Phys 2110-4 2/25/13

Note Title 2/25/2013

Ch 6 Ch 7

Energy, Momentum

(Work)

Definitions — Work

Energy

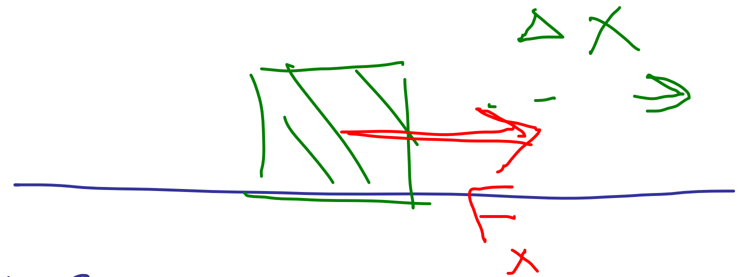
⋮

Theorems — Conservation of energy,

momentum

Work

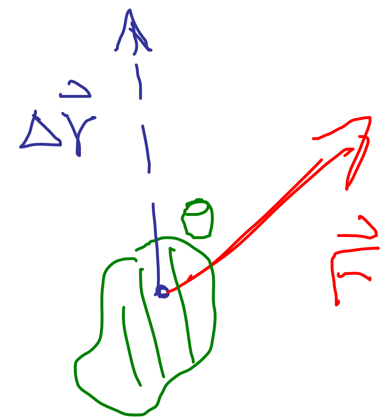
1D motion, constant



Work done by this force:

$$W = F_x \Delta x$$

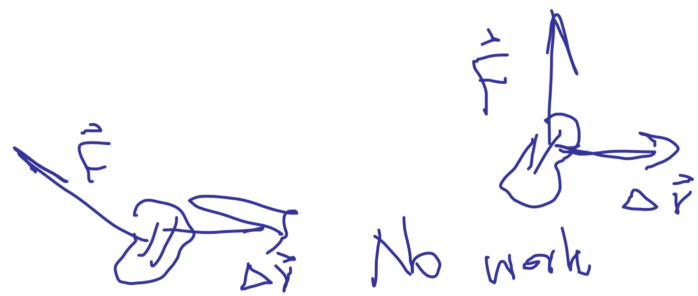
More general case ($\vec{F}$ const)



$$W = F|\Delta\vec{r}|\cos\theta$$

Work is a scalar

Could be pos or neg



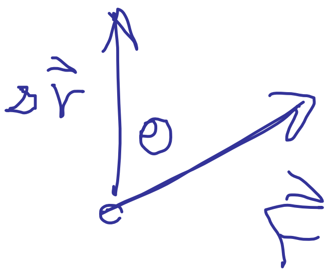
Units?
Units?

$W = F \cdot x$

$= N \cdot m$

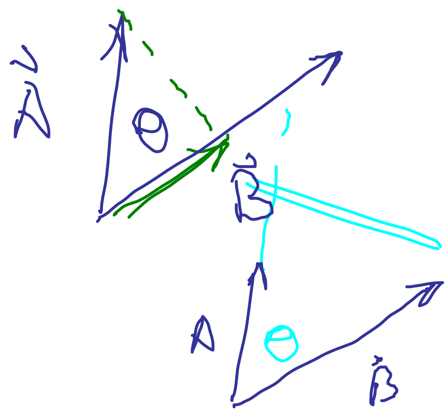
Units of W are $N \cdot m = \frac{kg\, m^2}{s^2} = 1\,J$

Joule



$F|\Delta \vec{r}| \cos\theta$

$AB\cos\theta = \vec{A}\cdot\vec{B}$

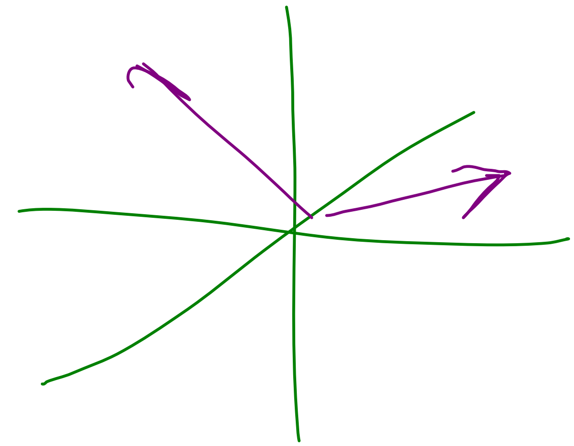


Product of one magnitude & parallel comp of other vector.

$$\vec{A}\cdot\vec{B} = AB\cos\theta$$

$$= \underbrace{A_x B_x} + A_y B_y + \underbrace{A_z B_z}$$

$$\cos\theta = \frac{\vec{A}\cdot\vec{B}}{A\ B}$$



Other units for energy/work

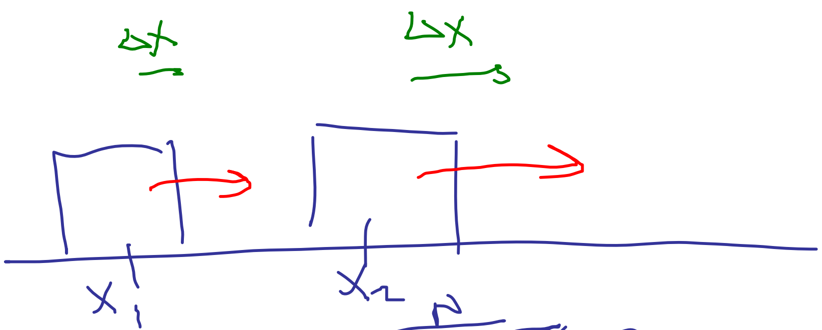
1 J   Also $\frac{g\cdot cm^2}{s^2} = 10^{-7}\ J = 1$ erg

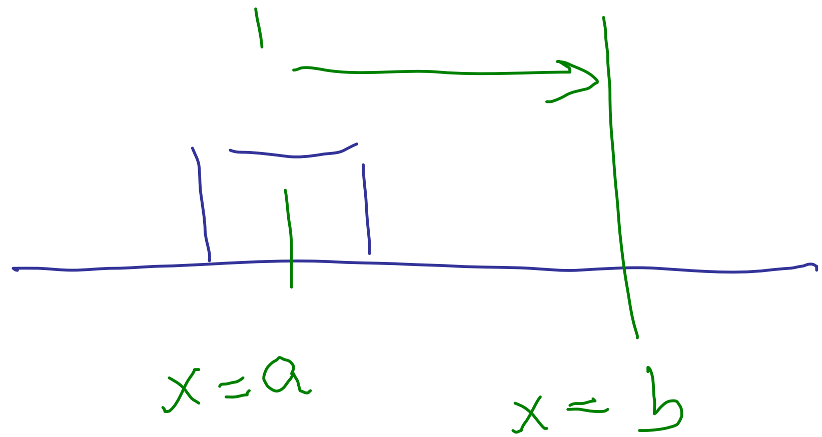
ft · lb = ft · lb   1 eV = 1.602×10^{-19} J   1 Btu = 1.054 kJ

electron volt

Work is basically force · distance $\quad F \cdot \Delta x$

Force not constant

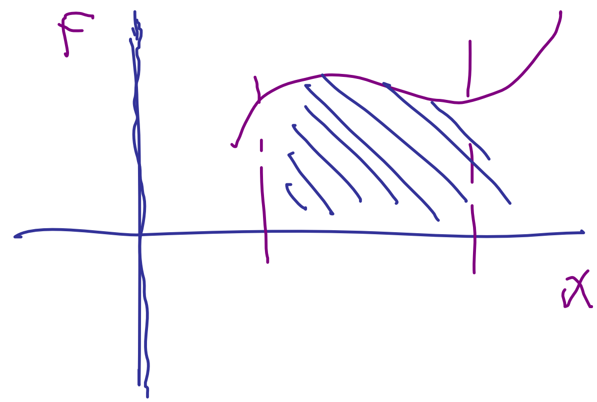




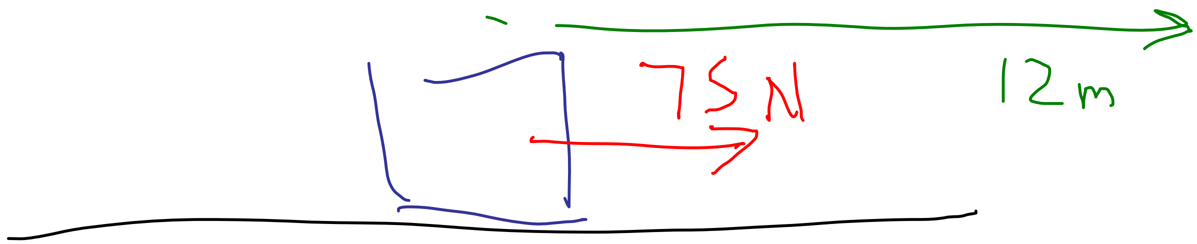
$$W = \sum_{i=1}^{n} F(x_i)\,\Delta x_i$$

Δx's $\to$ small

$$\Rightarrow \int_a^b F(x)\,dx$$



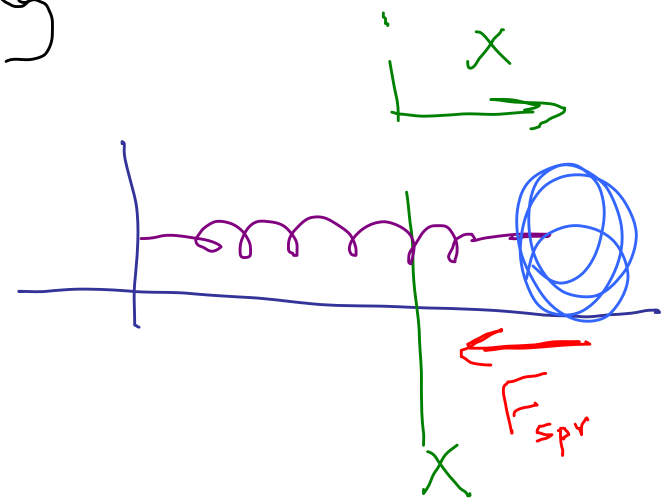
6.11 How much work do you do as you exert a 75-N force to push cart through 12-m long aisle



$$W = F\Delta x = 900\ J$$

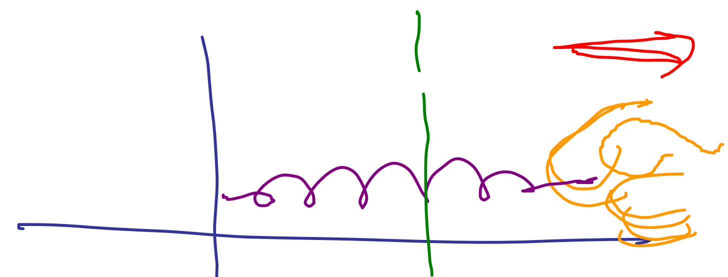
Example   Work done by spring

$$F_{spring} = -kx$$



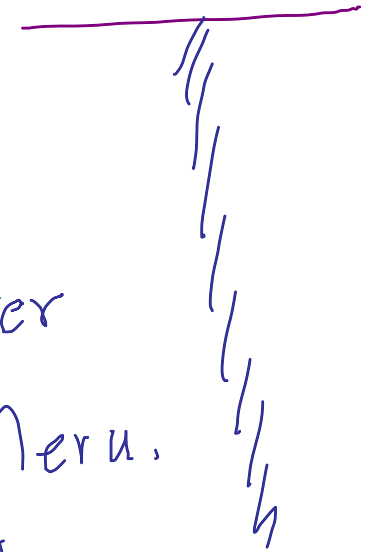
Use hand to stretch spring from elongation a to b

$$F_{hand} = -F_{spr} = kx$$



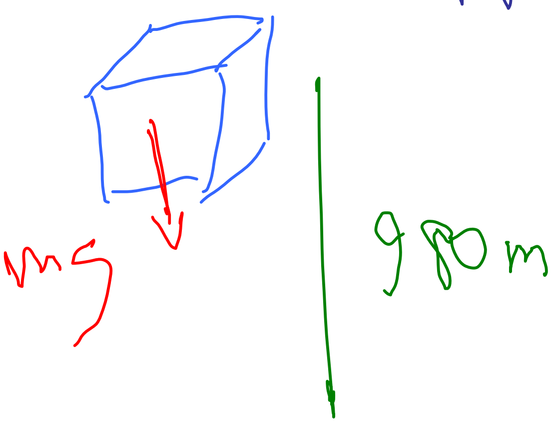
$$W_{hand} = \int_a^b F_{han}\,dx = \int_a^b kx\,dx = \frac{1}{2}kx^2\Big|_a^b = \frac{1}{2}k(b^2-a^2)$$

6.14 World's Highest Waterfall, Cherun-Meru Venezuela



Total drop of 980 m.

How much work does gravity do on a cubic meter of water dropping down the Cherun-Meru.



$$W = F \Delta x \cos\theta \quad 1$$

$$= mg(980\,m) =$$

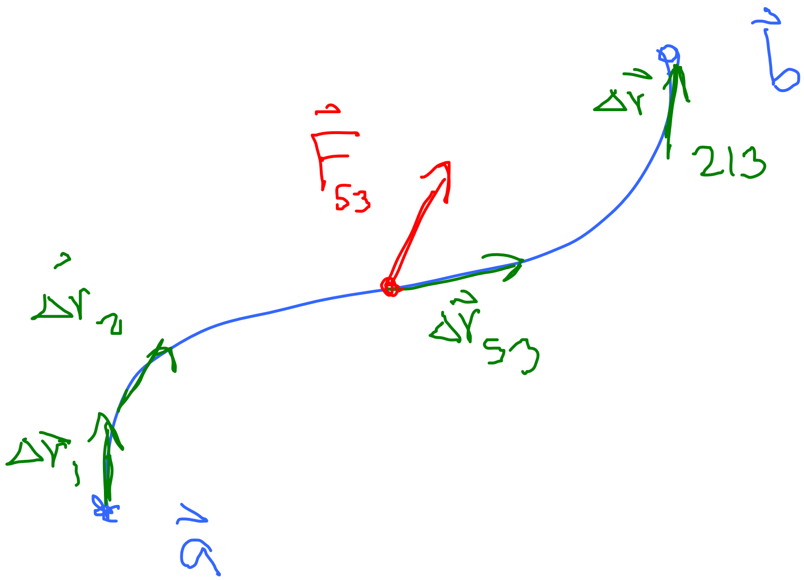
$$= 9.6\times10^{6}\,J$$

Mass of 1 m^3 water

$1000\,\frac{kg}{m^3}$

$1000\,kg$

General Def for Work.



$$W = \sum_{i=1}^{N} \vec{F}_i \cdot \Delta\vec{r}_i$$

$$\Delta\vec{r} \to 0 \quad = \int_{\vec{a}}^{\vec{b}} \vec{F} \cdot d\vec{r}$$

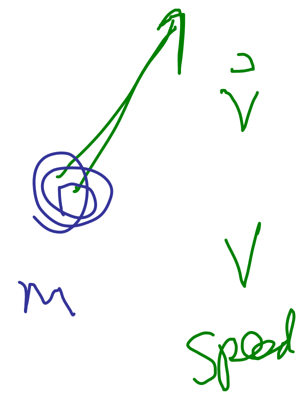
Line Integral.

Scalar, J

Definition of work.

Another def: Kinetic Energy

Kin. Energy $= K = \frac{1}{2}mv^2$



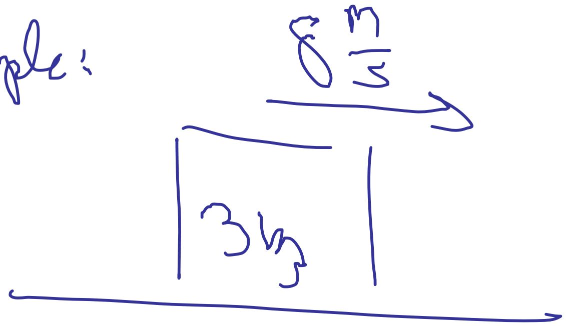
Scalar

Units?

Units?

$$[K] = kg\,\frac{m^2}{s^2} = \frac{kg\,m^2}{s^2} = J$$

Example:

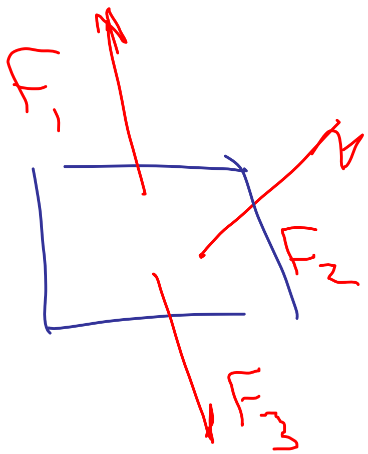


What's its KE?

$$K = \frac{1}{2}mv^2 = \frac{1}{2}(3\,kg)\left(8\,\frac{m}{s}\right)^2 = 96\,J$$

Work, K

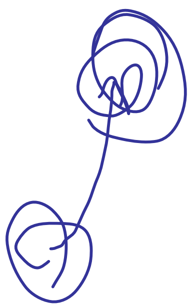
Work-Energy Thm



$$W_{net} = W_1 + W_2 + W_3$$

$$\Delta K = \frac{1}{2} m (v_2^2 - v_1^2)$$

$$\Delta K = W_{net}$$



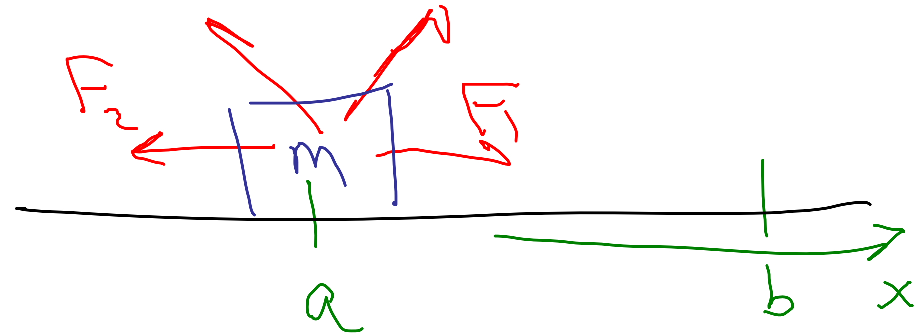
Ch 6

Show Thm in a simple case

mass m goes

$x = a$ to $x = b$

several forces



$$W_{net} = \int_a^b F_{net,x}\, dx = \int_a^b m a \, dx$$

Consider $\underline{a(x)}$

$$a = \frac{dv}{dt} = \frac{dx}{dt} \cdot \frac{dv}{dx} = v \frac{dv}{dx}$$

$$W = m\int_a^b \underbrace{v\frac{dv}{dx}}\,dx = \frac{m}{2}\int_a^b \underbrace{\frac{d}{dx}\left(v^2\right)}\,dx$$

$$= \frac{m}{2}v^2\Big|_a^b = \frac{m}{2}\left(v_b^2 - v_a^2\right) = \Delta K_{a\to b}$$