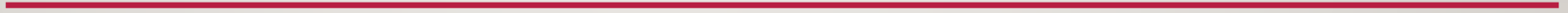# WORK & POWER

WHAT IS WORK?

- Work is the energy transfer that takes place when a force causes an object to move.

> **work done = force applied × distance moved in direction of force**
>
> *W = FD*

- work done is measured in joules (J)
- force is measured in newtons (N)
- distance is measured in metres (m)

AM I DOING WORK?

- In scientific terms, work is done when a force is applied to an object, causing it to move in the direction of the applied force.

- Doing work: lifting a stack of books; a force is exerted upwards, and the books move upward.

- Not doing work: holding a stack of books: you are exerting an upward force on the books, but the books re not moving.

- Not doing work: Carrying the stack of books across the room: you area exerting an upwards force on the books, but the books are moving horizontally across the room.

IS WORK BEING DONE?

- Picking up a heavy box

- Doing pushups

- Leaning against the wall

- Pushing a child on a swing

- Sitting in a chair

CALCULATING WORK

- Work = Force (in Newtons) x Distance Moved (in meters)

- Work is measured in Newton meters (N•m), which is the same thing as a scientific unit called a Joule (J)

- If you exert one Newton of force to move an object one meter, you have done one joule of work.

EXAMPLE: WHO IS DOING MORE WORK?

- Same lifts a 100 N plant 0.5m from the ground onto a bench, while Eddie lifts a 75 N plant 1.0 m from the ground onto a table.

- W=FD

  F= 100 N

  D= 0.5m

  W= (100N)(0.5m)

   = 50 N•m

Sam did 50 J of work

W=FD

F=75 N

D= 1.0 m

W=(75N)(1.0M)

   = 75 N•m
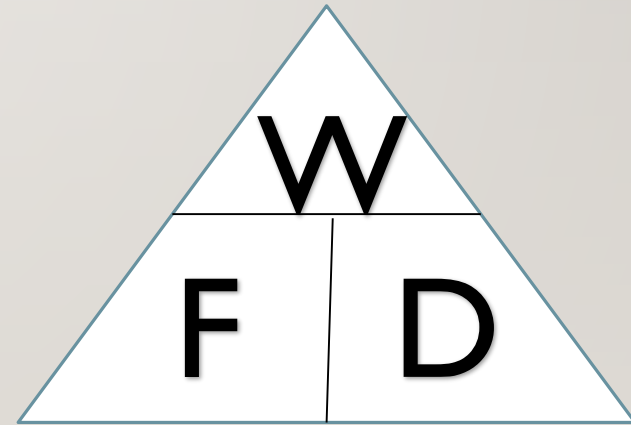
Eddie did 75 J of work

CALCULATING UNKNOWN QUANTITIES

- You can use the magic triangle to calculate Force and distance.

- 55,000 J of work is done to move a rock 25m. How much force is applied?

1 J = 1 N•m

W= 55,000 N•m

D= 25m

F= $\underline{W}$ = $\underline{55,000 \text{ N•m}}$ = 2200N

    D   25 m

WORK & TIME = POWER

- The amount of work done on an object is not affected by how long it takes to do the work; you will still do the same amount of work carrying a stack of books up the stairs if you walk or run.

- Power is the amount of work done on an object per unit of time, therefore the more power applied to do work, the faster the work gets done.

CALCULATING POWER

- Power is measured in N•m/s, which is called a watt (W)
  - 1 W of power is used to exert 1 N of force to move an object 1m in 1 second.
  - 1W = 1 J/s

- A watt is a very small unit of power, so power is often measured in kilowatts (kW)
  - 1000 W = 1 kW
  - Electricity is billed in killowatts per hour.

- Engine power is measured in horsepower (not a scientific unit.)
  - 1 hp = 746 W; when the steam engine was developed a contest was held that determined that it would take 746 horses to do the same amount of work as the engine could do in one hour.

CALCULATING POWER

- Power = $\underline{\text{work}}$ or Power = $\underline{\text{force x distance}}$

          time   time

- a tow truck exerts a force of 11,000 N to pull a car out of a ditch. The car moves a distance of 5 m in 25 seconds. What is the power rating of the tow truck's winch?

- F=11,000 N   P= $\underline{\text{(force)(distance)}}$

    D= 5 m   (time)

    t= 25 s   P= $\underline{\text{(11,000 N)(5m)}}$ = $\underline{\text{55,000 J}}$ =2200 J/s

                                                  (25 s)   25 s

    P= 2200 W of 2.2 kW

CALCULATING UNKNOWN QUANTITIES

- You can also use the magic triangle to calculate power

How much work is done by a 75 W hair dryer that is used for 25 minutes?

1 W = 1 J/s   W=(P)(T)

P= 75 J/s   =(75 J/s)(1500s)

T= 25 m (60s)=1500 s   =112,500 J