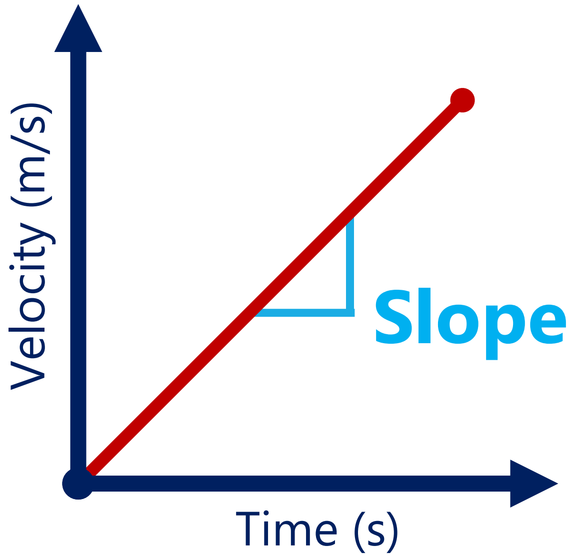
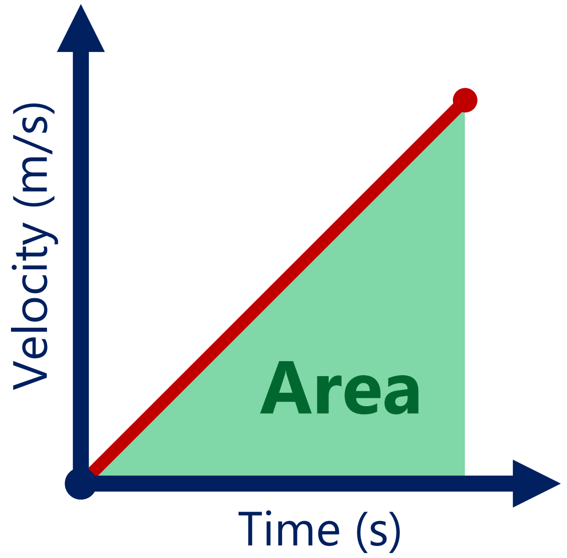
Elastic Potential Energy

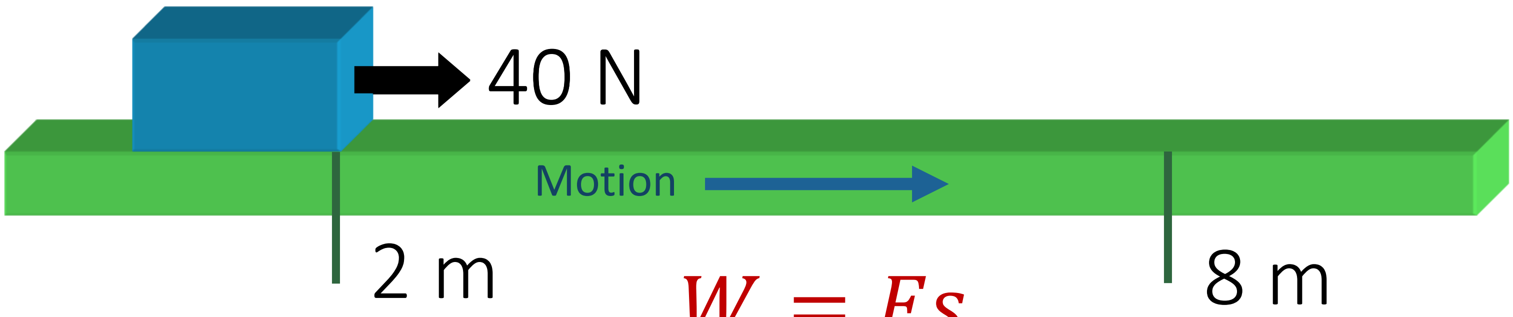
IB PHYSICS | ENERGY & MOMENTUM

Calculating from a Graph

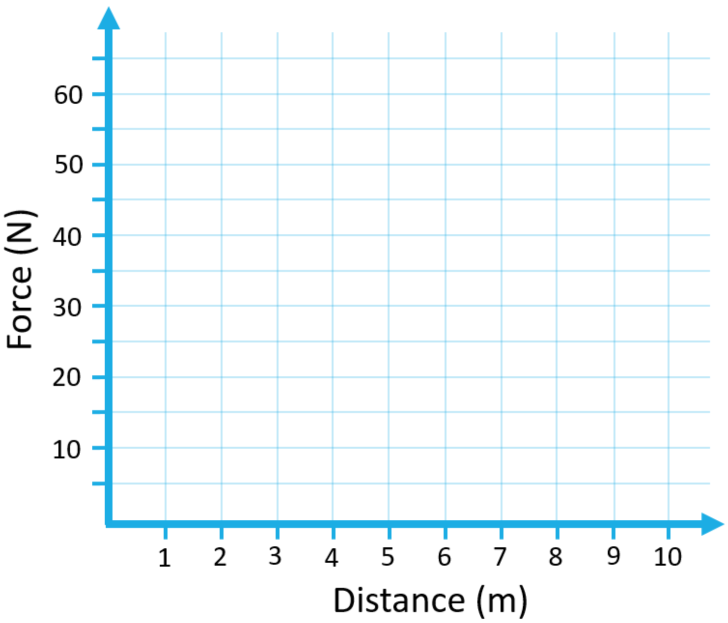




Graph of Force vs Displacement



$$W = Fs$$

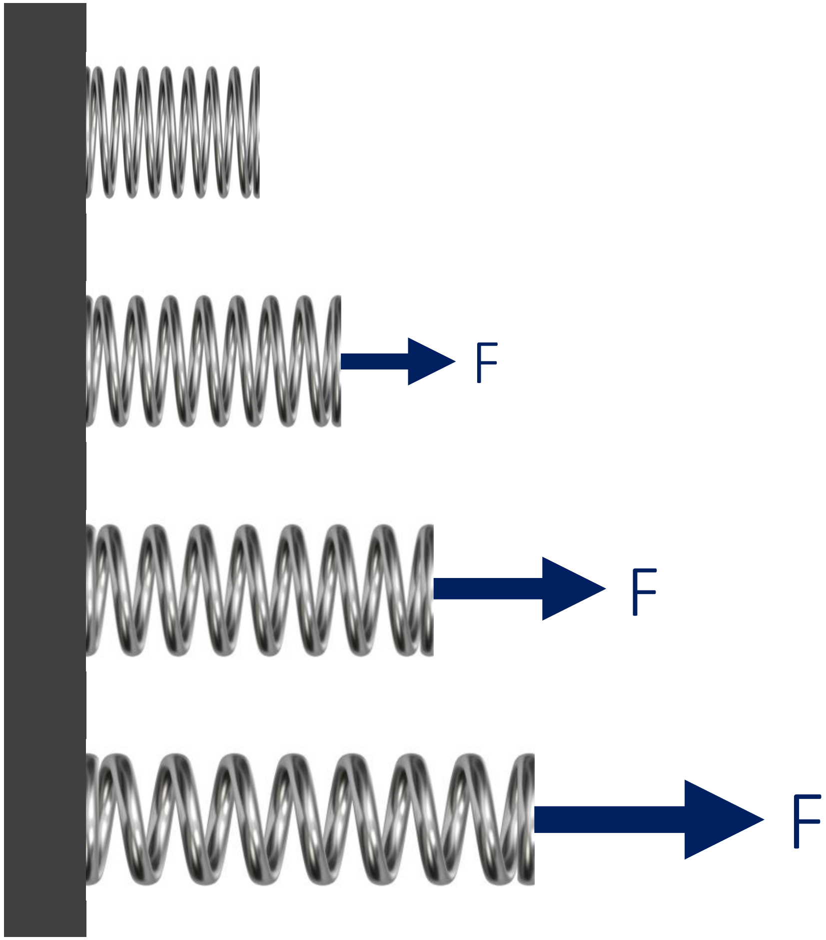


Work of a Varying Force

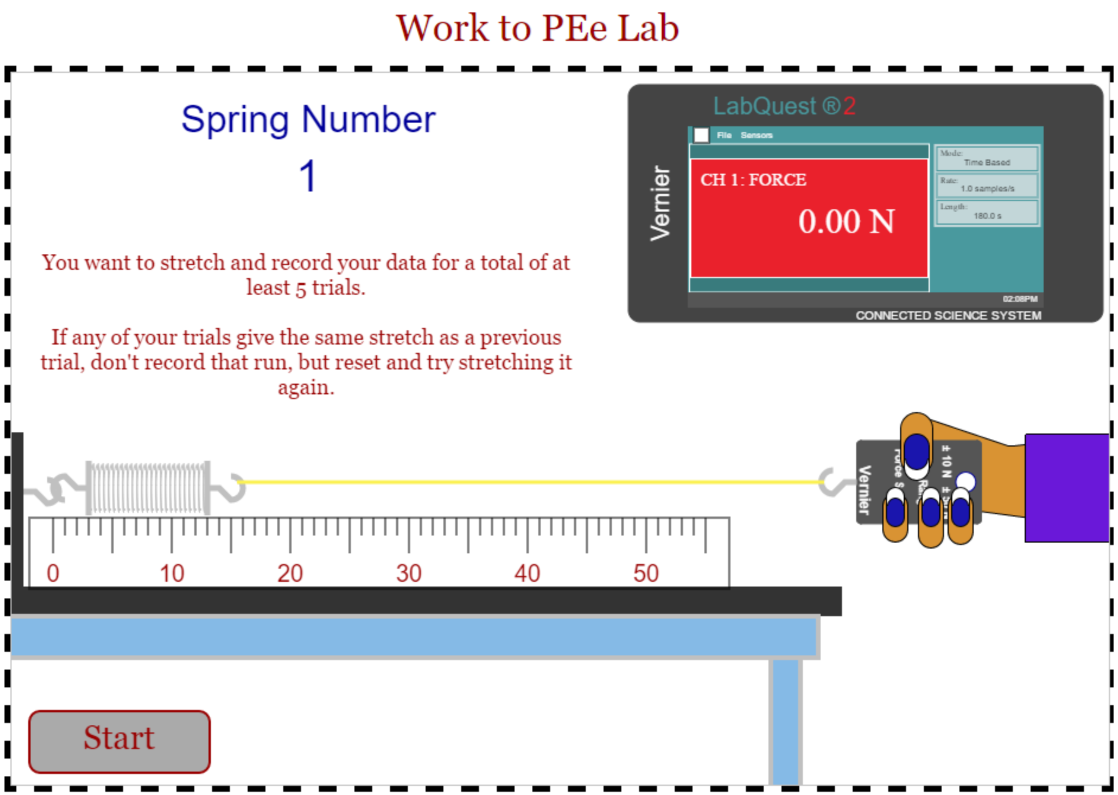
Our definition of work applies only for a constant force or an average force.

$$W = Fs \cos\theta$$

What if the force varies with displacement as with stretching a spring or rubber band?



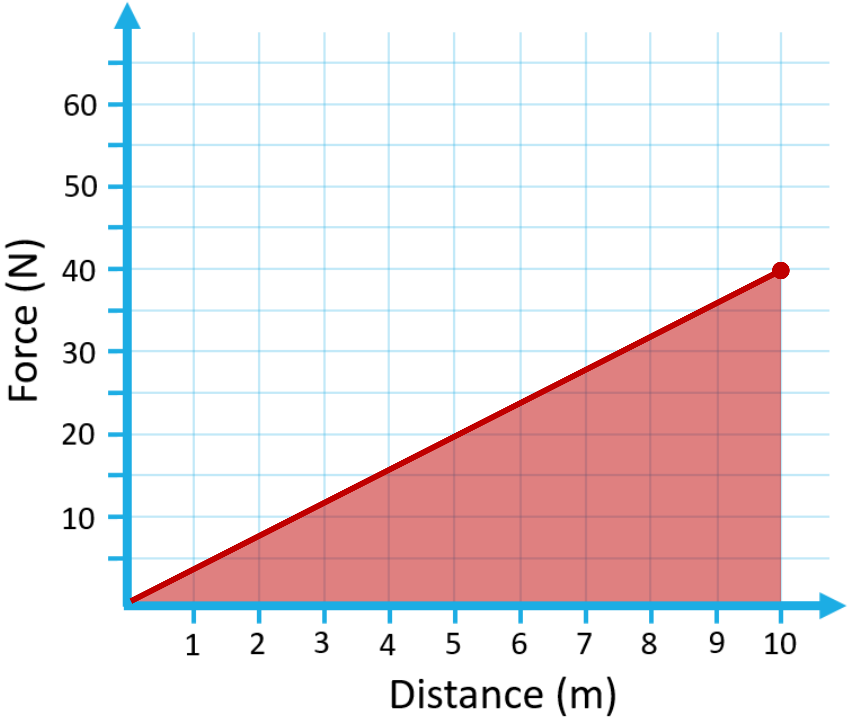
What about a Varying Force?



[Click here for the simulation]

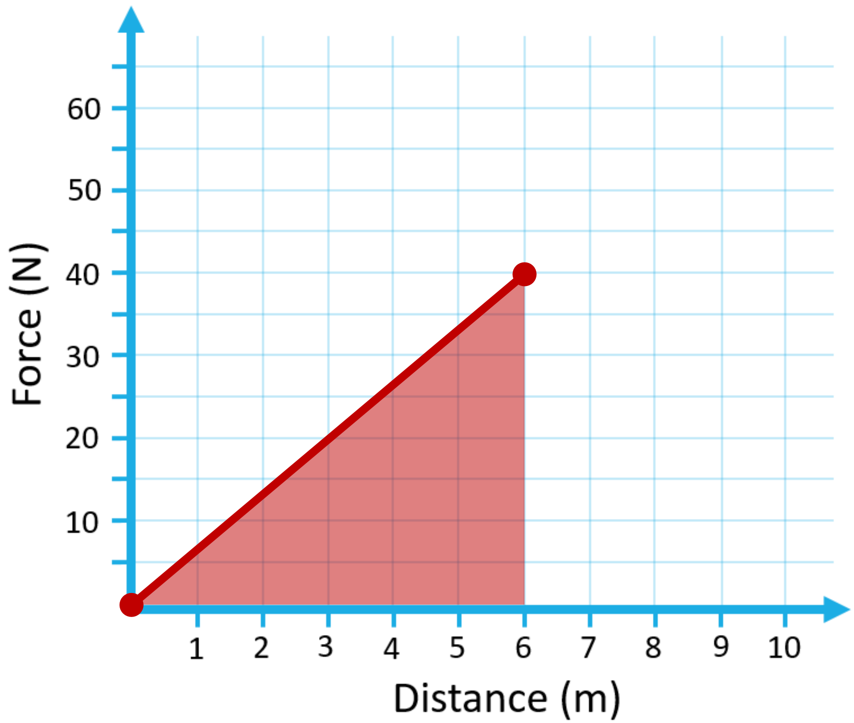
Work of a Varying Force

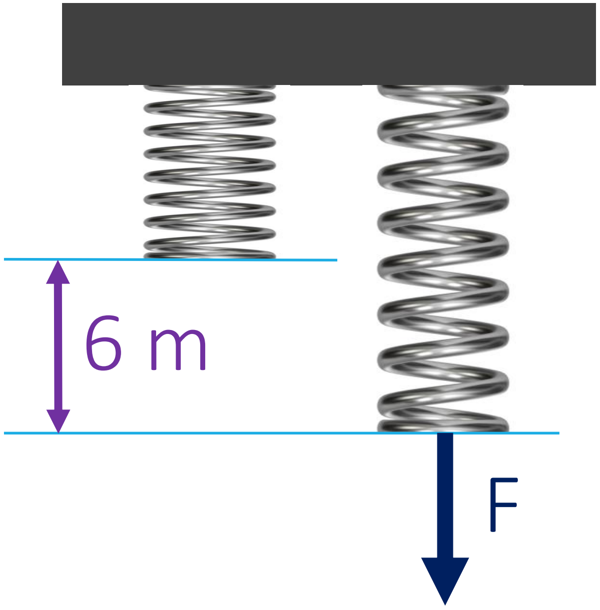
How can you calculate the work?



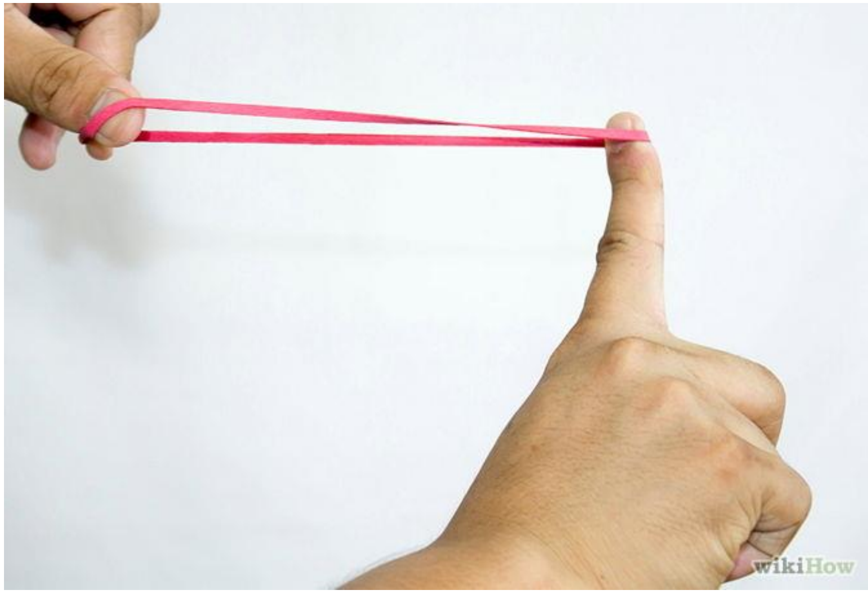
Work of a Varying Force

What **work** is required to stretch this spring from x = 0 to x = 6 m?



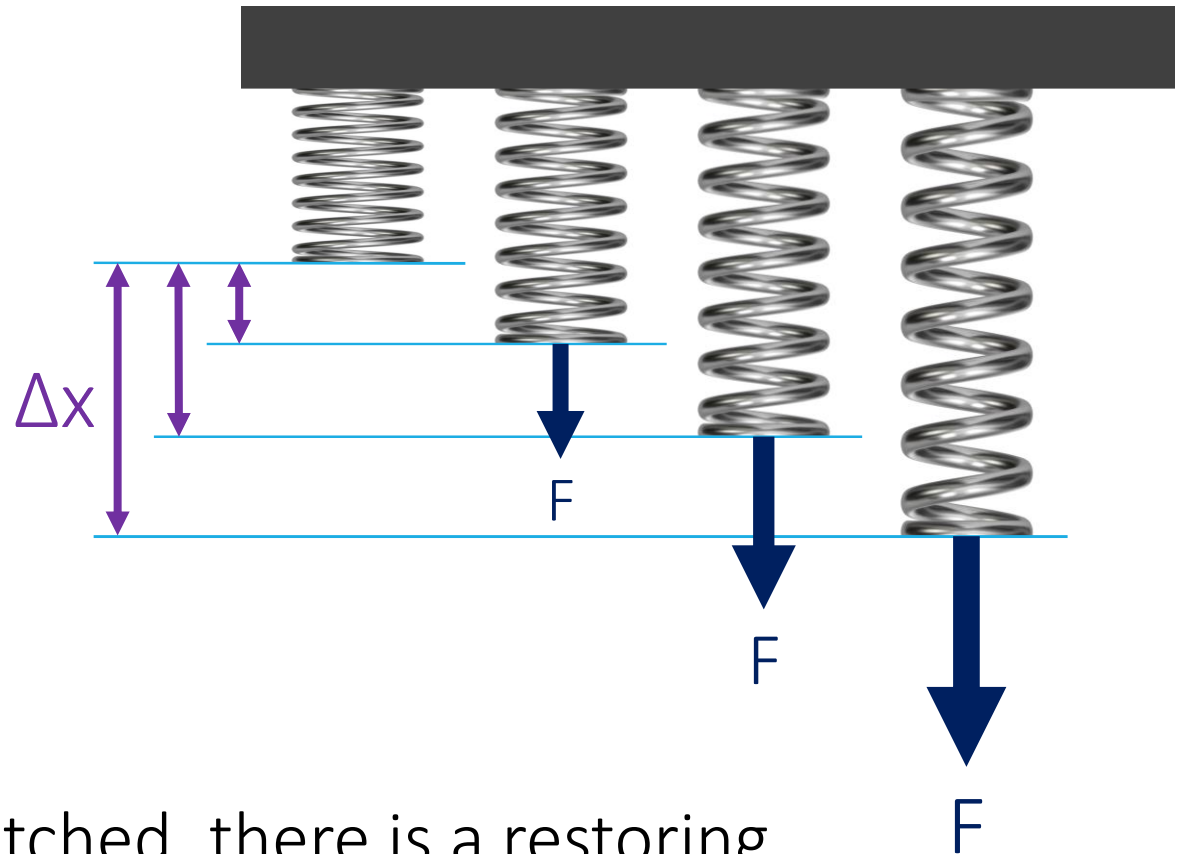


Elastic Potential Energy



As the pull back distance increases elastic potential energy ________________

Hooke's Law

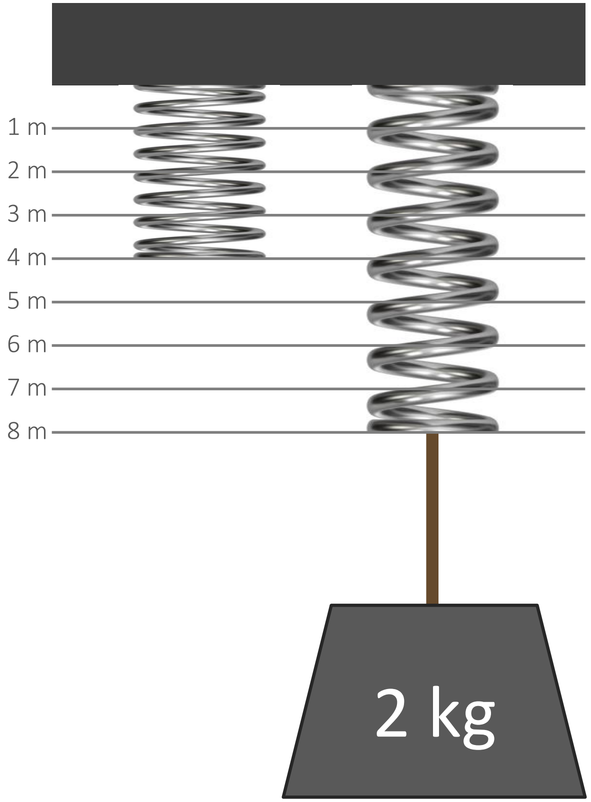


When a spring is stretched, there is a restoring force that is proportional to the displacement.

Try this...

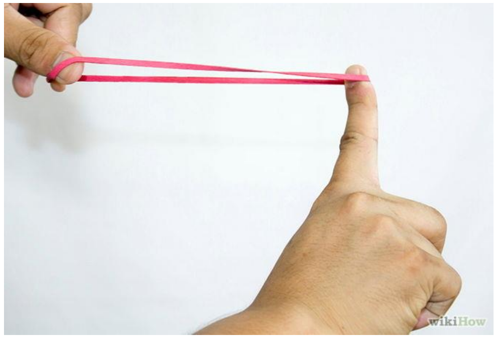
A block with a mass of 2 kg is suspended from a spring and produces the displacement shown. What is the spring constant?

$$F = k\Delta x$$



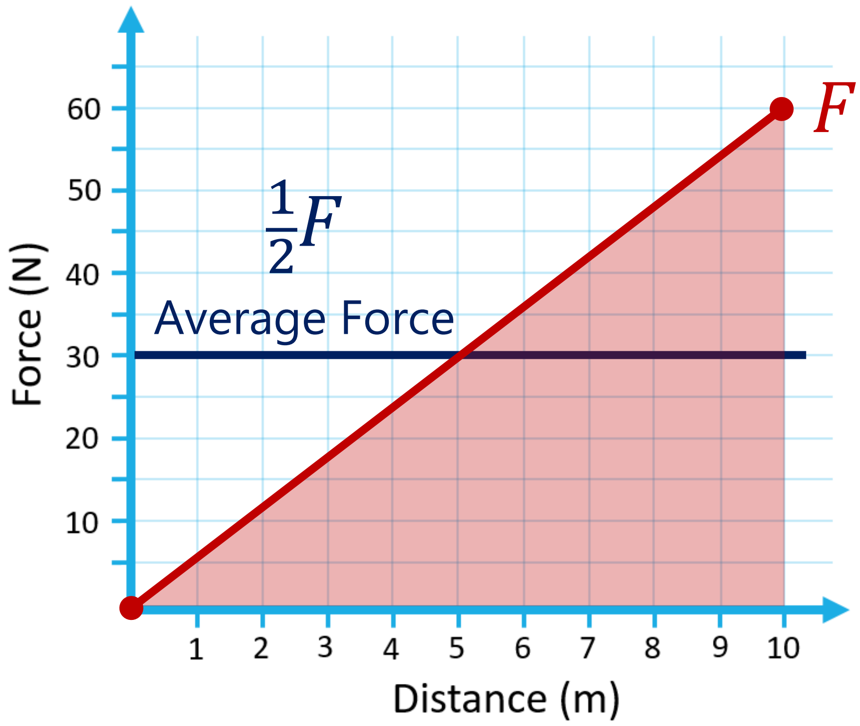
Work and Energy

Work done on a system causes the system to gain or lose energy



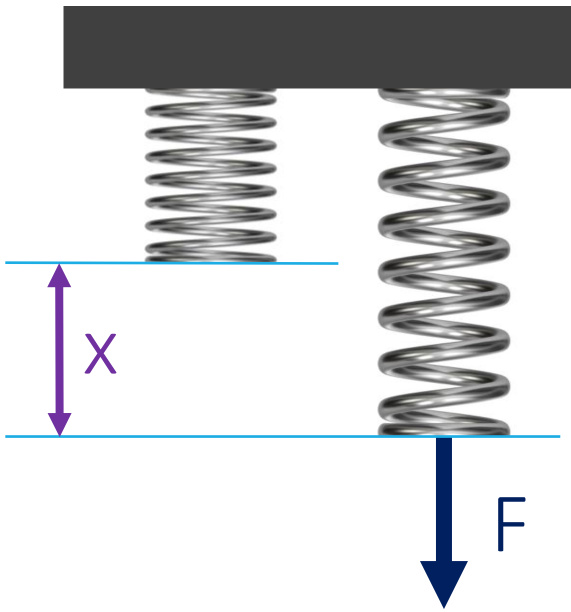
Work of a Varying Force

Now that we know that F = kΔx, we can calculate the stored elastic potential energy with the work equation



$$Work = Fs$$

Elastic Force and Work



$$F = k\Delta x$$

$$E_p = \frac{1}{2}k\Delta x^2$$

*****_The spring constant k is a property of the spring_

Data Booklet

Sub-topic 2.3 – Work, energy and power

$$W = Fs\cos\theta$$

$$E_K = \frac{1}{2}mv^2$$

$$E_P = \frac{1}{2}k\Delta x^2$$

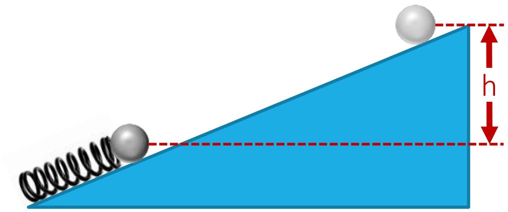
$$\Delta E_P = mg\Delta h$$

$$\text{power} = Fv$$

$$\text{Efficiency} = \frac{\text{useful work out}}{\text{total work in}} = \frac{\text{useful power out}}{\text{total power in}}$$

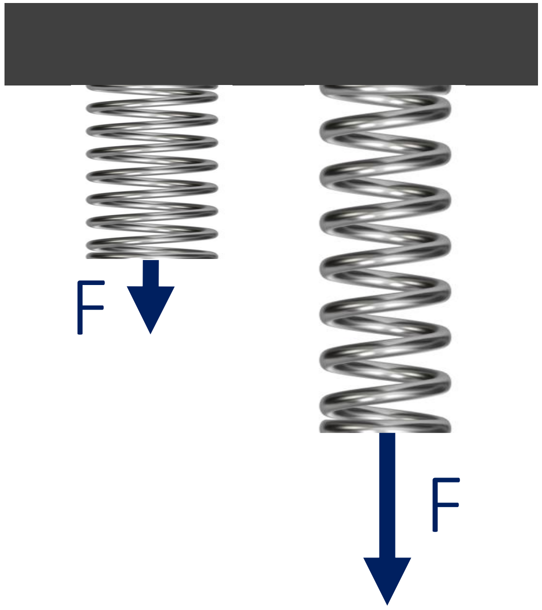
Conservation of Energy

How far up the 15° incline of a pinball table will a 0.1 kg pinball move after it is launched? The spring constant is 100 N/m and is compressed by 0.08 m.



Try this...

What **work** is required to stretch this spring ($k = 200\ N\ m^{-1}$) from $\Delta x = 0.1\ m$ to $\Delta x = 0.4\ m$?

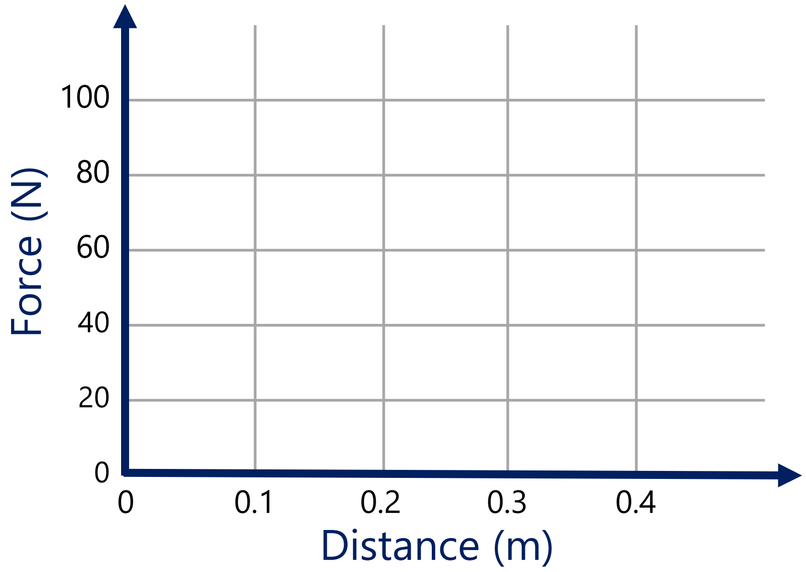


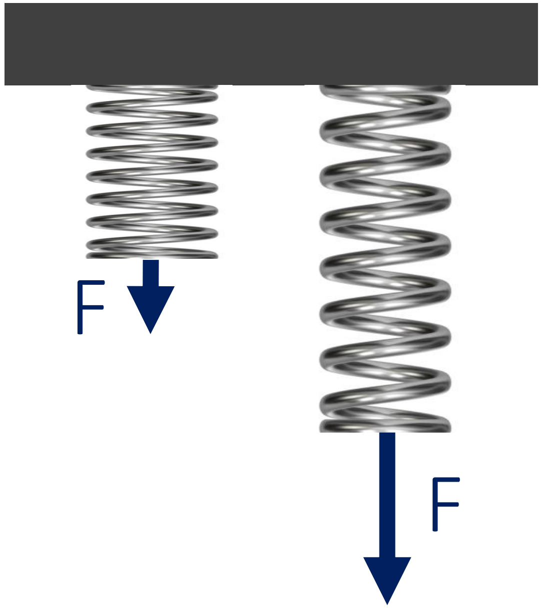
Try this...

What **work** is required to stretch this spring ($k = 200\ \text{N m}^{-1}$) from $\Delta x = 0.1$ m to $\Delta x = 0.4$ m?

Why not just use the stretch change?

$$\frac{1}{2}k\Delta x^2 = \frac{1}{2}(200)(0.3)^2 = 9\ \text{J}$$

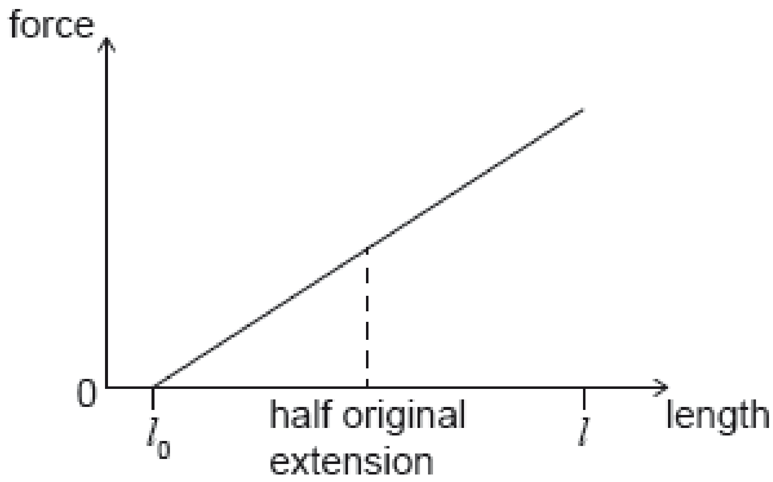




Example IB Question

An increasing force acts on a metal wire and the wire extends from an initial length l_0 to a new length l. The graph shows the variation of force with length for the wire. The energy required to extend the wire from l_0 to l is E. The wire then contracts to half its original extension. What is the work done by the wire as it contracts?

A. $0.25E$
B. $0.50E$
C. $0.75E$
D. E



Lesson Takeaways

- ❑ I can calculate work as area bounded by a Force vs Distance graph
- ❑ I can use Hooke's Law to calculate the elastic force at a given displacement
- ❑ I can describe and calculate elastic potential energy