PHYS 2010 LECTURE 21

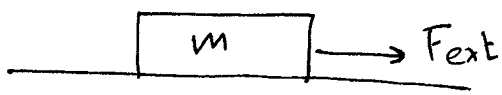
More on work, energy:

Recall: $W_F = |F||\Delta s|\cos\theta$; $KE = \frac{1}{2}mv^2$; $PE_{grav} =$

Units of work, energy = J = N·m = $\frac{kg\,m^2}{s^2}$

$W_{external} = \Delta KE + \Delta PE$: <u>conservation of energy</u>!

A basic example: Book on a horizontal, frictionless table:



$\Delta PE = 0$, since height is constant.

Take $V_i = 0$; V_f is V after moving Δx. Constant $\vec{F} \rightarrow$ const. $\vec{a}$.

$$V_f^2 = V_i^2 + 2a(x_f - x_i)$$

$$= 0 + 2\frac{F_{ext}}{m}\Delta x$$

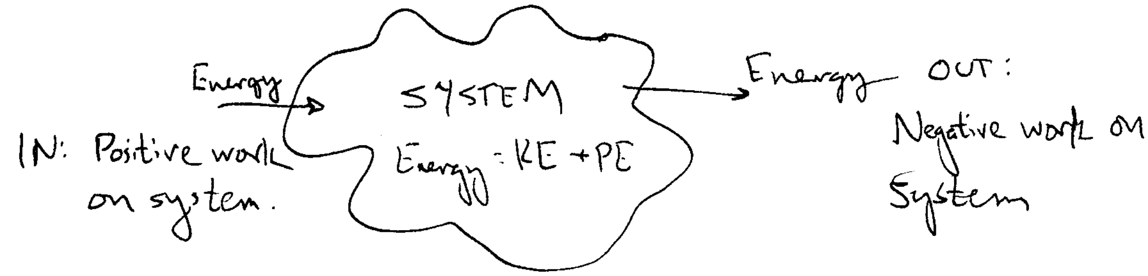
$$V_f^2 = \frac{2F_{ext}}{m}\Delta x$$

But $\Delta KE = KE_f - KE_i = \frac{1}{2}mv_f^2 - 0$

$$= \frac{1}{2}m\left(\frac{2F_{ext}\Delta x}{m}\right) = F_{ext}\Delta x = W_{ext}.$$

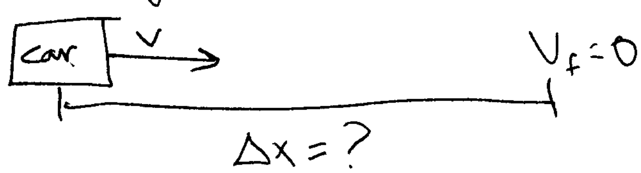
→ Newton's Laws can be used to prove $W_{ext} = \Delta(KE + PE)$ in <u>all</u> circumstances where there is no internal dissipation.

Think of work as "energy input."



Can still use work, energy if friction exists — but must define the "system" appropriately. Just make sure the friction is an <u>external</u> force:

Car skidding to a stop:



What is the work done by friction? Looks as if not enough info. Don't know the time it took or even how far Δx it took!

Start with $|W_{fric}| = |\Delta E_{mech}| = |\Delta KE| = \frac{1}{2}mv^2$

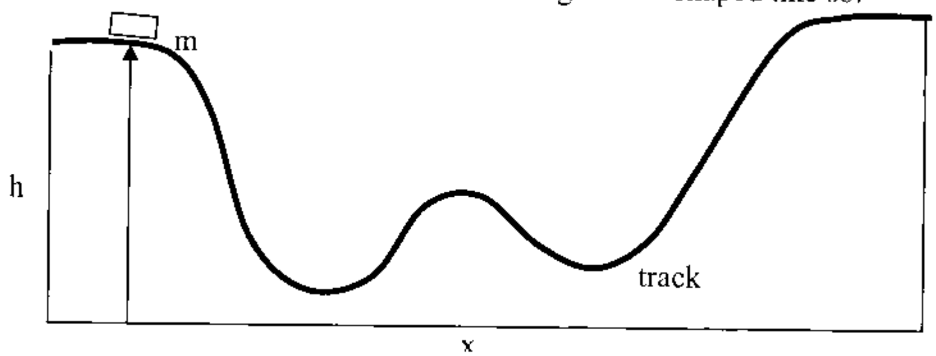
Now, take $|W_{fric}| = F_{fric}\Delta x = \mu_k N \Delta x = \mu_k mg\Delta x$:

$$\frac{1}{2}mv^2 = \mu_k mg\Delta x \implies \Delta x = \frac{v^2}{2\mu_k g}$$

So if speed is doubled, car skids 4 times as far.

KE+PE=total energy graphs

Suppose a roller coaster of mass m rolls along a track shaped like so:



The shape of the track is a graph of height h vs. horizontal position x. Since the gravitational potential energy of the coaster is PE = mgh, where mg is a constant, a graph of PE vs. x looks the same as the graph of h vs. x, but the vertical axis measuring energy (joules) rather than height (meters). Assuming no friction, the total mechanical energy E_{tot} = KE+PE of the roller coaster remains constant as it rolls along the track. We can represent this constant energy with a horizontal line on our graph of energy vs. x. From this "energy graph", we can read the KE and the PE of the coaster at any point.