December 6, 2018

4.4 Work

Energy: The ability to do work. Work and Energy are scalar values measured in Joules (J). =

Work can be defined as either:

1) A change in Energy OR 2) The product of Force and Distance

$$W = \Delta E \qquad\qquad W = Fd$$

In physics, we talk about work being done on an object . If I hold a 30 kg mass at a height of 1.5 m, I'm using energy so I must be doing work BUT... the work is NOT being done on the weight . The work is done on my muscles; the energy contained by the mass is not changing.

Think about it like this: though I am exerting a force on the weight, its distance moved is zero , therefore NO work is done on it.

When an object is lifted against gravity, the formula

$$W = Fd \quad \text{becomes} \quad W = (\overset{F}{\text{mass x}}\ \text{accel.}) \text{ x } \overset{d}{\text{height}}$$

$$W = mg\Delta h$$

$J = [kg][m/s^2][m]$

$J = [kg\,m^2/s^2]$

or $[N \cdot m]$

where: m = mass

$9.8\ m/s^2$

g = acceleration due to gravity

Δh = change in height

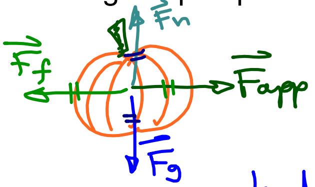
ex. If I were to lift the 30.0 kg mass up off the ground to a height of 1.5 m, how much work would be done on the weight?

$$W = mg\Delta h$$
$$= (30.0)(9.8)(1.5)$$
$$= 440\ J$$

2 S.F.

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?

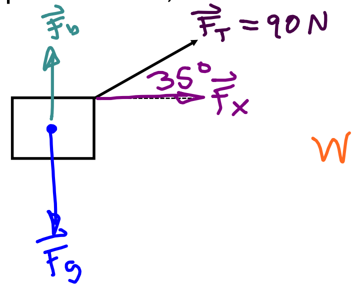
$\vec{F}_{net} = 0$



$$W = \vec{F}_{app} \times d$$
$$= (3.00\ N)(5.00\ m)$$
$$= 15.0\ J$$

note: it is the applied force, not the Net force doing the work. Otherwise, at constant velocity, $\vec{F}_{net}$ = 0 and no work would ever be done!!!

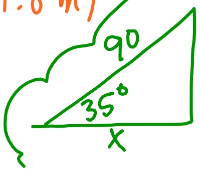
ex. A 50 kg box of bananas is being pulled 11.0 m along a level surface by a rope. If the rope makes an angle of 35° with the floor and the tension in the rope is 90.0 N, how much work is being done on the box?



$$\vec{F}_x = 90 \cos 35°$$
$$= 73.72\ N$$

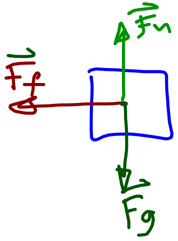
$$W = F_x d = (73.72\ N)(11.0\ m)$$
$$= 811\ J$$

$$\cos 35° = \frac{x}{90}$$



note: use the component of the applied force that is in the direction of displacement. If the object moves in the x-direction, use only $\vec{F}_x$.

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



$$W = \overset{?}{F} d ✓$$
$$F = m\vec{a}?$$

$V_2 = 0$

$V_1 = 61 km/h = 16.9\overline{4} m/s$

$\Delta d = 42 m$

$a = ?$

$$v_2^2 = v_1^2 + 2\vec{a}d$$
$$\vec{a} = \frac{v_2^2 - v_1^2}{2d}$$
$$= \frac{0 - (16.9\overline{4})^2}{2(42)}$$
$$= -3.42\ m/s^2$$

$$\therefore \vec{F}_f = m\vec{a}$$
$$= (1385\ kg)(-3.42\ m/s^2)$$

note: work can be negative if the force doing it acts in the negative direction.

practice: handout - Work #1-10

$$= -4734\ N$$

Now: $W = Fd$

$$= (-4734)(42)$$
$$\boxed{W = -2.0 \times 10^5\ J}$$