# Work, Power, Efficiency

Tuesday, April 12, 2016 12:16 PM

# Work and Power


$W = F \cdot d \cos\theta$

$= mad$

**Definition of Work:**

$W = \Delta E$

$W = $ Area under graph

**Definition of Power:**

$P = \frac{\text{Work}}{\text{time}} \rightarrow \frac{J}{s} = \text{Watt} = W$

The average speed of a MLB fastball is 42m/s. To get a home run (clear the park) you need to hit the ball with at least a velocity of 30.6m/s. How much work is done by the batter? $m = .2$

$W = \Delta E = \Delta E_p + \Delta E_k$

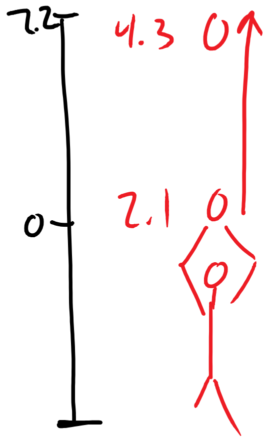
$= 0 + \frac{m v_f^2}{2} - \frac{m v_i^2}{2} = \frac{m}{2}(v_f^2 - v_i^2)$

$\neq (v_f - v_i)^2$

$= \frac{.2}{2}(30.6^2 - (42^2))$

$= 270\ J$

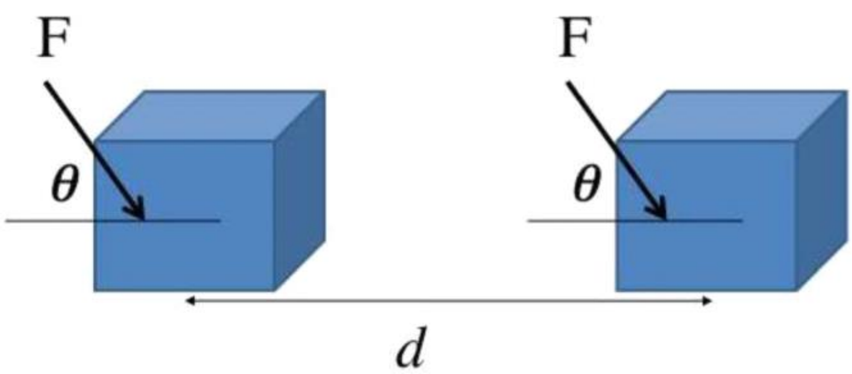
When Kyle plays volleyball he does not spike the ball every play. Sometimes he is a team player and sets up his team mate so that they can spike the ball too. If Kyle sets up the ball to a height of 4.3m and a volleyball weighs .275kg. How much work has Kyle done if he hit the ball from a height of 2.1m?




$$w = \Delta E = mgh_f - mgh_i$$
$$= mg(h_f - h_i)$$
$$= (.275)(9.81)(2.2)$$
$$= 5.93\ J$$

That was too easy. Let's do a tricky one.

The only force we care about is the force that is causing the ΔE.




If the force is 52N and θ is 60° and the distance is 12m. What is the work done?

$$W = Fd\cos\theta$$
$$= 52(12)\tfrac{1}{2}$$
$$= 312\ J$$

## MORE POWER NEEDED


$$Power = \frac{Work}{Time} = \frac{J}{s} = Watt = W$$

One common measurement of power is the horsepower (hp). It is good to note that 1hp $\approx$ 750W. Also important is that one horse has roughly 15hp…

A 100W lightbulb operates for one hour. How much work was done?

$$P = \frac{W}{t} \qquad 100 = \frac{W}{3600}$$

$$W = 360000$$
$$= 360 \text{ kJ}$$

☆ confirmed.

Abbey is pulling Alley in a wagon. She pulls her for 10m. She pulls at an angle of 32° and applies a force of 210N for 20s. What power does Abbey produce?


$$W = Fd\cos\theta$$
$$= 210(10)\cos(32)$$
$$= 1780 \text{ J}$$

$$P = \frac{W}{t} = \frac{1780}{20} = 89 \text{ Watt}$$

In Kelowna we pay at most \$0.15 per kW*hr.
Does your Mom tell you to turn off the lights?
Let's run a 60W (old style) light bulb for 8 hours.

60 W → .06 kW for 8 hours

.06 kW · 8 hours · \$15

\$.07

## Efficiency:

This is how much of the energy that you put into a system is the energy that you want. Some will be wasted.

$$Eff = \frac{Useful\ Out}{Total\ In} x100\%$$

Look at the total amount of energy that you put into a system, and decide how much of that is what you want.

A 60W light bulb produces 15W of light energy. What is its efficiency?

$$E_{ff} = \frac{15}{60} = 25\%$$

An Easy Bake oven uses this same light bulb to make cupcakes. What is its efficiency?

$$E_{ff} = \frac{45}{60} = 75\%$$

Chris drops a 5kg watermelon off of a tall building [redacted](20m) and it strikes the ground with a velocity of 15.0m/s. How much energy is lost as heat ($E_H$)? And, what is the efficiency of the fall?

$$E_{po} + E_{ko} = E_{pf} + E_{kf} + E_H$$

$$5(9.8)(20) + 0 = 0 + \frac{5(15)^2}{2} + E_H$$

measured

$$E_H = 418\text{ J}$$

$$E_{ff} = \frac{\text{useful}}{\text{total}} = \frac{\left[\frac{5(15)^2}{2}\right]}{5(9.8)(20)} = 57\%$$