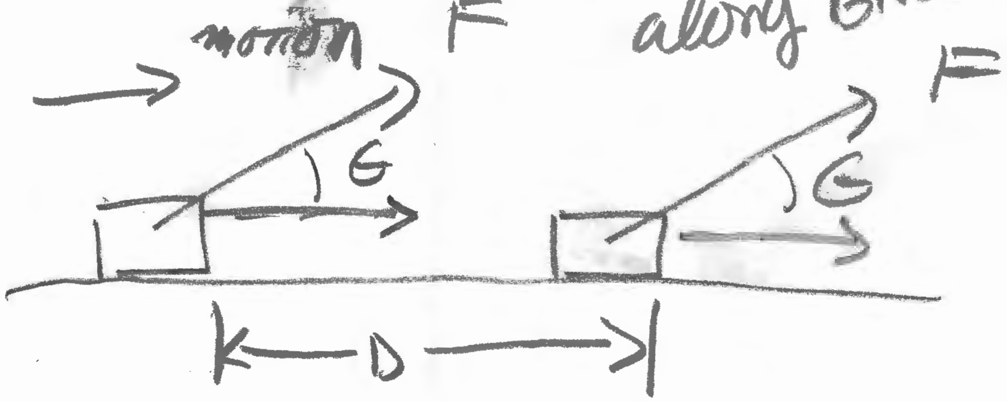
CH 7 WORK and ENERGY

WORK

BOX MOVES along GROUND

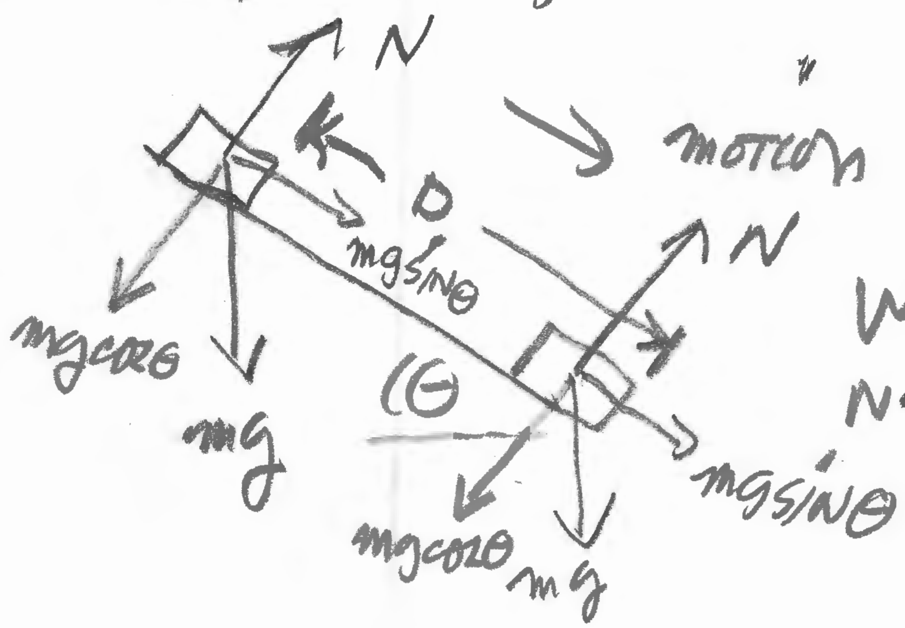


WORK = $F \cdot \cos\theta \cdot D$

IF $0 < \theta < 90^\circ$, WORK > 0

IF $90^\circ < \theta < 180^\circ$, WORK < 0

Example 2, CH 7

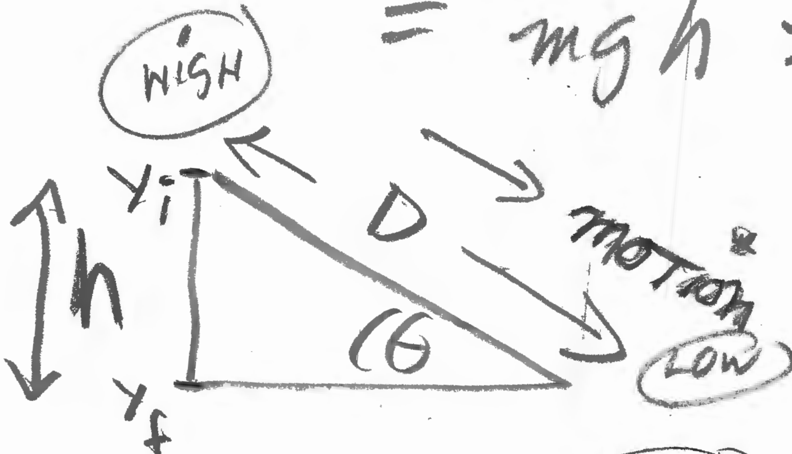


$W_N = 0$

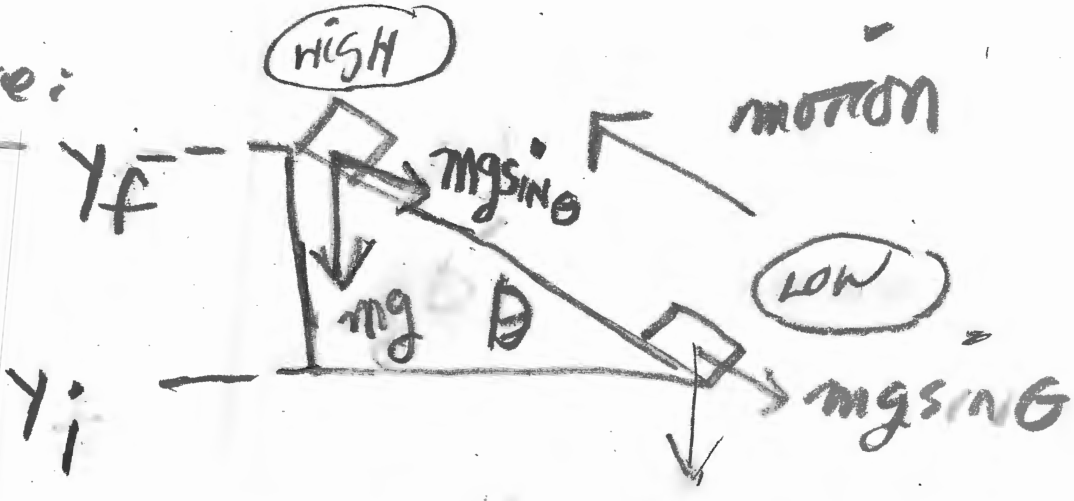
$N \cdot \cos 90^\circ \cdot D = 0$

GRAVITY WORK:

$$W_g = mg \cdot \sin\theta \cdot D$$
$$= mgD\sin\theta$$
$$= mgh > 0$$ if motion is "HIGH" to "LOW".

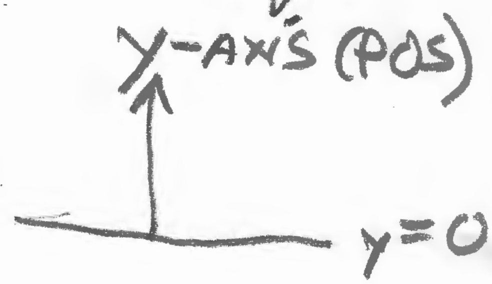


NOTE:



$$W_g = -mg\sin\theta \cdot D$$
$$= -mgD\sin\theta$$ "LOW" to "HIGH"
$$= -mgh < 0$$

GENERAL: $\boxed{W_g = mgy_i - mgy_f}$

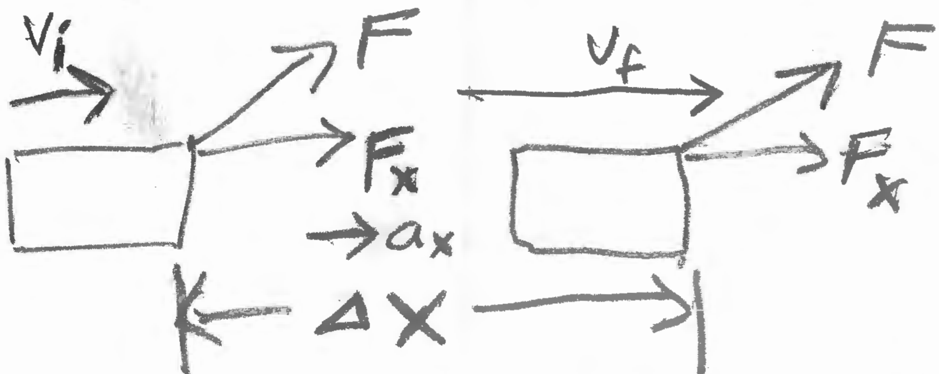


WORK-ENERGY THEOREM

Review CH 2, 4, 5

$$F_x = m a_x$$

$$\text{WORK} = F_x \cdot \Delta x = m a_x \cdot \Delta x$$



$$F_x \cdot \Delta x = m a_x \cdot \left(\frac{v_f^2 - v_i^2}{2a_x}\right) \text{ (CH 2)}$$

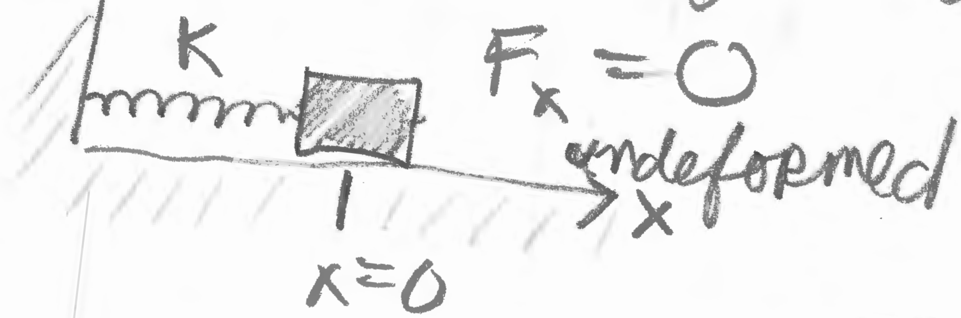
$$\text{WORK} = \frac{m}{2}\left(v_f^2 - v_i^2\right)$$

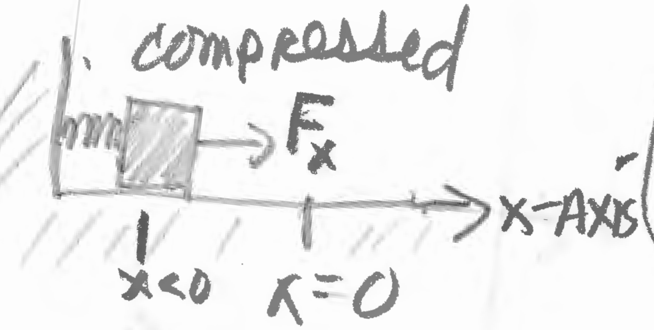
$$\text{WORK} = \frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2$$

$$\boxed{W_{TOTAL} = \Delta KE} \; ; \; KE = \frac{1}{2} m v_x^2$$

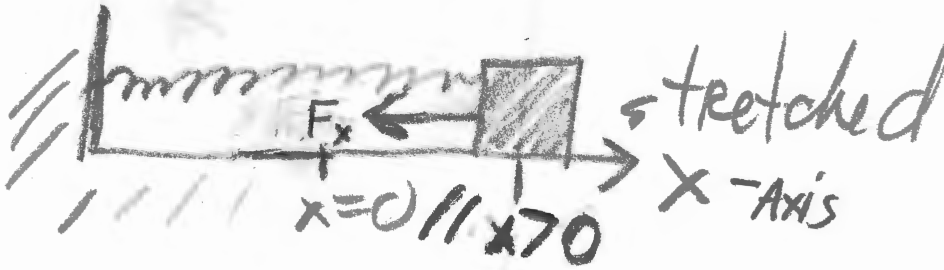
Springs

Work By spring $= W_S$



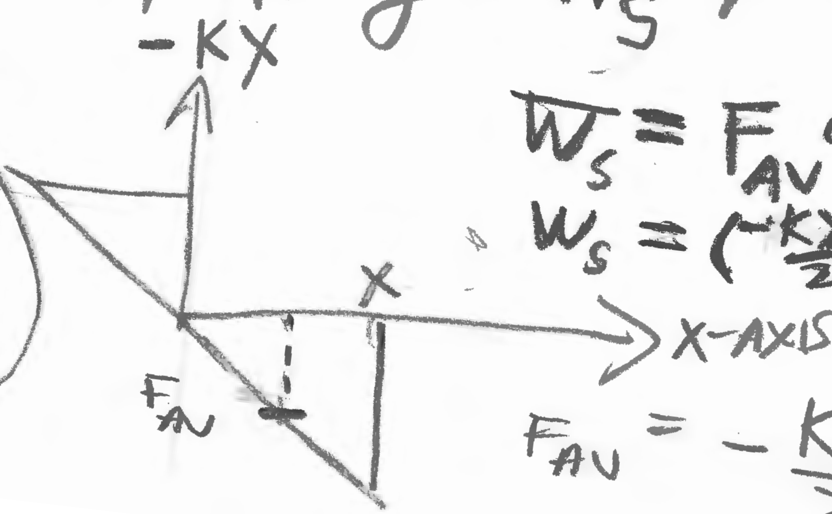


spring force
$$F_x = -KX$$



Work by spring $= W_S \neq F_x \cdot X$

suppose spring is stretched to X.



$$W_S = F_{AV} \cdot \cancel{X}$$
$$W_S = \left(-\frac{KX}{2}\right)X = -\frac{1}{2}KX^2$$

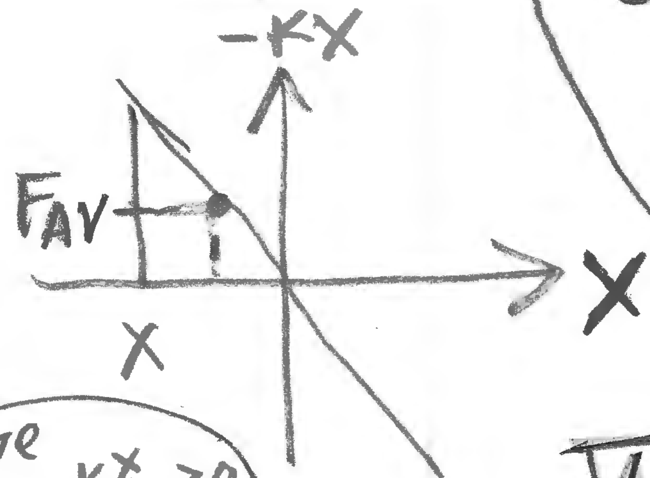
$$F_{AV} = -\frac{KX}{2}$$

stretch: $W_s = -\frac{1}{2}kx^2 < 0$

compress: $W_s = (F_{AV}) \cdot x$

$= \left(-\frac{kx}{2}\right) \cdot x$

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



Note
$F_{AV} = \frac{-kx}{2} > 0$
$x < 0$

$W_s = -\frac{1}{2}kx^2 < 0$

(compressed)

In general: $W_s^* = -\frac{1}{2}kx_f^2 - \left(-\frac{1}{2}kx_i^2\right)$

$$\boxed{W_s = \frac{1}{2}kx_i^2 - \frac{1}{2}kx_f^2}$$

x_i = initial x

x_f = final x

* stretched to undeformed:

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

compressed to undeformed:

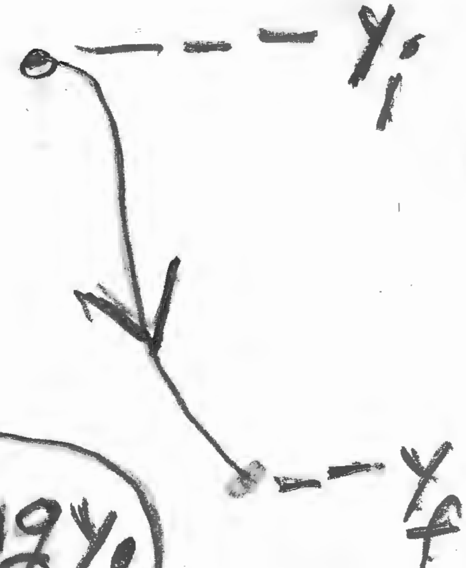
$W_s = \frac{1}{2}kx^2$

Potential Energy = U

PAGE 204: GRAVITY

$$\Delta U_g = -W_g = -(mgy_i - mgy_f)$$

or



$$\Delta U_g = mgy_f - mgy_i$$

Likewise springs

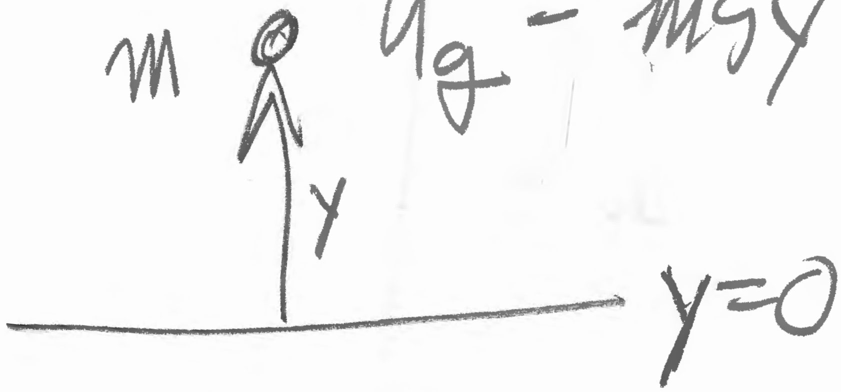
$$\Delta U_s = -W_s = -\left(\tfrac{1}{2}kx_i^2 - \tfrac{1}{2}kx_f^2\right)$$

$$\Delta U_s = \boxed{\tfrac{1}{2}kx_f^2 - \tfrac{1}{2}kx_i^2}$$

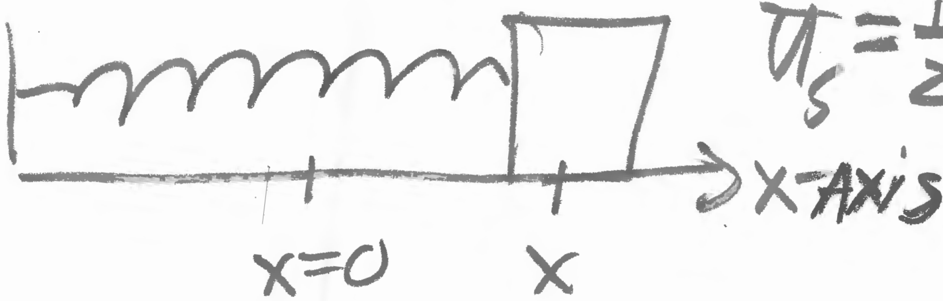
Define: $U_g = mgy$

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

$U_g = mgy$



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



Conservation of Energy: No Friction (6)

$$KE_i + U_i = KE_f + U_f$$

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

NOTE: x' = SPRING COORDINATE

NO FRICTION

friction work: $W_{f_k} = -f_k \cdot D$
(KINETIC FRICTION WORK)

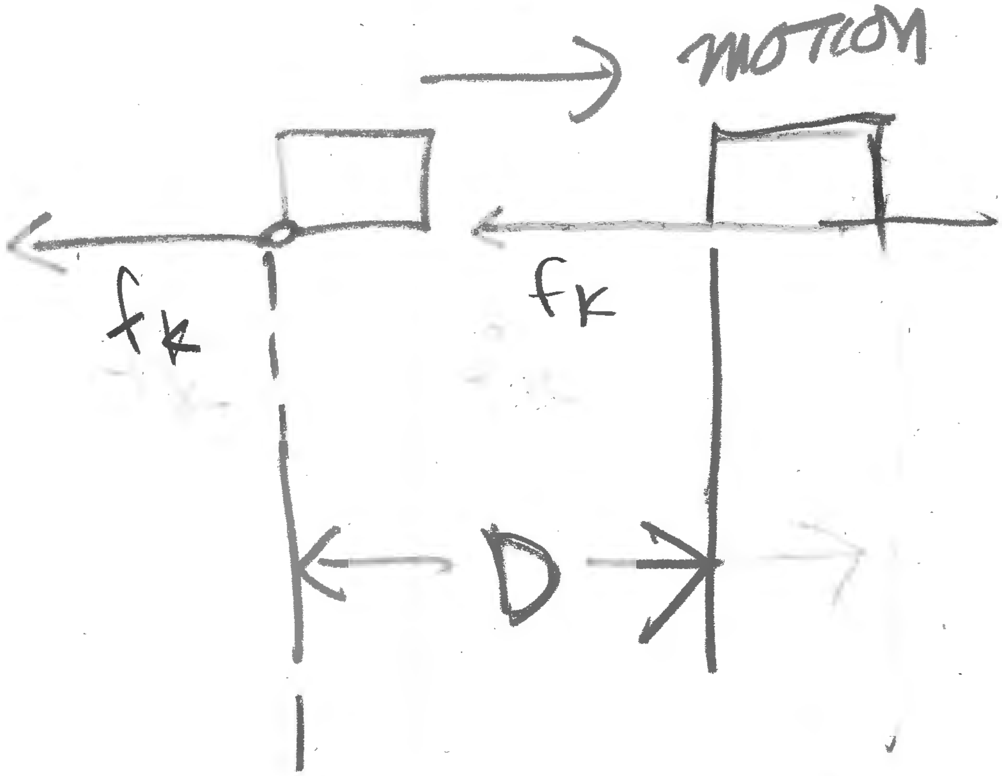
$W_{f_k} < 0$ ALWAYS

conservation of energy with friction:

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

$$\text{Heat} = -W_{f_k} = -(-f_k \cdot D)$$
$$= +f_k \cdot D$$

<u>NOTE:</u> $W_{f_k} < 0$ ALWAYS



$$W_{f_k} = f_k \cdot \cos 180^\circ \cdot D$$
$$= -f_k \cdot D$$