Gravitational Potential energy

$$E_g = mgh$$

$$W = \Delta E_g \quad \text{(work-energy theorem)}$$

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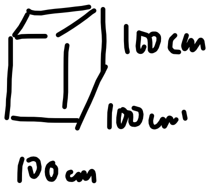

$$(100\,cm)^3 \left(\frac{1\,mL}{1\,cm}\right)\left(\frac{1\,g}{1\,mL}\right)\left(\frac{1\,kg}{1000\,g}\right)$$

$$\boxed{1000\,kg}$$

$$E_g = mgh$$

$$E_g = (1000\,kg)(9.81\,m/s^2)(250\,m)$$

$$\boxed{E_g = 2.5 \times 10^6\,J}$$

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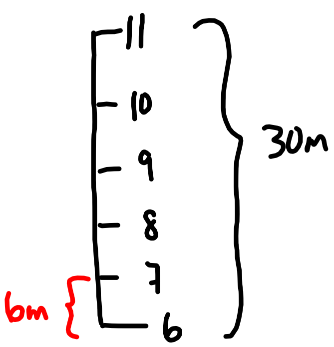
34.



$$m = 1.35 \times 10^3\,kg$$

a) $E_g = mgh$

$$E_g = (1.35 \times 10^3\,kg)(9.81\,m/s^2)(12\,m)$$

$$\boxed{E_g = 1.6 \times 10^5\,J}$$

Elastic Potential Energy

Hooke's Law

The restoring force in a spring or elastic is directly proportional to the extension of the spring but in the opposite direction to the applied force.

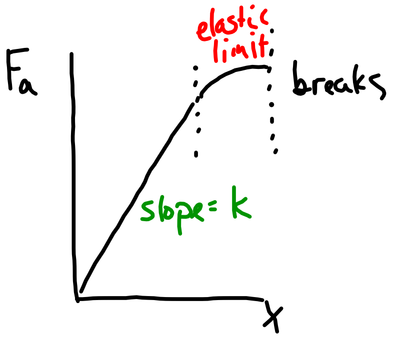
$$F \propto x$$

$$F = -kx$$

It is more practical to express Hooke's Law in terms of the applied force.

$$\boxed{F_a = kx}$$

where F_a is the applied force (N)
k is the spring constant (N/m)
x is the extension (+) | compression (−) (m)



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$F_a = 133\text{N}$

$x = \textcircled{+}\,71\text{cm}$ ← extension

$k = ?$

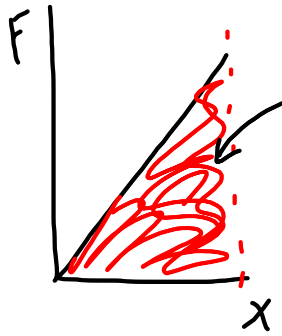
$$F_a = kx$$

$$k = \frac{F_a}{x}$$

$$k = \frac{133\text{N}}{(0.71\text{m})}$$

$$\boxed{k = 1.9 \times 10^2\ \text{N/m}}$$

Elastic Potential Energy



area = work = change in elastic potential energy

$$\text{Area} = \frac{1}{2}bh$$

$$\text{Area} = \frac{1}{2}Fx \quad \text{but } F = kx$$

$$\text{Area} = \frac{1}{2}(kx)x$$

$$\text{Area} = \frac{1}{2}kx^2$$

Since the spring had no potential energy to begin with, this area represents the final potential energy.

$$\boxed{E_e = \frac{1}{2}kx^2}$$

Where E_e is the elastic potential energy (J)
k is the spring constant (N/m)
x is the extension or compression (m)

The work energy theorem applies:

$$\boxed{W = \Delta E_e}$$

More generally: $\boxed{W = \Delta E}$

↑ any type of energy

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$k = 75 N/m$

$x = -28 cm$

↑ compression

a) $\Delta E_e = ?$

b) $F_a = ?$

a) $\Delta E_e = E_{e_2} - \cancelto{0}{E_{e_1}}$

$\Delta E_e = E_{e_2}$

$\Delta E_e = \frac{1}{2}kx^2$

$\Delta E_e = \frac{1}{2}\left(75 \frac{N}{m}\right)(-0.28 m)^2$

$\boxed{\Delta E_e = 2.9 J}$

b) $F_a = kx$

$F_a = \left(75 \frac{N}{m}\right)(-0.28 m)$

$F_a = -21 N$

↑ compression (pushing on the spring)

TO DO

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② PP|261