Kinetic Energy

$$E_K = \frac{1}{2} m v^2$$

"Is object moving?"

Spring Potential Energy

$$E_S = \frac{1}{2} k (\Delta L)^2$$

$L - L_0$

"Is a spring being compressed or stretched?"

Gravitational Potential Energy

$$E_G = mgh$$

(at surface of Earth)

height of object

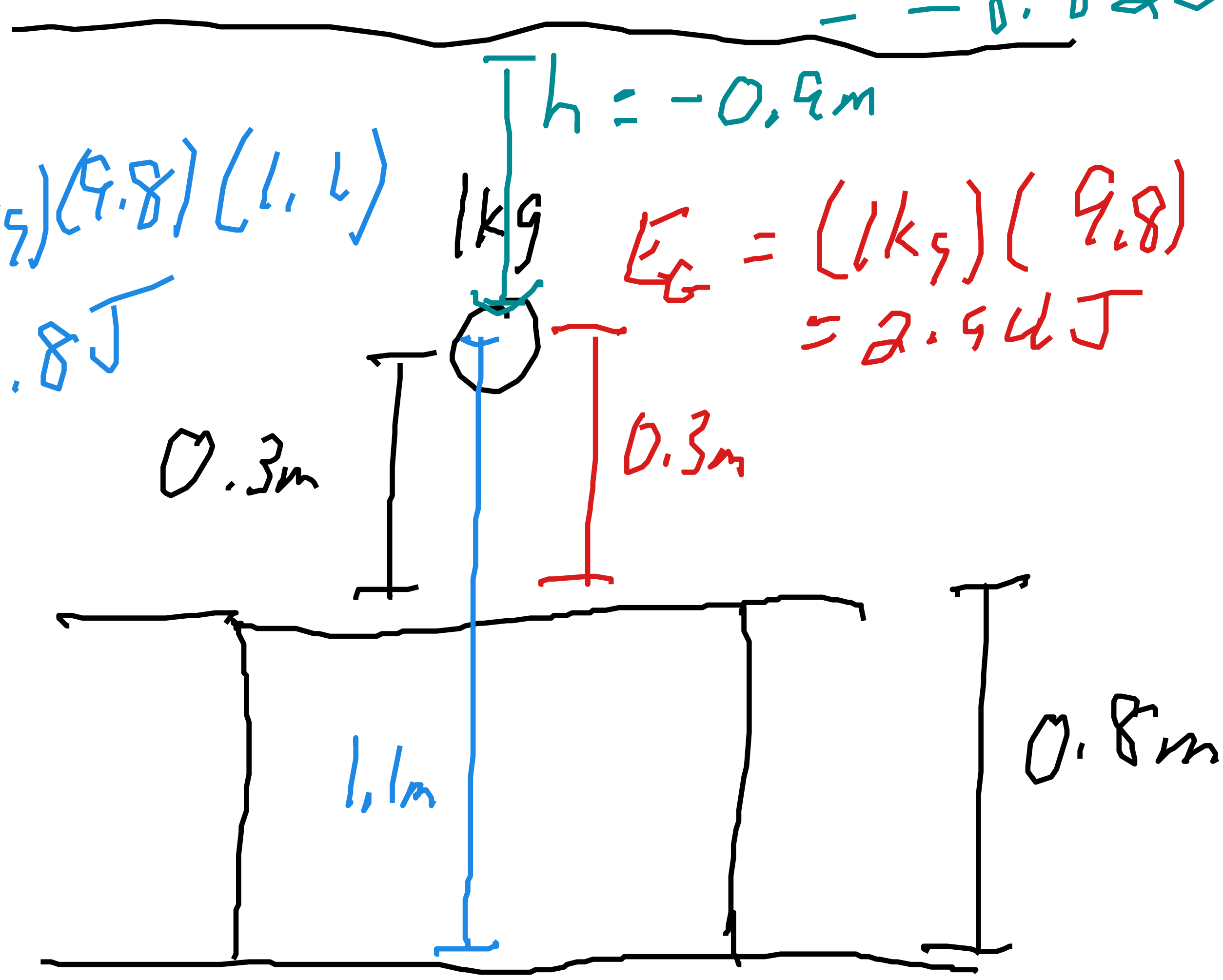
Height above what?

– your choice!

We choose one reference point which we call $h=0$

all other heights are measured from that

$E_G = (1)(9.8)(-0.9)$
$= -8.82\,J$



$E_G = (1kg)(9.8)(1.1)$
$= 10.8\,J$

$E_G = (1kg)(9.8)(0.3)$
$= 2.94\,J$

- Measure height from table

$$E_G = 2.94\,J$$

- Measure height from floor

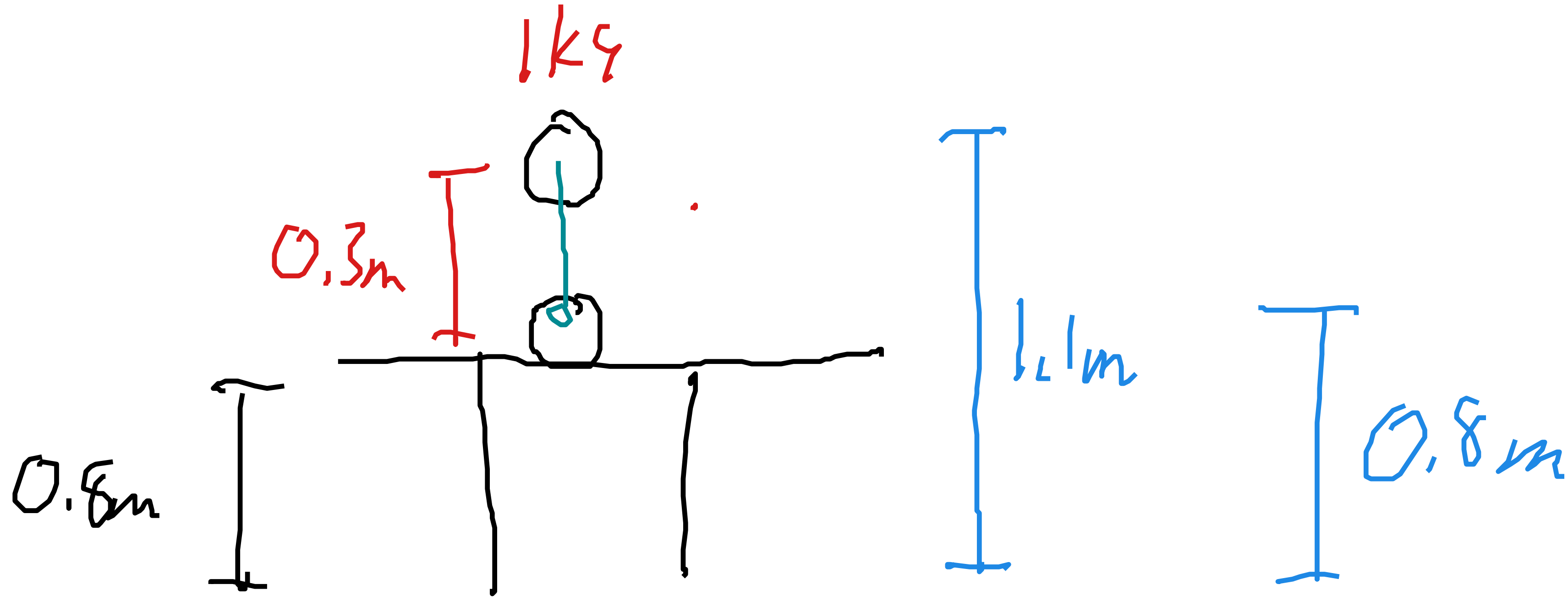
$$E_G = 10.8\,J$$

- Measure from 2m high ceiling

$$E_G = -8.82\,J$$

All of these are valid choices. Why?

Only changes in energy are physically relevant.



$\Delta E_G =$

Using tabletop as $h=0$

$$\Delta E_G = \underbrace{(1)(9.8)(0)}_{h_f} - \underbrace{(1)(9.8)(0.3)}_{h_i}$$

$$= \boxed{-2.94\,J}$$

Using floor as reference point

$$\Delta E_G = E_{Gf} - E_{Gi}$$

$$= (1)(9.8)(0.8) - (1)(9.8)(1.1)$$

$$= 7.84 - 10.78 = \boxed{-2.94\,J}$$

Unlike with vectors, positive energy is always higher than negative energy.

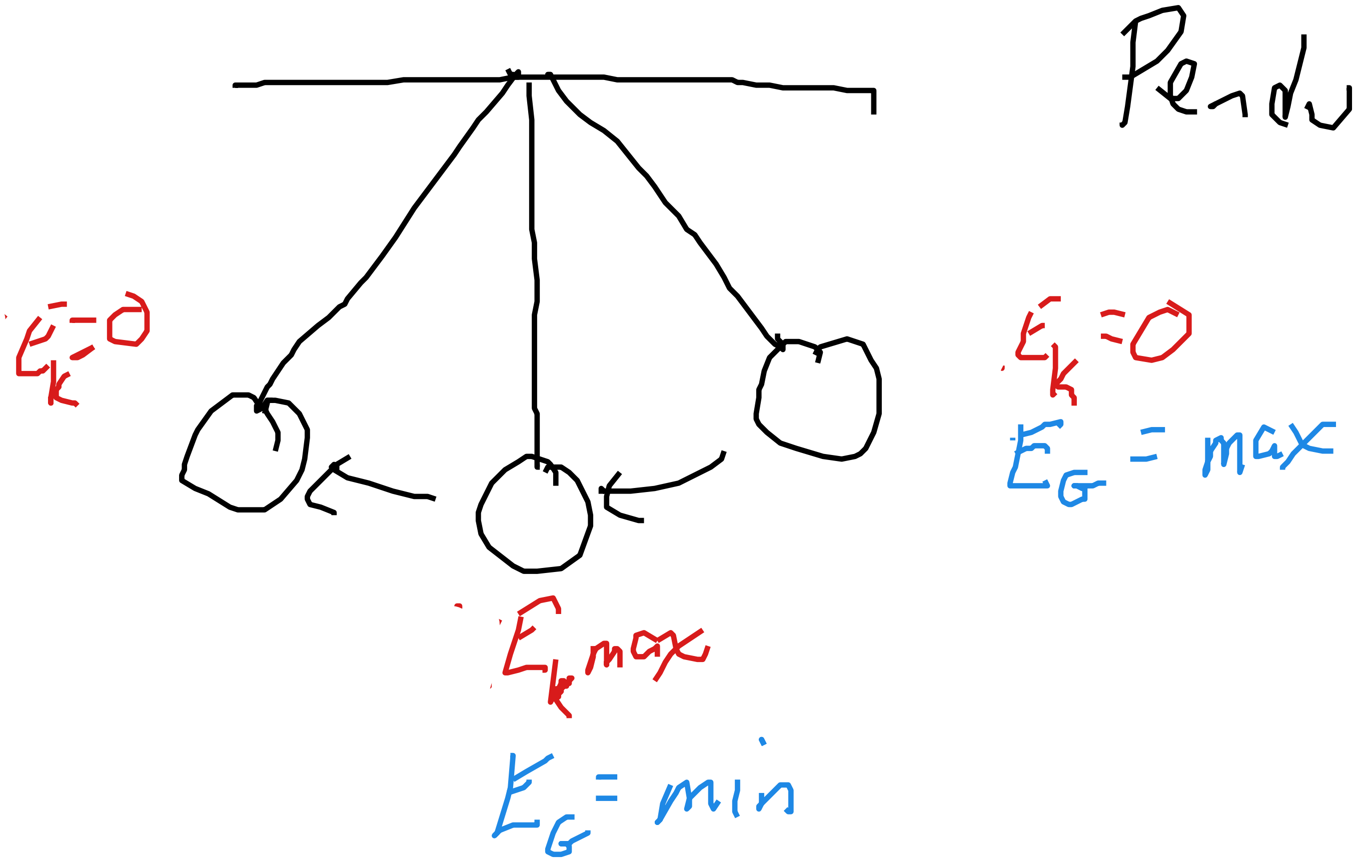
$$5J > -1{,}000{,}000J$$

compare

$+5 \, m/s \, \hat{x}$ $\quad$ $-1{,}000{,}000 \, m/s \, \hat{x}$

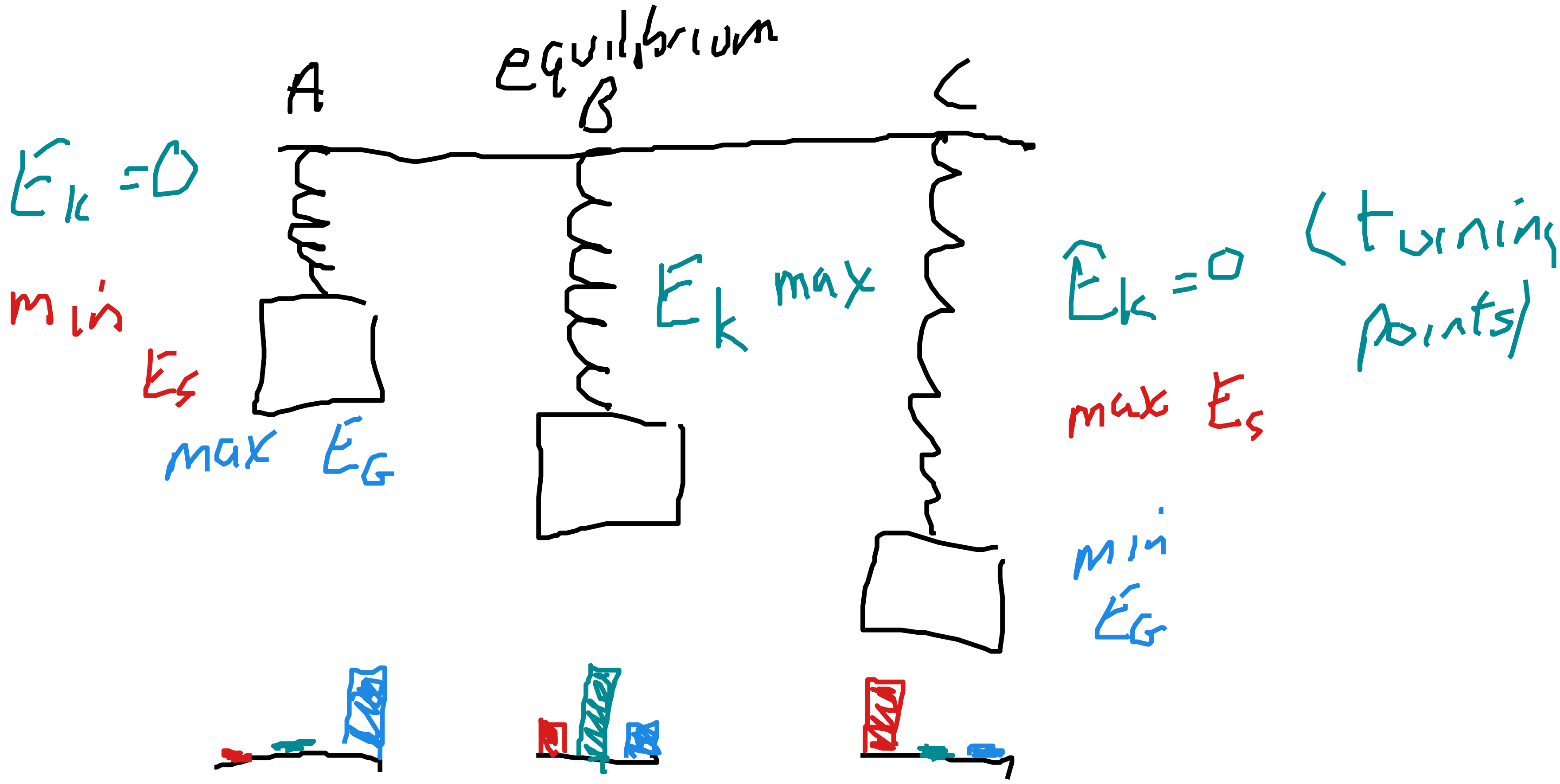
bigger because for vectors, sign means direction

Pendulum



Energy oscillates between kinetic and gravitational energy, but total energy remains constant

(unless friction or air resistance)

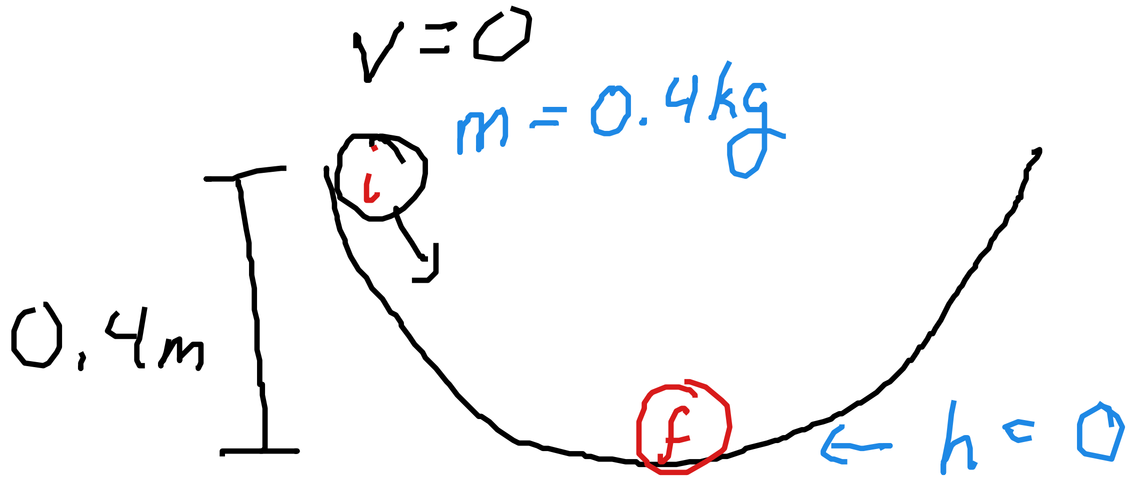


When is E_k maximal?

When is E_G maximal?

When is E_s maximal?

Energy again flows from one form to another as block oscillates.



What is the maximum speed of the ball? (Ignore friction)

$$E_f = E_i + W$$

$E_k = \frac{1}{2}mv_{max}^2$	$E_k = 0$	• weight ignore b/c E_G
$E_G = 0$	$E_G = mg(0.4)$	• normal zero b/c $\perp$ to motion
		• friction ignore b/c we were told to

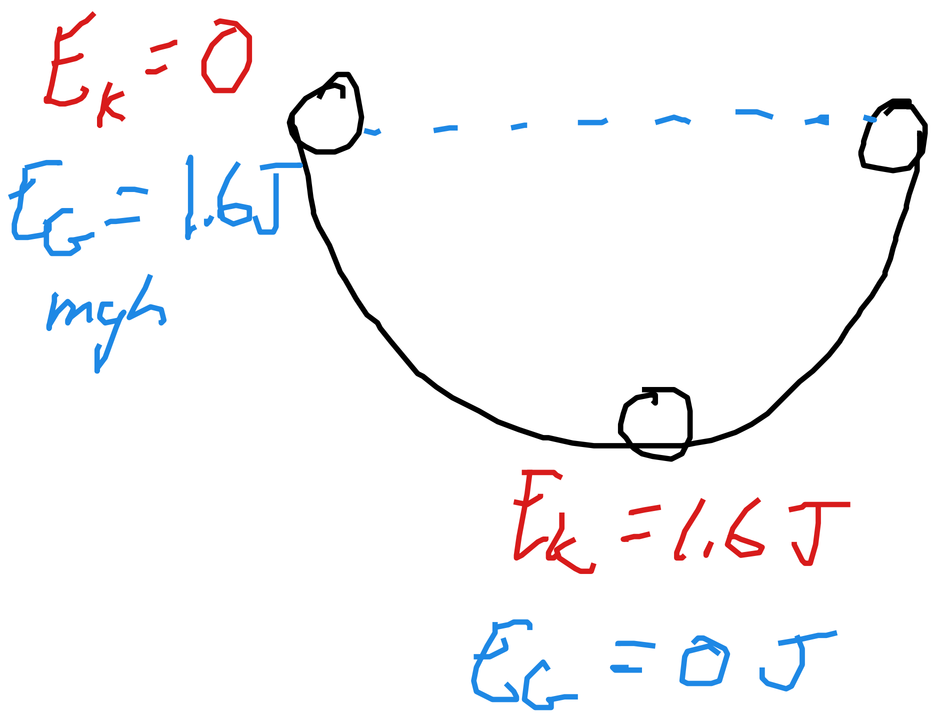
$$\frac{1}{2}mv_{max}^2 = mg(0.4) + 0$$

$$\frac{1}{2}\cancel{m}v_{max}^{2} = \cancel{m}g(0.4)$$

$$v_{max} = \sqrt{2g(0.4)}$$

$$= 2.8\,m/s$$

How high does ball go on the other side?

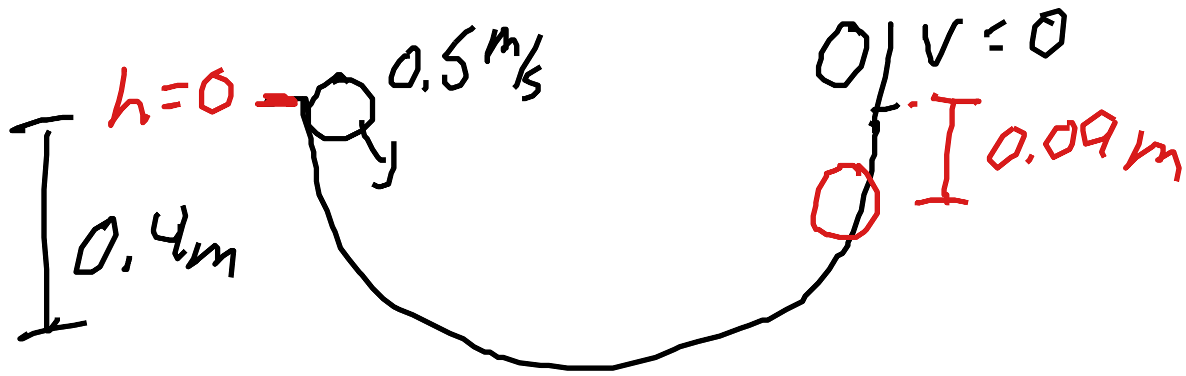


stops when $E_k = 0$

$E_G = 1.6J$

Same height as start

Suppose ball has initial kick of $0.5\,m/s$. And suppose friction does $-0.4J$ of work on ball. How high does it go?



E_f =	E_i +	W
$E_k = 0$	$E_k = \frac{1}{2}(0.4\,kg)(0.5)^2$	$-0.4\,J$
$E_G = (0.4)(9.8)h$	$E_G = 0$	

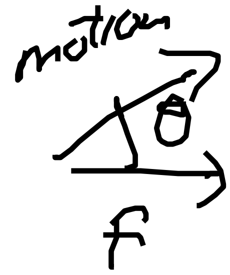
$$0.4(9.8)h = \frac{1}{2}(0.4)(0.5)^2 - 0.4$$

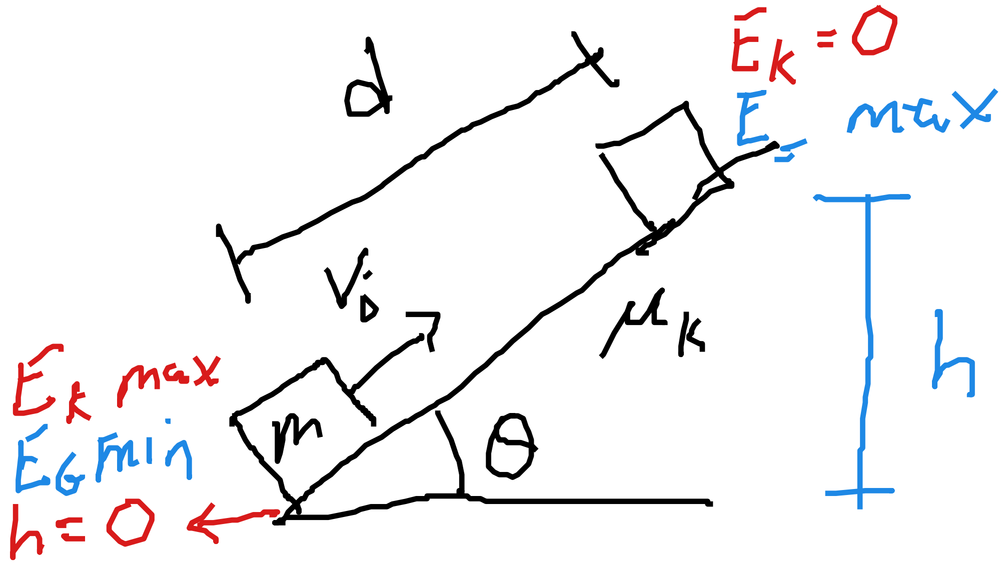
$$3.92h = 0.05 - 0.4$$

$$3.92h = -0.35$$

$$h = \frac{-0.35}{3.92} = -0.089\,m$$

$$W = Fd\cos\theta$$



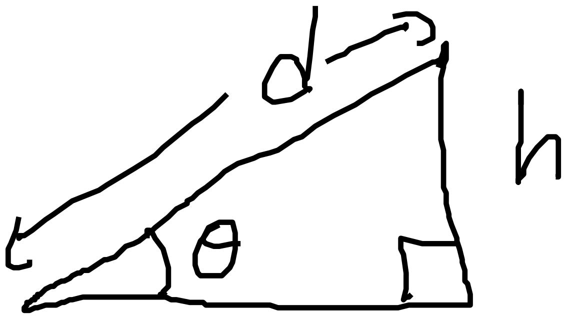


$$E_f = E_i + W$$

E_f	E_i	W
$E_k = 0$	$E_k = \frac{1}{2} m v_i^2$	$-\mu_k N d$
$E_G = mgh$	$E_G = 0$	$F_k = \mu_k N$

? NEED

$$mgh = \frac{1}{2}mV_i^2 - \mu_k N \underline{d}$$



$$\frac{h}{d} = \sin\theta$$

$$\boxed{h = d\sin\theta}$$

$$mgd\sin\theta = \frac{1}{2}mV_i^2 - \mu_k N d$$

N gets smaller as θ gets bigger

when θ = 0, N = mg

$$\therefore \quad \boxed{N = mg\cos\theta}$$

$$\cancel{m}g\,d\sin\theta = \frac{1}{2}\cancel{m}V_i^2 - \mu_k \cancel{m}g\cos\theta\, d$$

$$g\,d\sin\theta + \mu_k g\,d\cos\theta = \frac{1}{2}V_i^2$$

$$d\left(g\sin\theta + \mu_k g\cos\theta\right) = \frac{1}{2}V_i^2$$

$$d = \frac{V_0^2}{2g(\sin\theta + \mu_k\cos\theta)}$$

for example

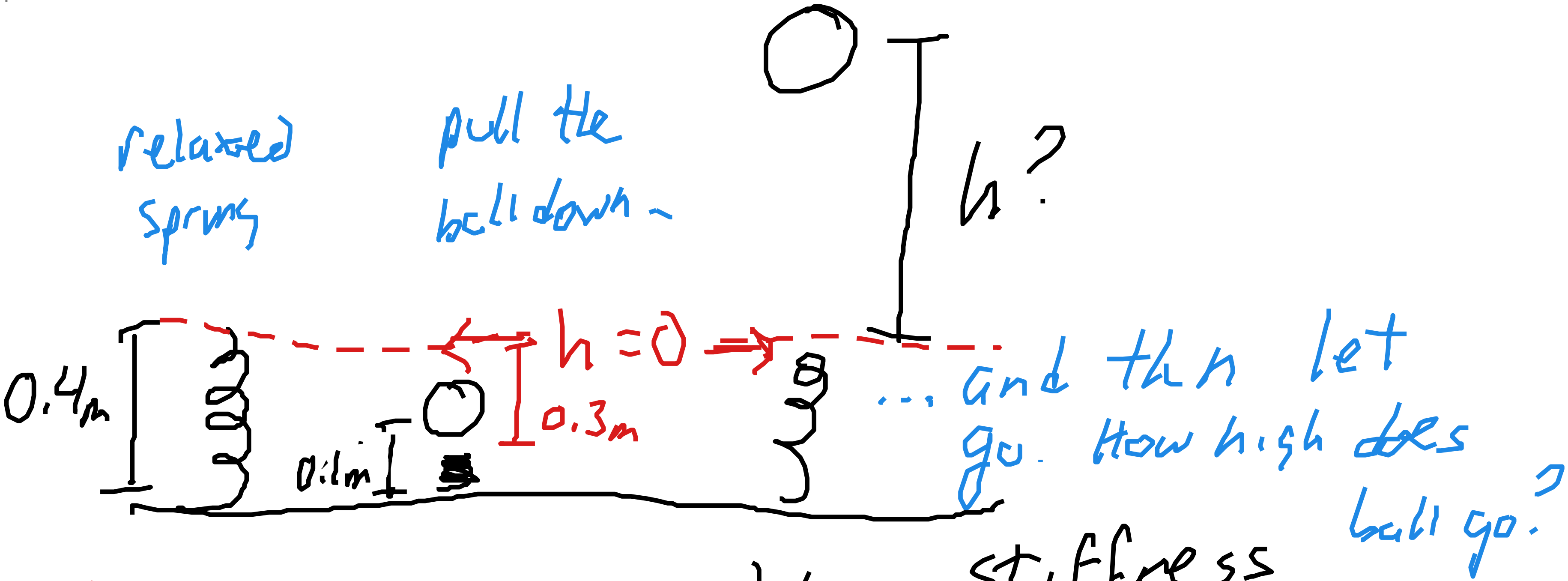
$V_i = 5\,m/s$

$\mu_k = 0.5$

$\theta = 10^\circ$ $\qquad\qquad \theta = 45^\circ$

$$d = \frac{(5)^2}{2(9.8)(\sin 10^\circ + 0.5\cos 10^\circ)} \qquad d = 1.2m$$

$= 1.92m$



not kinetic friction!

$k = 2000\ N/m$ stiffness of spring

$m_{ball} = 0.5\ kg$

How high does ball go?

	E_f	=	E_i	+	W
K:	0		0		0
G:	mgh		$mg(-0.3)$		no friction ignore spring and gravity
S:	0		$\frac{1}{2}k(0.3)^2$		

$$(0.5)(9.8)h = (0.5)(9.8)(-0.3) + \frac{1}{2}(2000)(0.3)^2$$

$$4.9h = -1.47 + 90$$

$$h = \frac{90 - 1.47}{4.9}$$

$$h = 18m$$