

# Work, Power and Machines

# What is work?

- Work is a Force applied over a distance (displacement)
- The Force must be applied in the same direction as the displacement
- If the object doesn't move (no displacement) then no work is done

$$W = F \cdot d$$

- Work is equal to the force applied to the object times the distance it travels
- Units: Force is measured in [N] and distance is measured in [m]
- So  $W = Fd = [\text{Nm}] = [\text{J}]$  ← Joules

# Weight

- We have already discussed weight, so what is the equation?
- $F_w = mg$
- The weight of an object is a measure of the affect of the gravitational Force
- The greater the weight of an object the greater the work required to lift it

# Power

- The rate at which work is done
- $P = \frac{W}{t} = \frac{[J]}{[s]} = \text{Watts (W)}$
- Time is *inversely* proportional to power
- More time required equals less power, and vice-versa

# MACHINES

- Machines change the amount of Force needed to do work by increasing the distance
- Mechanical Advantage: The ratio of the input force to output force, or input distance to output distance

# Mechanical Advantage

- $MA = \frac{F_r}{F_e} = \frac{d_e}{d_r}$

- Lets cross multiply...

- $W_r = F_r d_r$       and       $W_e = F_e d_e$        $W_e = W_r$

- The work MUST remain the same

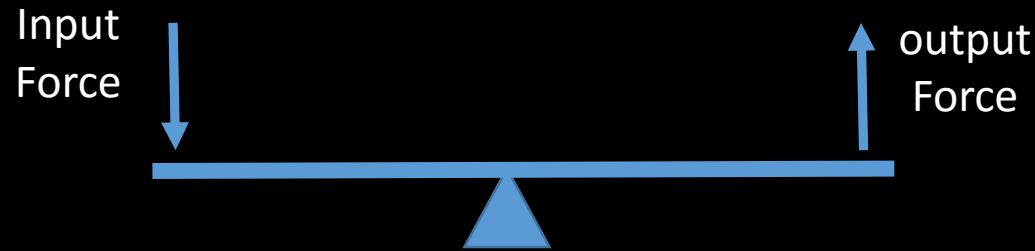
# The Simple Machines

- Lever
- Pulley,
- Wheel and Axle
- Inclined plane
- Wedge
- Screw

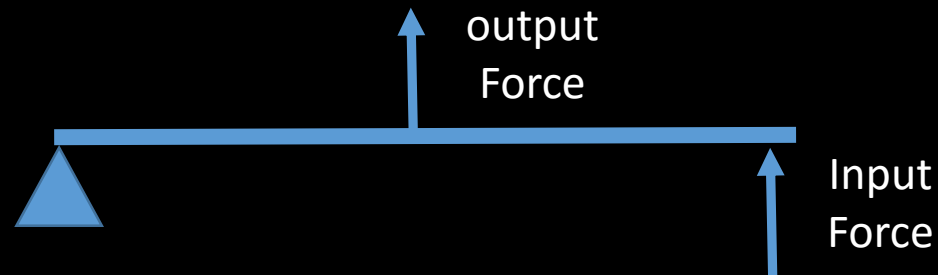


# Lever Classes

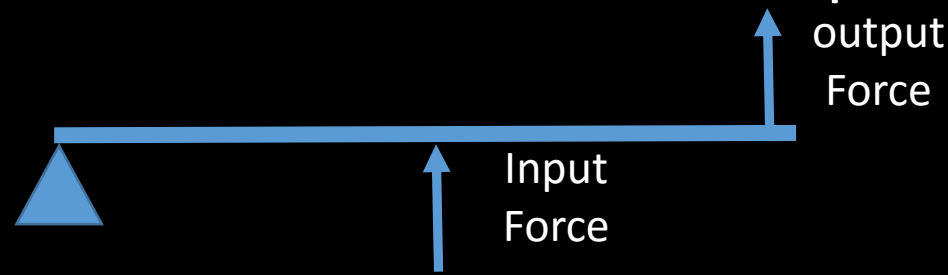
- 1<sup>st</sup> class: Fulcrum between the points of application



- 2<sup>nd</sup> Class: Fulcrum is at one end and the input is further away



- 3<sup>rd</sup> Class: Fulcrum is at one end and the output is further away



# Pulleys

- Each Pulley used Multiplies the Force by the Number of pulleys
- If you have 1 Pulley  $MA = 1$
- If you have 3 Pulleys  $MA = 3$

# Wheel and Axle

- A lever connected to a shaft
- A small force turns the wheel and turns a larger object on the other side of the shaft
- Your steering wheel is a wheel and axle

# Inclined plane

- Helps counter-act the weight force
- Requires a Force less than the weight force to lift something a distance

# Wedge

- A modified Inclined Plane
- They turn Downward forces into directional forces
- An axe blade is a wedge



# Screw

- An inclined plane wrapped around a cylinder
- Drill bits, jar lids

# Compound Machines

- Any mechanical device is a compound machine
- A compound machine is a machine made up of multiple simple machines
- Even car engines are compound machines... they just have a boat load of simple machines all working together