided by time.

  also... $a = (v_2 - v_1)/(t_2 - t_1)$

- Deceleration – To slow velocity.
  The same formula but value will be negative.

- Momentum: A measure of the motion of a body equal to the product of its mass and velocity.
  - Momentum = Mass times velocity
  - Law Conservation of Momentum: The momentum of an object is the product of its mass and its velocity.
  - Angular momentum: Rotating objects tend to remain rotating at the same speed / direction unless acted upon.

- When you draw the weights inward, your moment of inertia decreases, and your velocity increases (spin faster).

- Amount of Work (w) done depends on two things: The amount of Force (F) exerted.

    The Distance (d) over which the Force is applied.

- Equation for Work - w = F x d

- Joule: Unit of energy, work, or amount of heat.
    - Equal to the energy expended in applying a force of one newton through a distance of one meter.

- Catapults - By the law of conservation of energy, the stored potential energy (U) is transferred into rotational kinetic energy (K), with some loss due to friction. U = K

- Trajectory – The path of flying object: the path that a projectile makes through space under the action of given forces such as thrust, wind, and gravity.

- Force: Is a PUSH or a PULL, that causes a change in the motion or shape of an object
    - Gravity, Electricity, Magnetism, and Friction
- F = w x d.
- W = F x d

Machines...
    - Transfer force from one place to another.
    - Change direction of a force.
    - Increase the magnitude of a force.
    - Increase the distance or speed of a force.

- Machine: Anything that helps you do work.
    - Work = Force x Distance

Efficiency: A measure of how much more work must be put into a machine than you get out of the machine.

- The efficiency of a machine will always be less than 100%.
- If there was no friction, the best you could hope for is an efficiency of 100% meaning work in = work out.

- Law Conservation of energy: energy cannot be created or destroyed.

  -Simple machines generally require more work / energy to complete a task.

- Force is a quantity which is measured using the standard metric unit known as the newton
- One newton is the amount of force required to give a 1-kg mass an acceleration of 1 m/s/s.

$$1 \text{ Newton} = 1 \text{ kg} * \frac{m}{s^2}$$

Quick Cheat Sheet

- Potential Energy (PE) = mass kg * gravity (9.8 m/s²) * height (Answer is in Joules)

- Kinetic Energy (KE) = ½ mass kg * Velocity squared (velocity * Velocity) (Answer is in Joules)
    - Square velocity first because it an exponent (PEMDAS)

- Mechanical Energy (ME) = Kinetic Energy + Potential Energy (Answer is in Joules)

- Speed – A Measure of motion, = Distance divided by time (Answer in meters per second m/s)

- Velocity – Rate of which an object changes its position. = Distance divided by time and direction. (Answer in meters per second and direction such North, East, South, West, or Northwest etc.) (m/s)

- Acceleration – Change in velocity over time. Final Velocity minus the starting velocity divided by time. (Answer is in meters / sec²/ and direction North, etc. (m/s² North)

- Deceleration – Same as acceleration but the number will be negative. (m/s²)

- Mass – Amount of matter in an object. On earth, weight and mass are the same. (Metric unit is the gram)

- Force = (F=MA) F = Mass (Weight on earth) * Acceleration (Answer is in newtons (m/s)

- Work – Force * Distance the force was applied (Answer is in newtons)

New Area of Focus: Simple machines

- **Law Conservation of energy: energy cannot be created or destroyed. Simple machines generally require more work / energy to complete a task. But they….**
  - *Transfer force from one place to another.*
  - *Change direction of a force.*
  - *Increase the magnitude of a force.*
  - *Increase the distance or speed of a force.*
    - *This makes work seem easier.*

To find Mechanical Advantage
  - **Divide resistance force (usually weight in g) by the effort force (Newton)**

  - Types of machines that do work with one movement.
Pulley
  - Uses grooved wheels and a rope to raise, lower or move a load.
   Three types of pulleys
- A pulley makes work seem easier
  - Changes the direction of motion to work with gravity. Instead of lifting up, you can pull down.
  - Uses your body weight against the resistance.

- The more pulleys that are used, the more the MA (Mechanical Advantage).
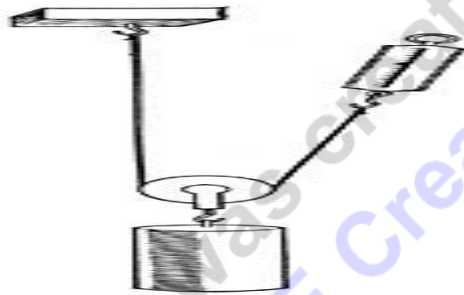- MA = The number of ropes that support the pulley. The end of the rope doesn't count.

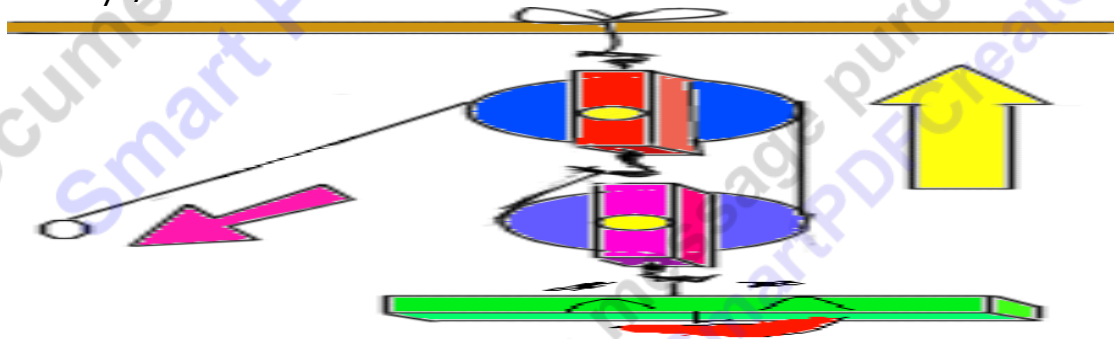The three types of Pulleys
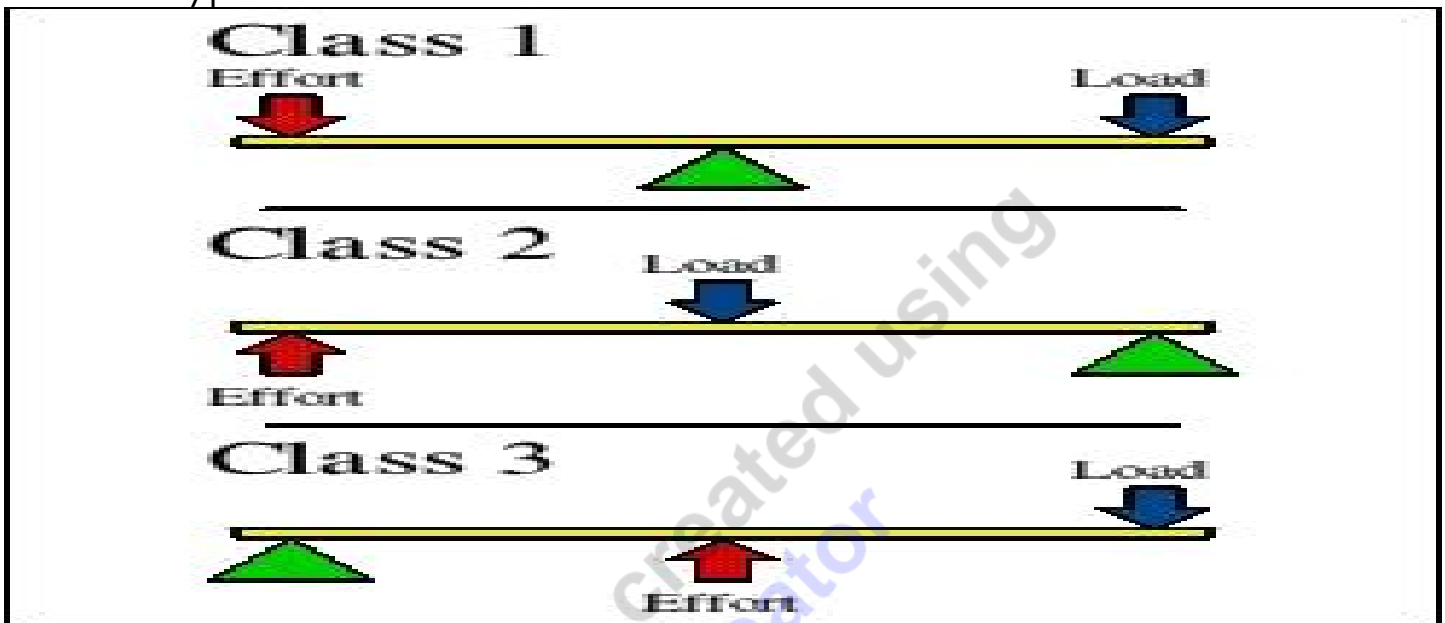　　Fixed pulley
　　No Mechanical Advantage
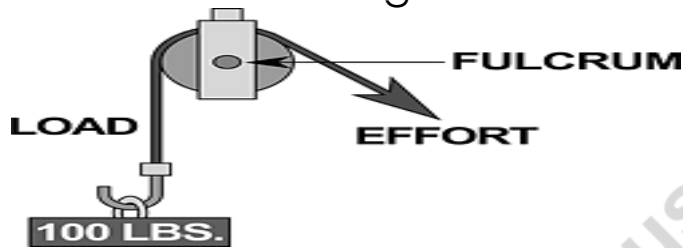
Movable Pulley

Combined Pulley / Block and tackle

Lever

- A stiff bar that rests on a support called a fulcrum which lifts or moves loads
- MA = length of effort arm ÷ length of resistance arm.

The 3 types of levers

Class 1
Effort   Load

Class 2
Load
Effort

Class 3
Load
Effort

Third Class Lever.

- Has Mechanical Disadvantage.
- Requires more force to lift the load.

- Wedge: An object with at least one slanting side ending in a sharp edge, which cuts material apart.
  - The mechanical advantage of a wedge can be found by dividing the length of the slope (S) by the thickness (T) of the big end.

- Wheel and Axle: A wheel with a rod, called an axle, through its center lifts or moves a load.
  - The mechanical advantage of a wheel and axle is the ratio of the radius of the wheel divided by the radius of the axle.
  - Radius: A straight line from a circles center to its perimeter.

Wheel

Axle

1" 5"
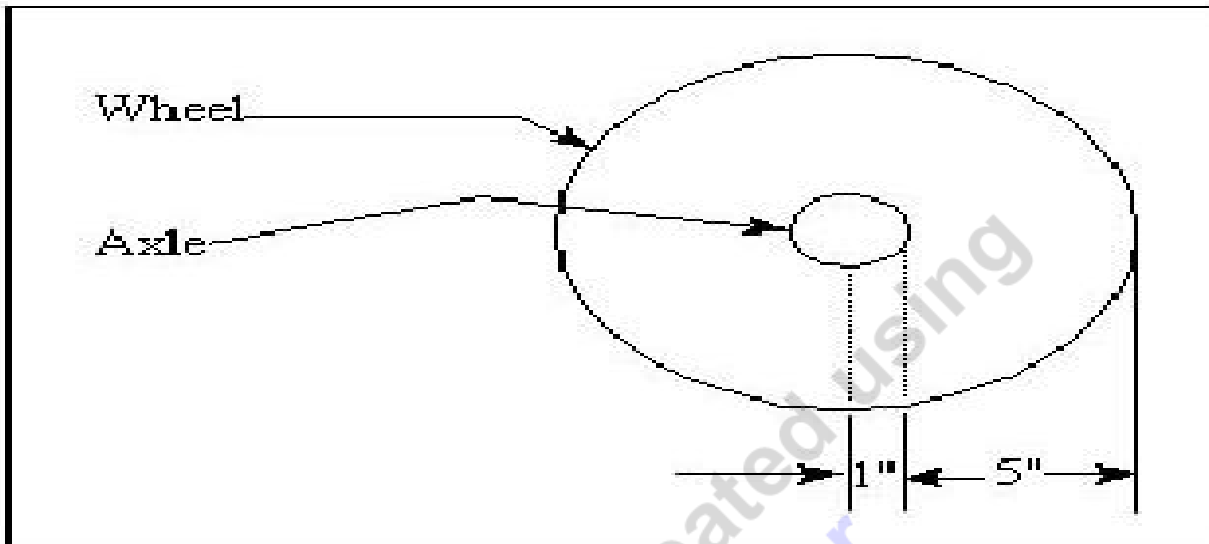
Divide 5 by 1

- An Inclined plane: A slanting surface connecting a lower level to a higher level
    - MA for an inclined plane is the length of the slope divided by the height (Rise).

Length

Rise

Run

- Screw: An inclined plane wrapped around a pole which holds things together or lifts materials.
    - The mechanical advantage of a screw can be found by dividing the circumference of the screw by the pitch of the screw.

- The circumference of a circle is the distance around the circle. It is the circle's perimeter. The formula for circumference is:
    - Circumference = **π** times Diameter
    - C = πd
    - Where π = 3.14
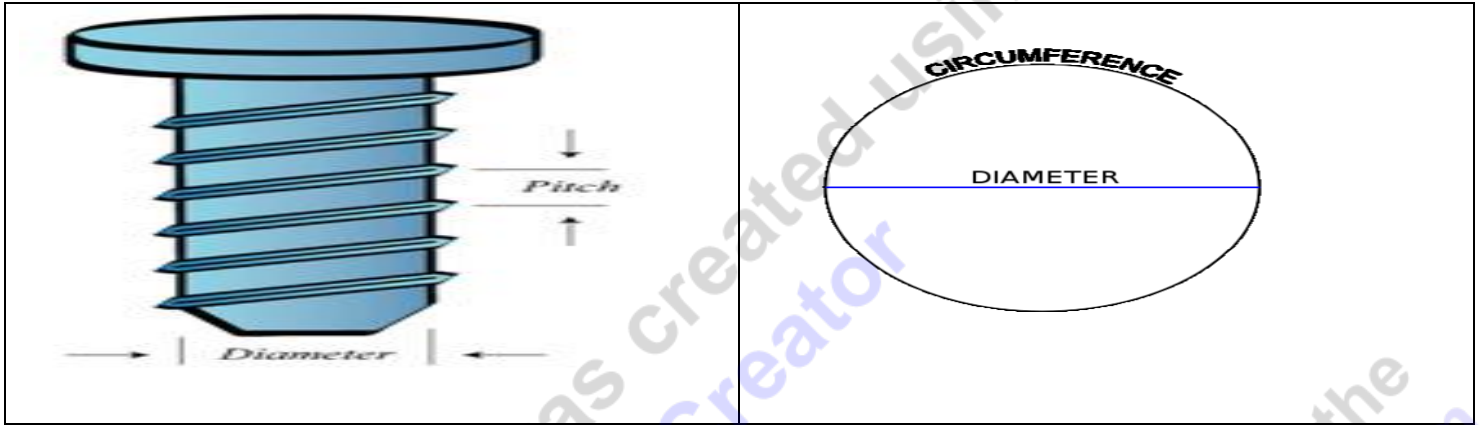
- Compound machines: Two or more simple machines working together.

DO NOT LOSE THESE NOTES! PLEASE PUT THEM IN YOUR SCIENCE FOLDER!