Conservation of Energy

Problems involve moving from one place to another

$E = K + U$ (i) (f)

$$E_i = E_f$$

changes to the total mechanical energy will occur if there are NON-CONSERVATIVE forces (any force other than gravity springs)

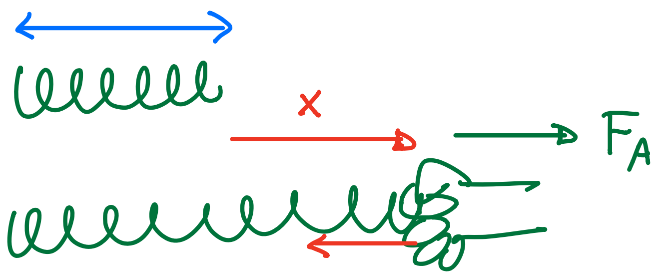
$W_{nc} > 0$ Energy is added

$W_{nc} < 0$ Energy removed

when including U_g make sure you know where $h = 0$ is

Springs/elastics

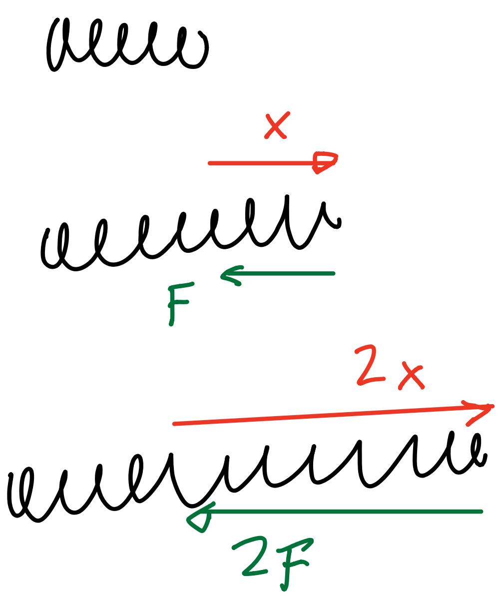
relaxed length



x = change in spring length from its relaxed length

Hooke's Law: $F_s \overset{\text{proportional to}}{\propto} -x$

spring force opposite direction of x



$$F = kx$$

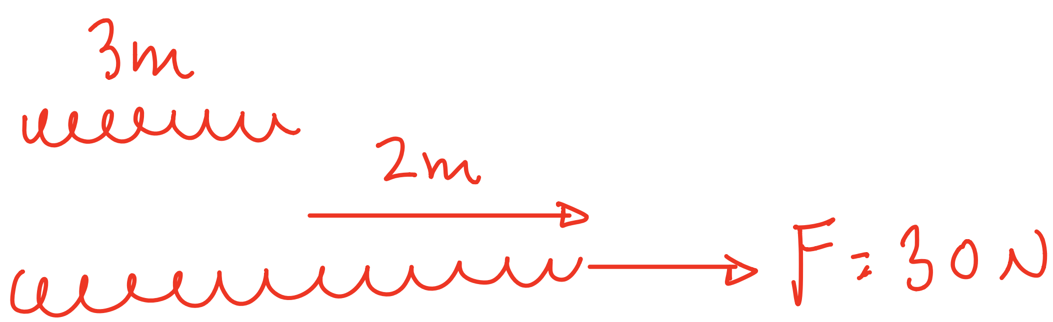
Force required to stretch or compress a spring

k = spring constant

unit: N/m

a measure of <u>stiffness</u>

stiffer = larger k



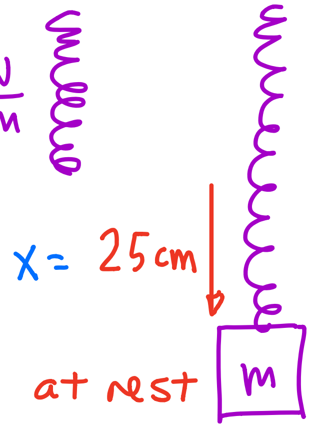
what is the spring constant?

$$F = kx$$

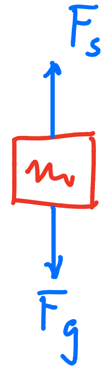
$$30N = k(2m)$$

$$k = 15 \, N/m$$

$k = 100 \frac{N}{m}$



← what is m?



in equilibrium

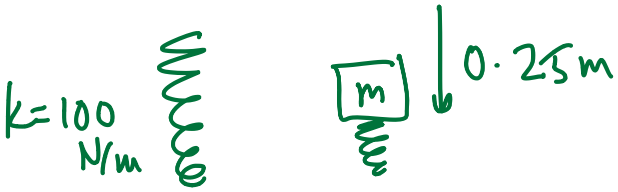
$F_s = F_g$

$kx = mg$

$100 \frac{N}{m} \times 0.25\,m = m \cdot 10\,m/s^2$

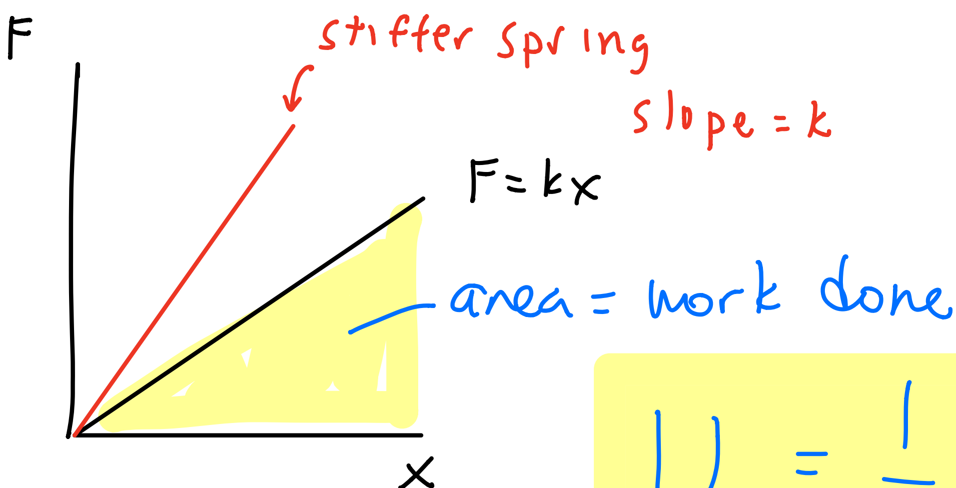
$m = 2.5\,kg$

same question



Energy stored in a spring

U_s (or PE_s)

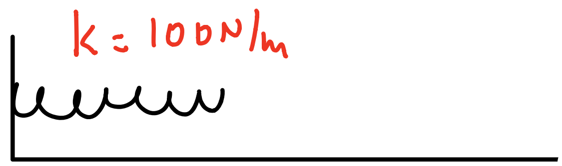


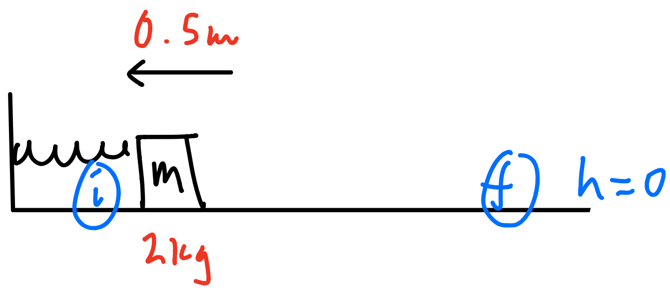
$$\boxed{U_s = \frac{1}{2} k x^2}$$

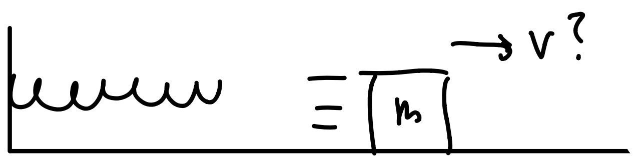
>0 $\quad$ >0

$$E_i = E_f$$

$$K_i + U_{gi} + U_{si} = K_f + U_{gf} + U_{sf}$$







$$U_{si} = K_f$$

$$\cancel{\tfrac{1}{2}} k x^2 = \cancel{\tfrac{1}{2}} m v^2$$

$$v^2 = \frac{k}{m} x^2$$

$$v = \sqrt{\frac{k}{m}}\, x$$

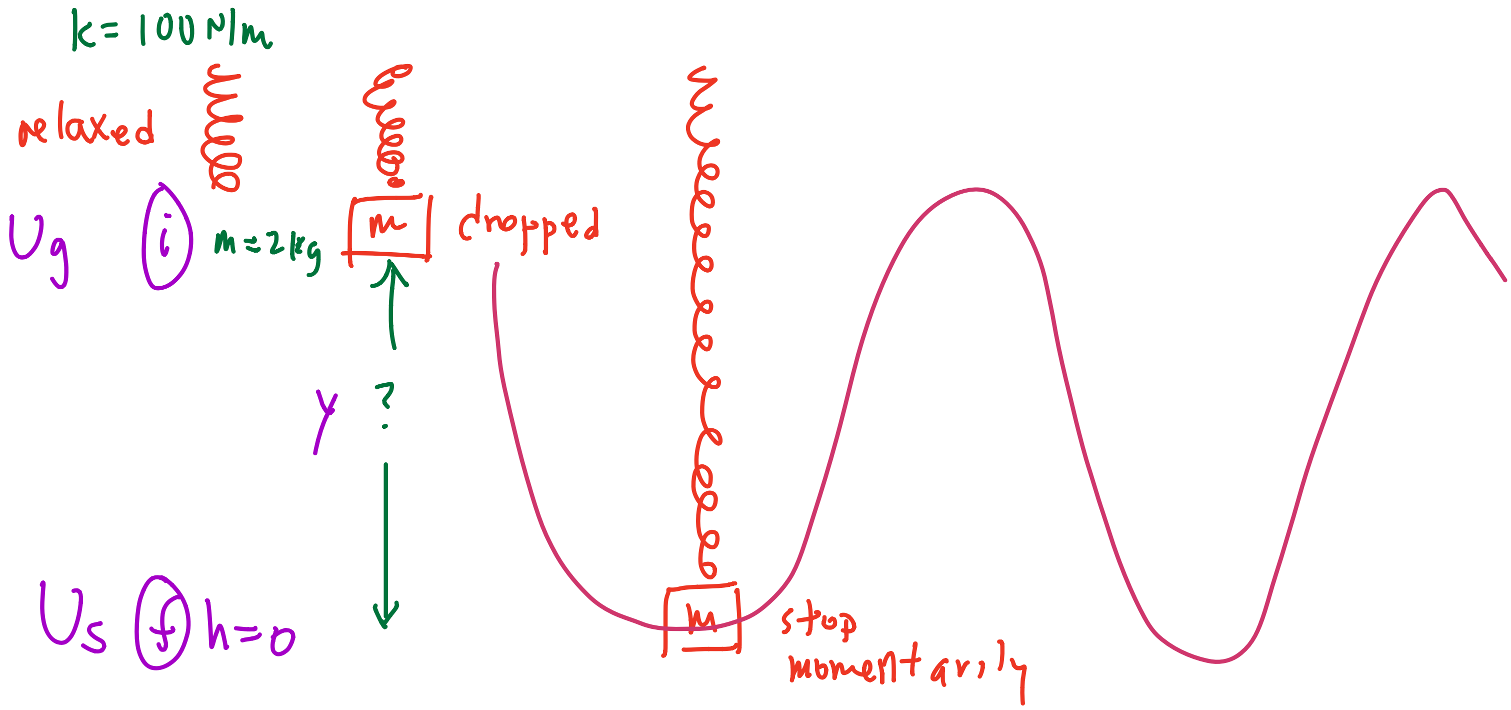
$$v = \sqrt{\frac{100}{2}} \cdot 0.5$$

$$v = 3.5 \text{ m/s}$$

If compression is doubled how would the speed be different?

also doubled

(energy is quadrupled)



$$U_{gi} = U_{sf}$$

$$mg\cancel{y} = \frac{1}{2}ky^{\cancel{2}}$$

$$y = \frac{2mg}{k} = \frac{2 \cdot 2\,kg \cdot 10\,m/s^2}{100\,N/m}$$

$$y = 0.4\,m$$

why didn't we use $mg = kx$ at bottom? just because the block was at rest doesnt mean equilibrium. The forces at the bottom are <u>NOT</u> balanced

In general

$F = kx$

object at rest and remains at rest

or question is asking about acceleration

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

"action!"

energy into or out of the spring