Physics 200 Day 12

I'm posting notes: there were two day 8's. one is "promoted" to day 9.

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other forms of energy: Potential energies U_x.

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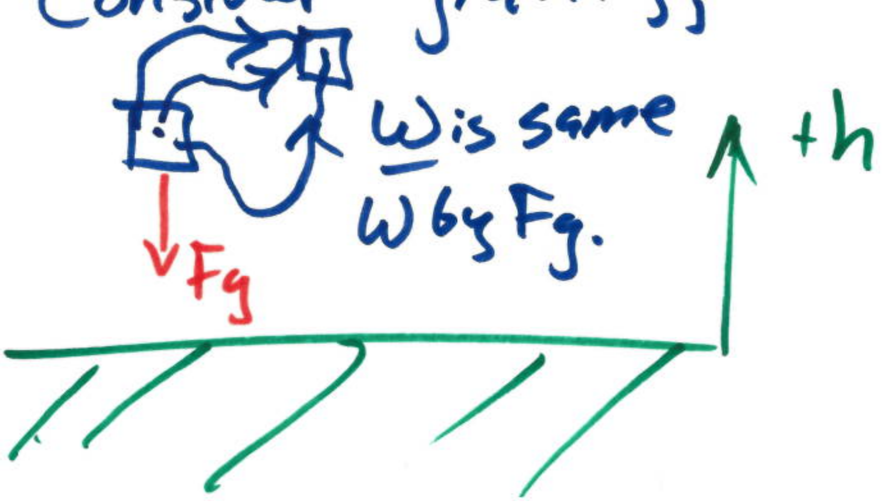
last time: $\sum W = \Delta E_K$

$W = \int \vec{F}(x) \cdot d\vec{x}$ $\quad E_K = \frac{1}{2}mv^2$

Some forces can move to right-hand side. These are called: "Conservative" forces and the ones left as Work are called "Non-Conservative" forces.

Consider gravity, near Earth: $F_g = mg$ down.



break path up into tiny motions either up or right or down or left

$\Delta y \uparrow \xrightarrow[\Delta x]{}$ $$W = \int_0^f \vec{F}_g \cdot d\vec{x} = \int_0^f mg(-\hat{y}) \cdot d\vec{x}$$

$$W = mg \int_0^f (-\hat{y}) \cdot d\vec{x} = mg \underbrace{\int_0^f (-\hat{y}) \cdot dy}_{\text{up/down}} + \underbrace{\int_0^f \overbrace{(-\hat{y}) \cdot dx}^{0}}_{\text{left/right}}$$

$$W = -mg\int_0^f dy = -mg(\underset{\text{final}}{h_f} - \underset{\text{initial}}{h_0})$$ indep. of path.

$$\Sigma W = \Delta E_K$$

$$\Sigma W_{N.C.} = \Delta E_K + \sum_i \Delta U_i$$

i ← conserv. forces acting gravity etc.

$$\Delta U = -W$$
$$\Delta U_g = -(-mg)(h_f - h_0)$$

$U_g = mgh$

other Conservative forces:

elastic $\vec{F_e} = -k\,\vec{\Delta x}$

Gravity, not near Earth $F_G = G\frac{m_1 m_2}{r^2}$

Electric

other (Nuclear)

Note: If you have a $U_x \rightarrow F_x$

you can take derivitives

$$F_x = -\frac{\partial U_x}{\partial x}\hat{x}$$

x component of force x

U_x pot. x

$$F_{x_y} = -\frac{\partial U_x}{\partial y}\hat{y}$$

$$\vec{F_x} = -\nabla U_x$$

Some U formuli:

$U_g = mgh$ $\qquad U_e = \frac{1}{2} k (\Delta x)^2$

$U_G = -G \frac{m_1 m_2}{r}$

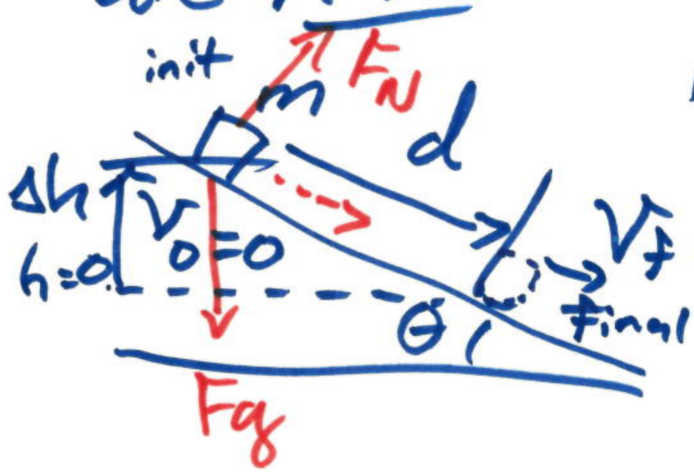
Non-Conservative forces

Normal, Friction, Tension, ...

magnetism

W_{F_f} does depend on path because $\vec{F}_{f_k}$ always opposes sliding motion.

Examples using energy to solve problems in which Force/Work are hard:



No friction (yet)

E_k

U_g

U_e

U_G X

init:

U_g

final:

E_K, U_g maybe

$U_g = mgh$ ← from where? you pick $h=0$ but don't change where $h=0$ is

Given: m θ d g $v_0 = 0$

Want: v_f

$\sin\theta = \frac{opp}{hyp} = \frac{h}{d} \rightarrow h = d\sin\theta$

$$\Sigma W_{N.C.} = \Delta E_K + \Sigma \Delta U \quad 0 \xrightarrow{mgh}$$

$$0 = \frac{1}{2}mv_f^2 - \cancel{\frac{1}{2}mv_0^2} + \cancel{U_{g_f}} - U_{g_0}$$

there are none doing work.

$$0 = \frac{1}{2}\cancel{m}v_f^2 - \cancel{m}g\underbrace{(d\sin\theta)}_{h}$$

$W_{F_N} = 0$

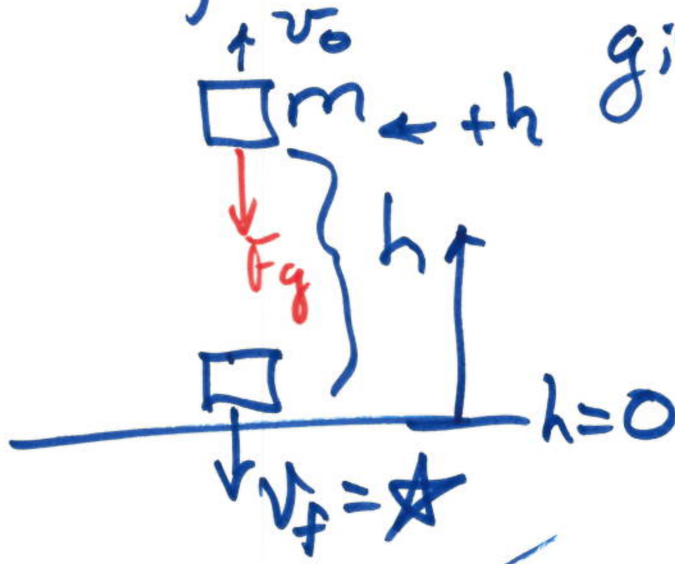
$\vec{d} \perp \vec{F_N}$

$W_{F_N} = F_N d \underbrace{\cos 90°}_{0}$

$$gd\sin\theta = \frac{1}{2}v_f^2$$

$$\sqrt{2gd\sin\theta} = v_f$$

falling with energy



given: $m = 1.23\,kg$

$v_0 = 5.5\,m/s$

$h = 6.6\,m$

find: v_f

$U_g = mgh$

$$\cancel{\Sigma W_{N.C.}} = \Delta E_K + \overbrace{\Sigma \Delta U}^{U_g \text{ only}}$$

0

init

$U_g + E_K$

$mgh + \frac{1}{2}mv_0^2$

final:

$E_K + 0$ ← $h=0$

$\frac{1}{2}mv_f^2 + 0$

$$0 = \overbrace{\frac{1}{2}mv_f^2 - \frac{1}{2}mv_0^2}^{\Delta E_K} + \overbrace{0 - mgh}^{\Delta U}$$

when $\underline{W_{NC}} = 0$, E_{TOT} is <u>same</u> throughout whole motion!

$E_0 = E_f = E_1$ ← max height

$$mgh + \frac{1}{2}mv_0^2 = 0 + \frac{1}{2}mv_f^2 = mgh_{max} + \underset{v_f=0}{0}$$

1. Draw Pictures → init
   → final
2. Any W_{NC}?
3. List forms of energy (E_K U ...) in init and final pictures.
4. Plug form of E into big $\Sigma W_{NC} = \Delta E_K + \ldots$ law of conserv. of energy.

Given: m, H_0, L, k, g, $v_0 = 0$

Find: Δx (max. compression)