Unit 7: Work, Energy and Power

1 - Work

Energy: the ability to do work.

Work and energy are:

Scalar values

Measured in Joules (J)

Work can be defined as either:

A change in Energy or The product of... Force and distance

$W = \Delta E$

$W = Fd$

In physics we talk about work being done... on an object.

Ex.

- ☐ If I hold a 30 kg weight at a height of 1.5 m, I'm using energy, therefore...
- ☐ However the work is **not** being done on the weight, it is being done on my muscles.
- ☐ *Think of it like this: though I am exerting a force on the weight, its distance moved is zero, therefore NO work is done on it.*

Ex. If I were to lift the 30.0 kg weight up off the ground to a height of 1.5 m, how much work would be done on the weight?

$W = mg\Delta h$

$= (30.0\text{kg})(9.80\text{m/s}^2)(1.5\text{m})$

$= 440\text{ J}$

When an object is lifted against gravity the formula:

W = Fd

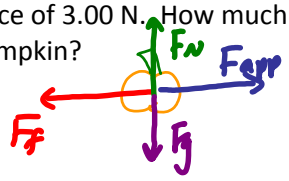
$W = mg\Delta h$

Where: m = mass

g = acceleration due to gravity

Δ h = change in height

Ex. A 10.0 kg pumpkin is moved horizontally 5.00 m at a constant velocity across a level floor using a horizontal force of 3.00 N. How much work is done in moving the pumpkin?



$W = F_{app}\, d$

$= (3.00\text{N})(5.00\text{m})$

$= 15.0\text{ J}$

Note: Use applied force, not net force

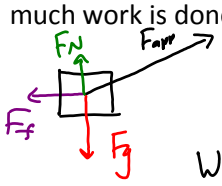
Ex. A 3.0 kg pineapple is held 1.2 m above the floor for 15 s. How much work is done on the pineapple?

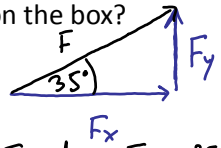
$W = Fd$ ← zero distance covered

$= 0\text{ J}$

Note: No distance means no work

Ex. A 50.0 kg banana box is pulled 11.0 m along a level surface by a rope. If the rope makes an angle with the floor of 35° and the tension in the rope is 90.0 N, how much work is done on the box?



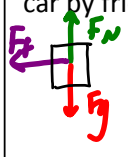


$W = F_x\, d = F\cos 35\, d = 811\text{ J}$

Note: Use on the component of the force that is in the direction of displacement

ie. if we move in the x-direction then we only use F_x.

Ex. A 1385 kg car traveling at 61 km/h is brought to a stop while skidding 42 m. What is the work done on the car by frictional forces?



$v = 0$

$v_0 = 16.94$

$a = ?$

$d = 42$

$a = \frac{v^2 - v_0^2}{2d}$

$= -3.42\text{ m/s}^2$

$F_{net} = F_f = ma = -4737\text{ N}$

$W = F_f d = -2.0 \times 10^5\text{ J}$

Note: Work can be negative if the force doing the work acts in the negative direction.