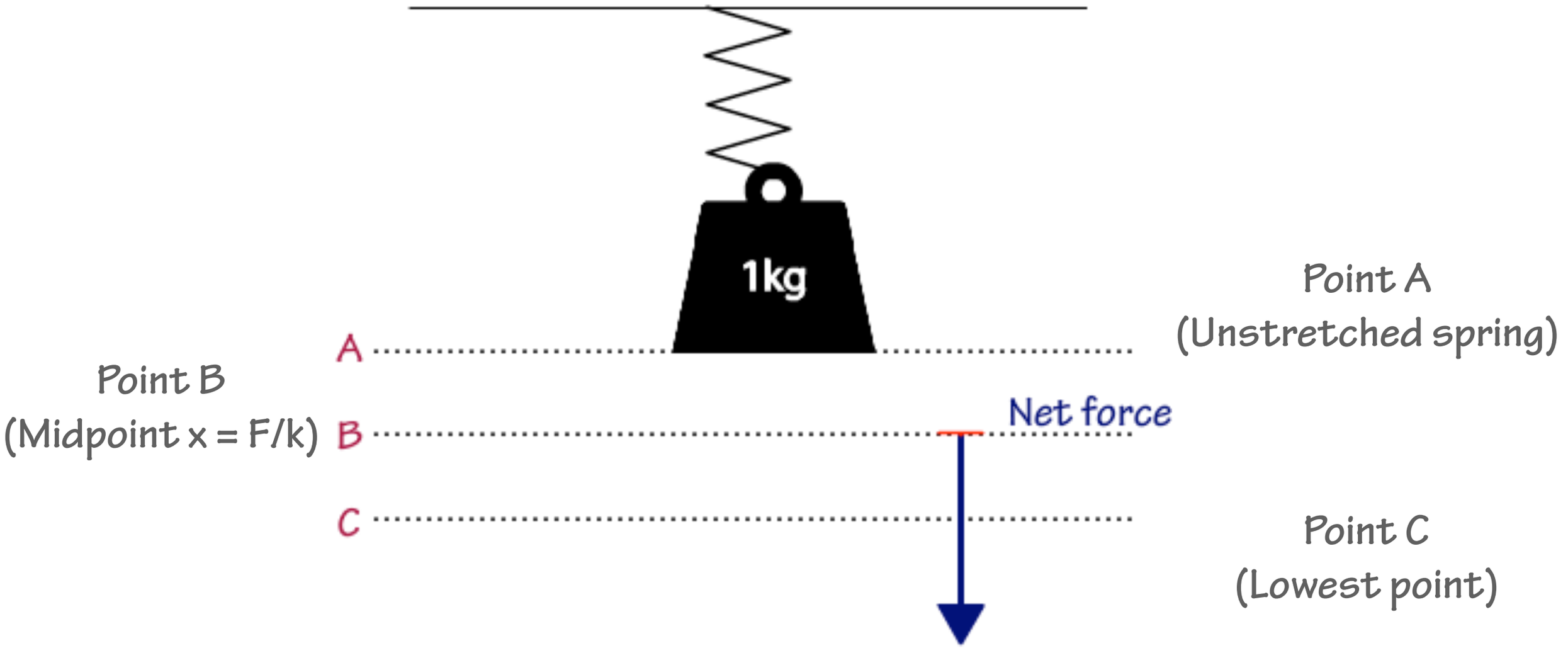
The Spring pendulum



The Spring pendulum

- A mass of 1.0 kg is attached to a long spring of stiffness k = 30 N/m. The mass is allowed to fall from the starting height, at which the spring was unstretched.
- Calculate the distance (x) over which the mass will oscillate.
- Calculate the maximum speed reached.
- Calculate the % of each energy type at the three points.

Conservation of energy: maximum extension

Kinetic energy $\longrightarrow$ $E_k = mgx - \frac{1}{2}kx^2$

Difference of gravitational & elastic energy

At point c, all of the potential energy from point a has been converted into elastic energy. $E_k = 0$ at both points.

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

$0 = x(mg - \frac{1}{2}kx) \longrightarrow x = \frac{2mg}{k} = 0.67m$

$x = 0m$

x = 0.67m is the maximum extension

Conservation of energy: maximum speed

$$E(x) = mgx - \frac{1}{2}kx^2$$ Kinetic energy as a function of height

$$E'(x) = mg - kx$$ Derivative of kinetic energy

Maximum kinetic energy occurs at: $O = mg - kx$ $x = \frac{mg}{k}$

$$x = 0.33m$$

(That's where there is zero net force - it slows down as it gets past this.)

Potential energy = mgx = 3.3J

Elastic energy = ½kx² = 1.7J

Kinetic energy = 1.7J

$$v = \sqrt{\frac{2E_k}{m}}$$

$$v = 1.8m/s$$

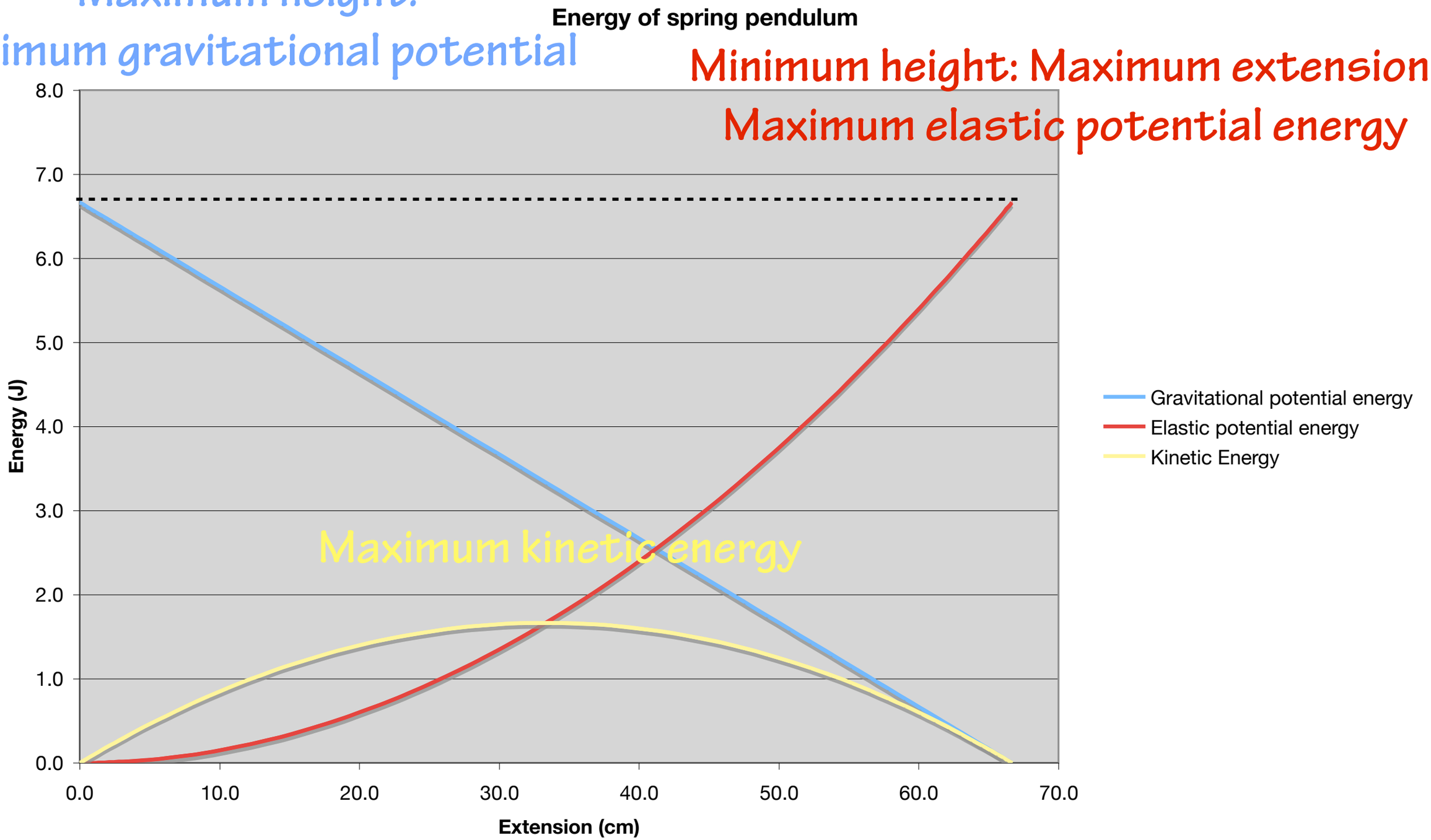
Conservation of energy: energy balance

Energy form	a (highest)	b (mid point)	c (lowest)
Potential	6.7J = 100%	3.3J = 50%	0J = 0%
Kinetic	0J = 0%	1.7J = 25%	0J = 0%
Elastic	0J = 0%	1.7J = 25%	6.7J = 100%

Energy vs extension

Maximum height:
maximum gravitational potential

Minimum height: Maximum extension:
Maximum elastic potential energy



Energy vs time

Maximum height:
maximum gravitational potential

Minimum height: Maximum extension:
Maximum elastic potential energy