Chap 5 HW Answers

22) $\vec{F}_3 = \frac{225}{\sqrt{2}}(-\hat{i} + \hat{j})$

34) (a) $a_x = 2.5\ m/s^2$

(b) $F_x = 2.5 \times 10^3\ N$

46) $F_a = 7240\ N$

48) (a) $F = m(g - a)$

(b) $F = 432\ N$

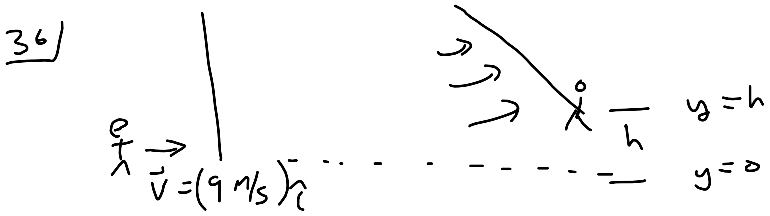
54) $a_{car} = -40\ m/s^2$

66) $F = 690\ N$

Oct 10-9:36 AM

HW problems from chap 7-8

36)



$E = K + U$ = constant without dissipation

intitially, $K = \frac{1}{2}mv^2$ $\quad E_i = \frac{1}{2}mv^2$

$U = 0$ when $y = 0$

at peak height, $K = 0$ $\quad E_f = mgh$

$U = mgh$

$\frac{1}{2}\cancel{m}v^2 = \cancel{m}gh \quad v = \sqrt{2gh}$

$= 4.1\ m$

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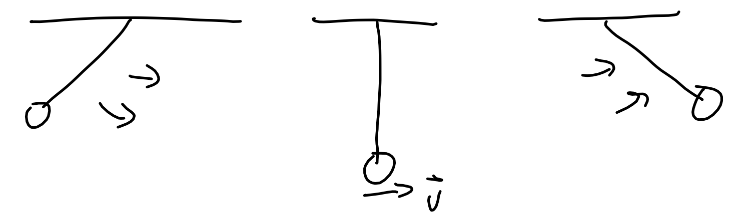
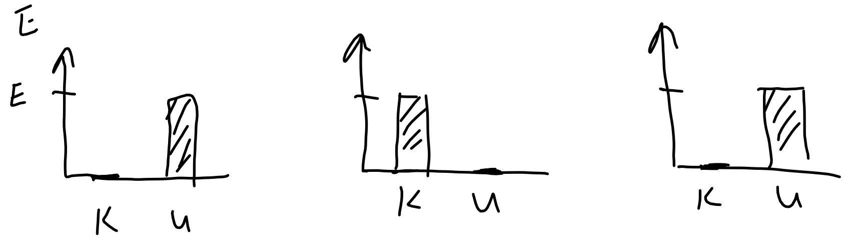
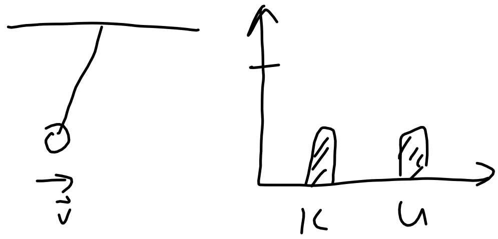
An aside: pendulum





Suppose



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Spring

$\Delta U = -W_{AB}$ where W_{AB} is work done by spring in going from point A to point B

$$\Delta U = -\int_A^B \vec{F}\cdot d\vec{r} = -\int_A^B F_x\,dx$$

But we know from Hooke's Law $F_x = -kx$

$$\Delta U = \int_A^B kx\,dx = k\int_A^B x\,dx$$

Let's define $x=0$ at equilibrium point,
$x = X$ at the end point

$$\Delta U = k\int_0^X x\,dx = k\left(\frac{x^2}{2}\right)\Big|_0^X = \frac{1}{2}kX^2$$

Contrast with gravity acting on mass m: $F_y = -mg$

$U = mgy$

Spring $F_x = -kx$

$U = \frac{1}{2}kx^2$

Oct 10-10:02 AM

Note from previous 2 situations:

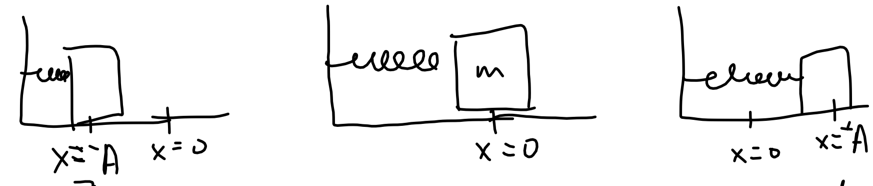
$-\frac{dU}{dx} = F_x$: for spring: $U = \frac{1}{2}kx^2$

$$-\frac{dU}{dx} = -kx = F_x$$

for gravity: $U = mgy$

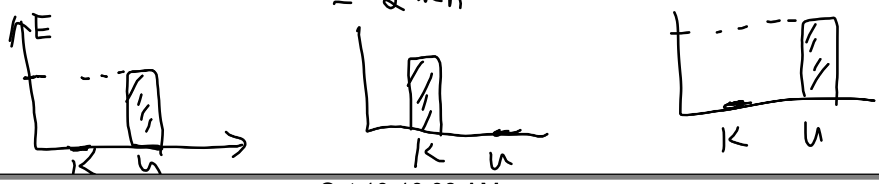
$$-\frac{dU}{dy} = -mg = F_y$$

Back to spring



amplitude

E = total energy = $K+U$ = constant $= \frac{1}{2}kA^2$



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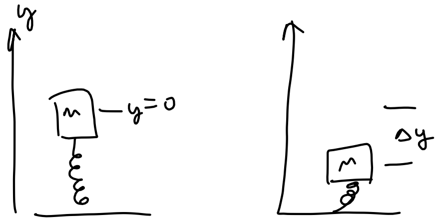
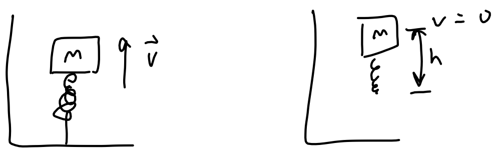
ETA Pogo stick problem



$U_s = \frac{1}{2}k(\Delta y)^2$



$U_g = mgh$

E = constant, $U_s = U_g$

$$\frac{1}{2}k(\Delta y)^2 = mgh$$

$$h = \frac{k(\Delta y)^2}{2mg}$$

$$h = \frac{(2.5\times10^4\ N/m)(0.1m)^2}{2(38\ kg)(9.8\ m/s^2)} = \frac{2.5\times10^2\ N\cdot m}{8\times10^2\ N}$$

$= 0.3$ m

Oct 10-10:21 AM

ETA toy gun problem

(a) $|F_x| = kx$

(b) $\frac{1}{2}kx^2 = mgh$

(c) $R = \frac{v_0^2 \sin 2\theta}{g}$

$R(max)$ when $\theta = 45^0$

$R(max) = \frac{v_0^2}{g}$, need v_0

$\frac{1}{2}kx^2 = \frac{1}{2}mv_0^2 \Rightarrow v_0^2 = \frac{kx^2}{m}$

$R(max) = \frac{kx^2}{mg}$

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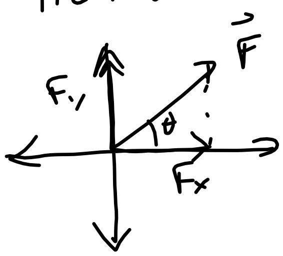
Here are some relations you might want to keep handy



$F_x = F\cos\theta$

$F_y = F\sin\theta$

$\vec{v} = \frac{d\vec{r}}{dt} \begin{cases} v_x = \frac{dx}{dt} \\ v_y = \frac{dy}{dt} \\ v_z = \frac{dz}{dt} \end{cases}$

$\vec{a} = \frac{d\vec{v}}{dt} \begin{cases} a_x = \frac{dv_x}{dt} \\ a_y = \frac{dv_y}{dt} \end{cases}$

If a = constant, then for x components,

$x = x_0 + v_{0x}t + \frac{1}{2}a_x t^2$

$a_x = \frac{v - v_{0x}}{t}$

$v_x = v_{0x} + a_x t$

$v_x^2 = v_{0x}^2 + 2a_x(x - x_0)$

Oct 10-10:34 AM

For projectiles,

$a_y = -g$ all of the time.

$a_x = \emptyset$ " " " " $\Rightarrow V_x = V_{0x} = \text{constant}$

For Newton's laws,

$$\underbrace{\sum \vec{F}}_{\vec{F}_{net}} = m\vec{a} \left\} \begin{array}{l} \sum F_x = ma_x \\ \sum F_y = ma_y \end{array} \right.$$

For friction, $f_s \le \mu_s N$

$f_k = \mu_k N$

Know how to draw a FBD!

Know Kinetic energy $K = \frac{1}{2}mv^2$

$$\text{Work} = \underbrace{\int \vec{F} \cdot d\vec{r}}_{\text{simplifies in most cases}}$$

Spring $F_x = -kx$ Gravity $F_y = -mg$

$U = \frac{1}{2}kx^2$ $U = mgy$

$E = K + U = \text{constant}$

Oct 10-10:39 AM