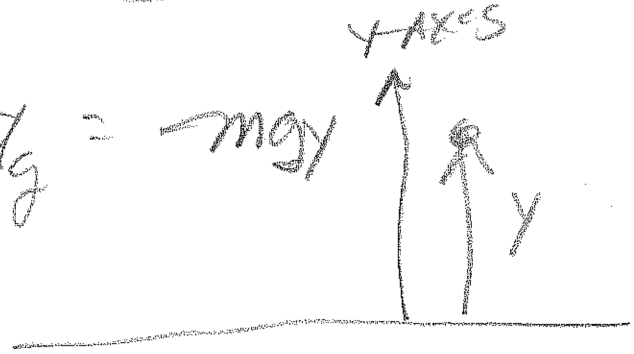
3-25-13

CH. seven continued     notes not posted

<u>so far:</u>

$U_g = -mgy$



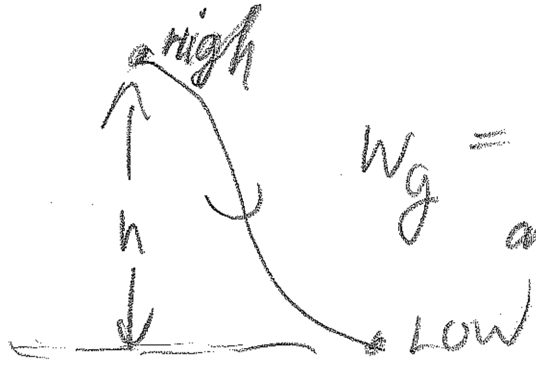

$$KE_i + U_{g_i} = KE_f + U_{g_f}$$

<u>note:</u> $\Delta U_g = mg(y_f - y_i)$

and $mg(y_f - y_i) = -mg(y_i - y_f)$

Thus: $\Delta U_g = -W_g$

makes sense physically.




$W_g = +mgh$

and $\Delta U_g < 0$

$U_g$ turned into kinetic energy

Apply rule $\Delta U_g = -W_g$ to

springs: $\Delta U_s = -W_s$

THUS $\Delta U_s = -\frac{1}{2}k(x_i'^2 - x_f'^2)$

and $U_s = 0$ at $x = 0$.

THUS: $U_s = \frac{1}{2}kx'^2$; $x'$ = spring coordinate.

(I) Energy Conservation with springs and gravity:

$$W_{net} = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$$

$$W_s + W_g = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$$

Ch6: $\frac{1}{2}k(x_i'^2 - x_f'^2) + mg(y_i - y_f) = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$

Re-arrange:

Ch7 $$\boxed{\frac{1}{2}mv_i^2 + mgy_i + \frac{1}{2}kx_i'^2 = \frac{1}{2}mv_f^2 + mgy_f + \frac{1}{2}kx_f'^2}$$

3-27-13 Review

conservation of Energy!

($x'$ = spring coordinate)

(II) ADD friction: $W_{f_k} = -f_k \cdot D \le 0$ ALWAYS

**ch 6** $\quad -f_k \cdot D + \frac{1}{2}k(x_i^2 - x_f^2) + mg(y_i - y_f) = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$

RE-ARRANGE:

**ch 7** $\quad \boxed{\frac{1}{2}mv_i^2 + mgy_i + \frac{1}{2}kx_i^2 = \frac{1}{2}mv_f^2 + mgy_f + \frac{1}{2}kx_f^2 + \underline{Heat}}$

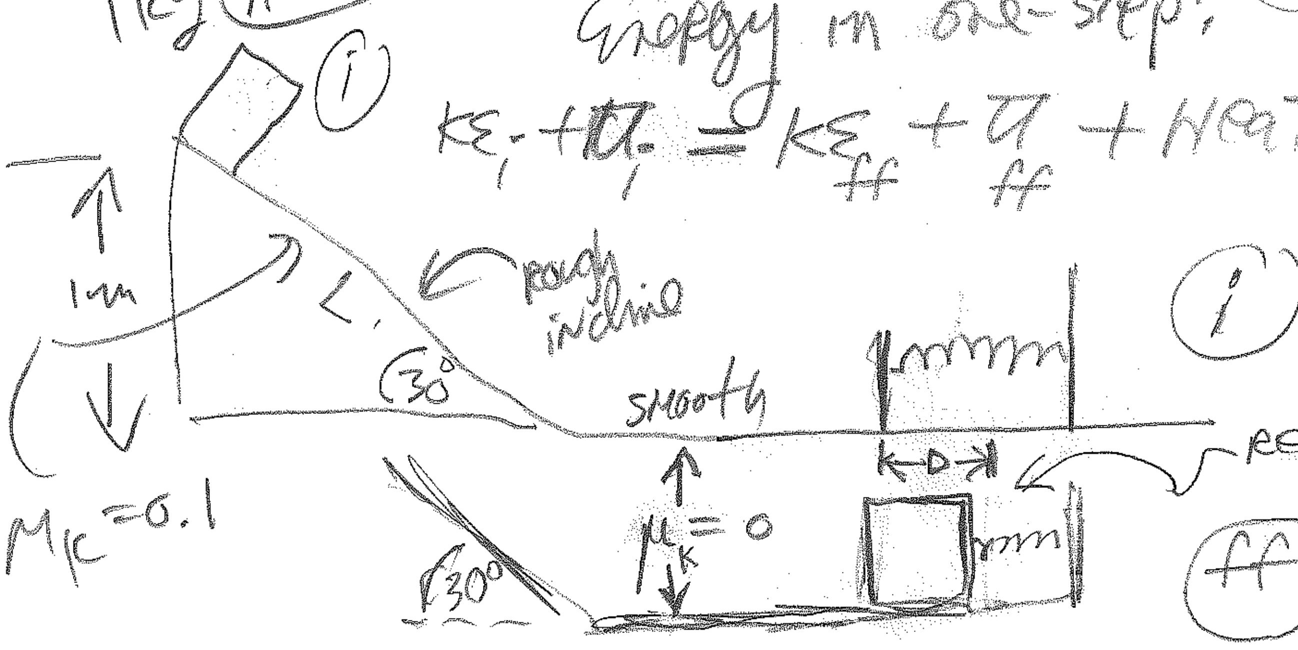
3-27-13 REVIEW

Heat $= f_k \cdot D \ge 0$; Note: Heat $= -W_{f_k} = -(-f_k \cdot D)$

Redo CLASS example using conservation of Energy in one-step!

3-22-13

$KE_i + U_i = KE_{ff} + U_{ff} + Heat$



$KE_i + U_i = KE_{ff} + U_{ff} + \text{Eheat}$

$0 + mgy_i = 0 + \frac{1}{2}KD^2 + \text{Eheat}$

$D = ?$

$(1)(9.8)(1) = 0 + \frac{1}{2}(10)D^2 + f_k \cdot L$

$(1)(9.8)(1) = \frac{1}{2}(10)D^2 + (0.1)(1)(9.8)\cos 30 \cdot 2$

$\approx 9.8 - 1.73 = \frac{1}{2}(10)D^2$

$* \; 8.07 = 5 \cdot D^2$

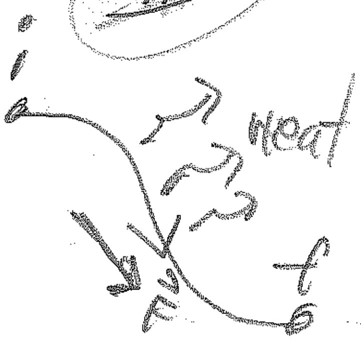
$\sqrt{\frac{8.07}{5}} = D^2$

$D \approx 1.27 (m)$

Same!

$$\begin{array}{r} * \; 9.80 \\ -\;1.73 \\ \hline 8.07 \end{array}$$

III. ADD an external APPLIED force $\vec{F}$ that produces $W_F$.




$$\boxed{\text{ch6} \quad W_F - f_k \cdot D + \tfrac{1}{2}k(x_i^2 - x_f^2) + mg(y_i - y_f) = \tfrac{1}{2}mv_f^2 - \tfrac{1}{2}mv_i^2}$$

rearrange

CH7

$$\boxed{W_F + \tfrac{1}{2}mv_i^2 + mgy_i + \tfrac{1}{2}kx_i^2 = \tfrac{1}{2}mv_f^2 + mgy_f + \tfrac{1}{2}kx_f^2 + \underline{\text{heat}}}$$

3-27-13

heat $= f_k \cdot D$

* NOTE: heat $= -W_{f_k} \geq 0$

since $W_{f_k} \leq 0$.

* This approach works when $f_k \neq$ constant

In general: $W_F + KE_i + U_i = KE_f + U_f + \text{heat}$

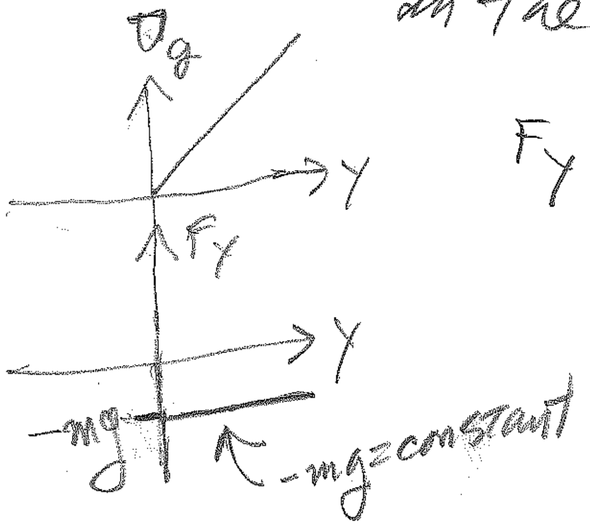
heat $= -W_{f_k}$

Secs 7.4, 7.5

Force and potential energy

(A) Gravity
NOTE: $F_y = -mg$ and $U_g = mgy$

in the gravitational case.



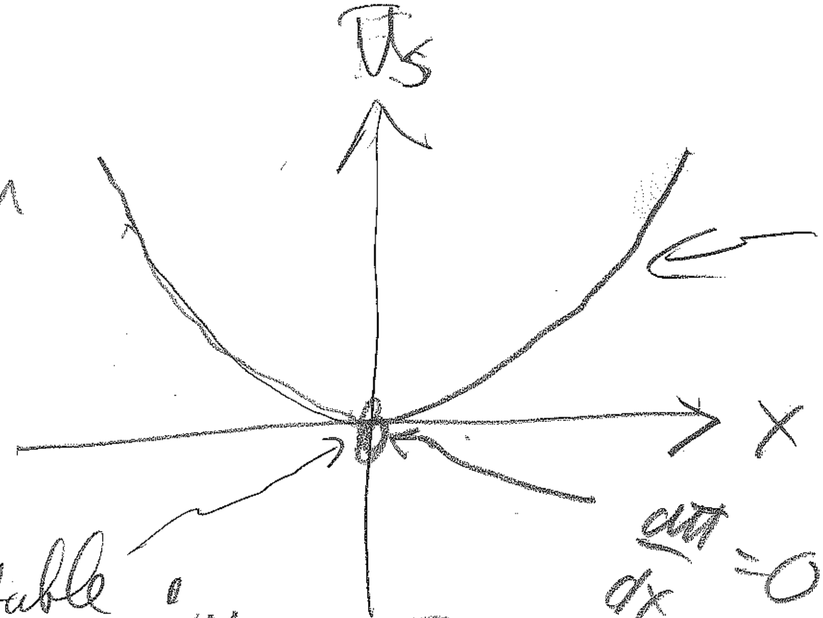

$$F_y = -\frac{dU_g}{dy} = -\frac{d(mgy)}{dy}$$
$$= -mg$$

(B) Springs
NOTE: $F_x = -kx$ and $U_s = \frac{1}{2}kx^2$

in the spring case

$$F_x = -\frac{dU_s}{dx} = -\frac{d(\frac{1}{2}kx^2)}{dx}$$
$$= -(kx) = -kx$$

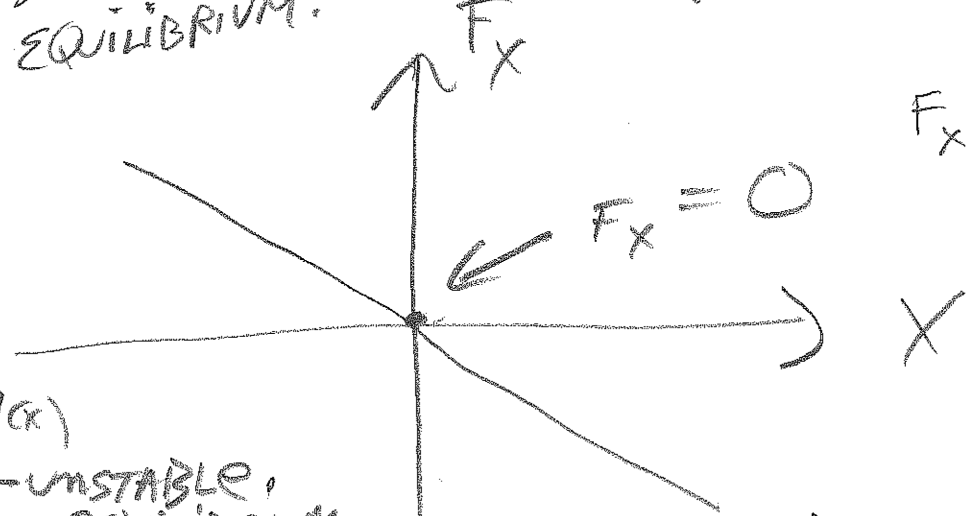
Energy Diagram




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

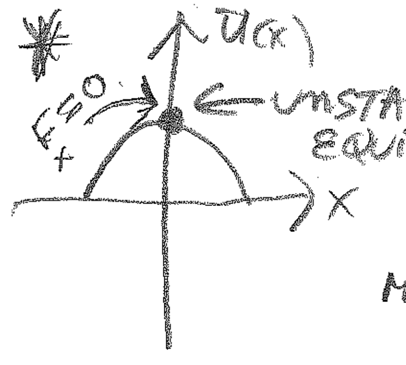
$\frac{dU}{dx} = 0$

* Stable equilibrium.



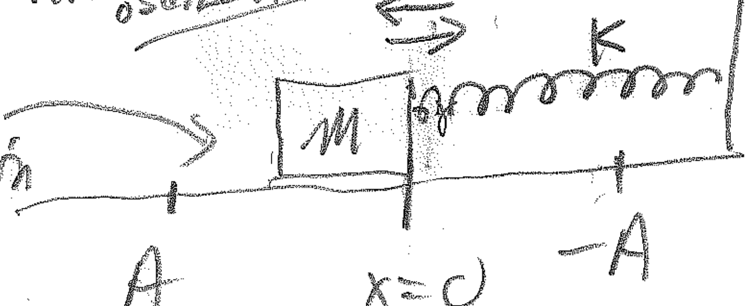

$F_x = -\frac{dU_s}{dx}$

$F_x = 0$



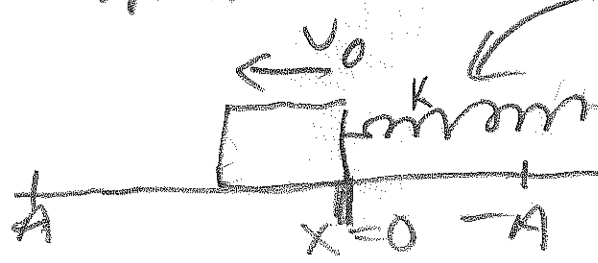

* unstable equilibrium

Mass attached to a spring oscillates back and forth. No friction

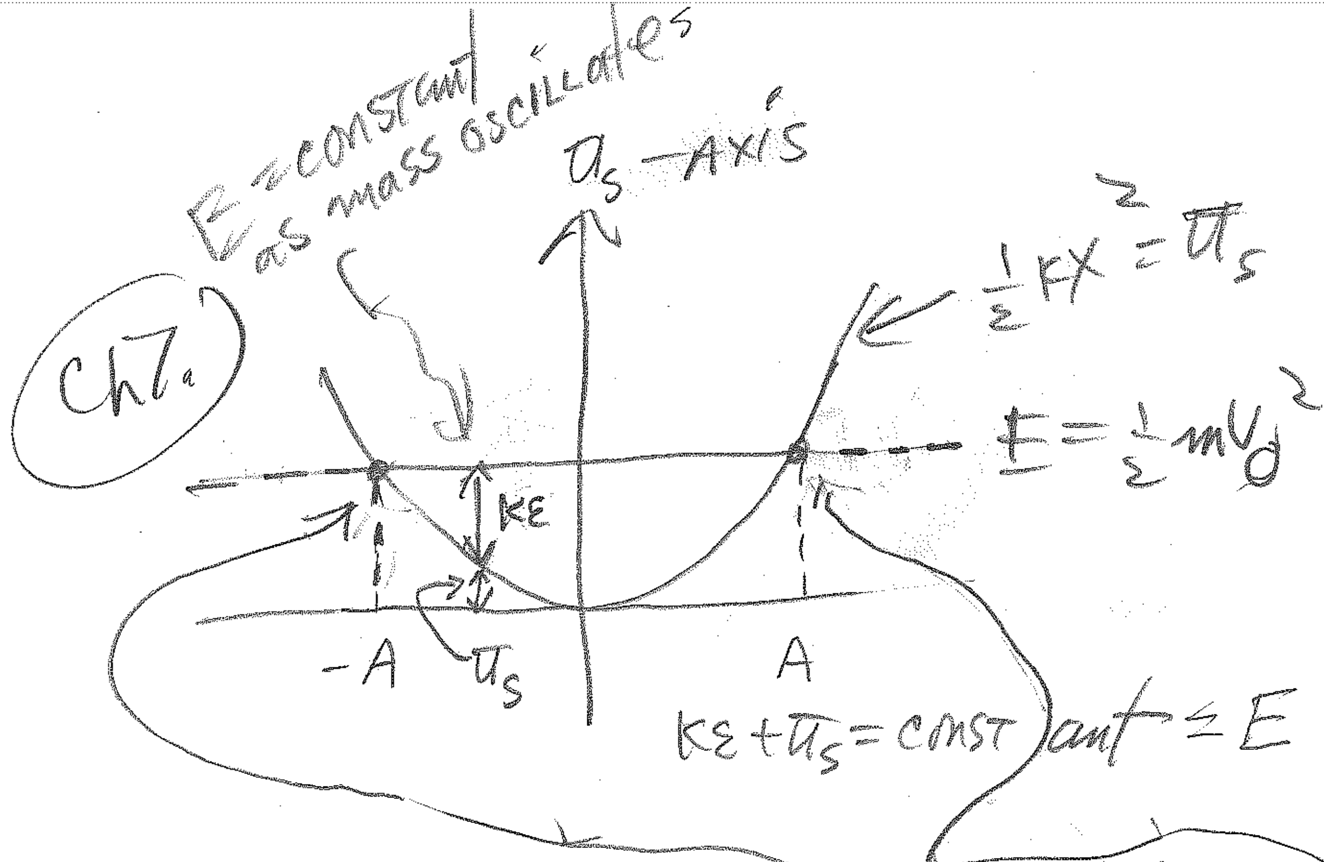



no friction

Let speed $= v_0$ at $t=0$; $x=0$ at $t=0$.




undeformed




TURNING POINTS where velocity $v_x$ = 0

A = amplitude

E = constant.

CH 14

$$\frac{1}{2}mv_0^2 = \frac{1}{2}mv_x^2 + \frac{1}{2}kx^2$$

for values of $v_x$ and $x$

such that $|x| \le A$

and $|v_x| \le v_0$