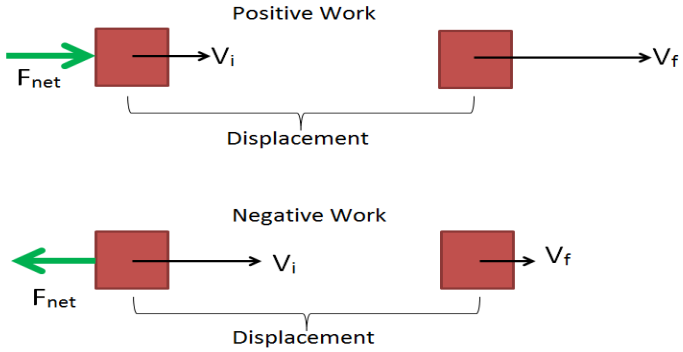
Chapter 4: Work and Energy

Section 1: Work and Machines

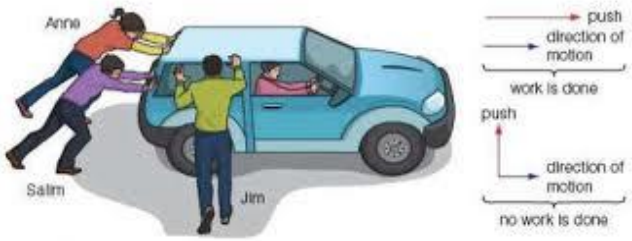
Work means to do something to earn money

Work: (symbol W)

- According to physics, work is done when a force is applied through a distance
- W = F*d
  - Force is constant
  - Label for work is N*m = Joule
    - SI unit for work
- The application of a force alone does not constitute work
  - Force and distance need to be in the same direction (+work) or in opposite directions (-work)
  - Force and distance need to be parallel to each other



  - A force applied perpendicular to the direction of motion does not constitute work being done to the system
    - Ex. You are in an airplane flying west. You push down on your seat. You are not doing work on the airplane (system). You are doing work on yourself.



Machine: a device that makes tasks easier by changing either the magnitude or the direction of the applied force

- Changes the forces or increases the motion from work

Simple machines: a machine that does work with only one movement of the machine

- 6 types of simple machines:
  - Lever
  - Pulley
  - Wheel and axle
  - Inclined plane
  - Screw
  - Wedge

Compound machine: a combination of two or more simple machines

- Examples include a pair of scissors or a bicycle

Efficiency: ratio of output work to input work

- Measured in percent
- You put more work into a machine than you get out of the machine
  - Fundamental scientific law that cannot be broken by building better machine
- Efficiency (%) = $\frac{\text{output work (in joules)}}{\text{input work (in joules)}} \times 100$
- You can make machines more efficient by reducing friction (adding a lubricant)
- All machines are less than 100% efficient

Machines are useful

- Increase speed
  - You can travel more quickly by riding a bicycle than on foot.
- Change the direction of force
  - An ax changes the downward force of the ax to the outward forces that split the wood sideways.

- Increase force
  - A car jack increases force but decreases speed.
  - Your force on the jack is less than the force exerted by the jack even though you have a greater distance to push compared to the distance the car is raised.
  - **Mechanical advantage:** the ratio of the output force to the input force
    - mechanical advantage (MA) = $\frac{\text{ouput force (in Newtons)}}{\text{input force (in Newtons)}}$
    - The output force is the force that the machine applies to another object
    - The input force is the force a person applies to the machine
    - Mechanical advantage of the car is greater than one