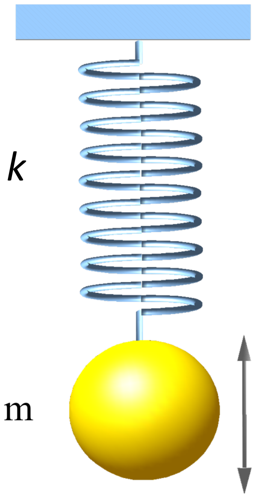
6.3.1 Applications of simple harmonic motion

The spring pendulum



There are two factors that affect the period of oscillation of a mass-spring system - the spring constant ('stiffness' of the spring) k and the mass m.

videos

Have a go at changing each in the following simulation:

https://tinyurl.com/yy9atno9

(1)✐How would the period change if you increased the spring constant?

(2)✐How would the period change if you increased the mass?

Provided the spring is not stretched beyond its elastic limit is will obey Hooke's Law:

$$F = -kx$$

The minus sign is there because the restoring force F is always in the opposite direction to the displacement (from equilibrium).

(3)✐Using F=ma, substitute for F in the equation, above, and rearrange to make x the subject.

We know that the mass-spring system will oscillate with SHM, and a defining feature of SHM is:

$$a = -(2\pi f)^2 x,$$

where A is the amplitude, x is the displacement and f is the frequency.

(4)✐Substitute for x, using the previous equation and rearrange this equation to make f the subject.

(5)✐The period $T = \frac{1}{f}$*. Substitute for f and rewrite the equation to make T the subject.*

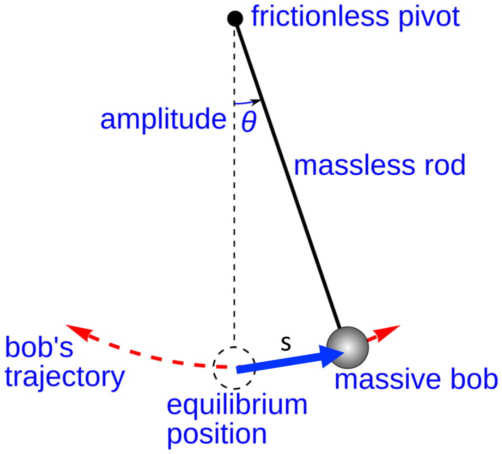
You should have found the period of the spring pendulum is given by:

$$T = 2\pi\sqrt{\frac{m}{k}}$$

(6)✐How would you show experimentally that this relationship is correct?

The Simple pendulum

There are two factors that affect the period of a pendulum; the length of the pendulum l and the gravitational field strength g.



The period of a pendulum is given by:

$$T = 2\pi\sqrt{\frac{l}{g}}$$

Systems will oscillate with SHM if the restoring force is proportional to the displacement from the equilibrium position.

(7)✐For a pendulum, where does the restoring force come from?

(Note: This is tricky.)

(8)✐Show that for small angles (Hint: use small angle approximation), the restoring force is proportional to the displacement s.