Oscillations

- When the net force on an object is proportional to its displacement from equilibrium it will undergo "simple harmonic motion" with an equation of motion given by

$$\vec{F} = m\vec{a}$$

$$\vec{F} = -k\vec{x} \qquad m\vec{a} = m\frac{d^2\vec{x}}{dt^2}$$

$$-k\vec{x} = m\frac{d^2\vec{x}}{dt^2}$$

- The solution to this equation for the displacement is a *sinusoidal* oscillation

$$\vec{x} = A\cos\left(2\pi\frac{t}{T} + \phi_0\right)$$

- The velocity can of the object can be found frmo the solution for its displacement

$$\vec{v} = \frac{d\vec{x}}{dt} = -\frac{2\pi A}{T}\sin\left(2\pi\frac{t}{T} + \phi_0\right)$$

where A is the amplitude (maximum displacement), T is the period of motion (time for one complete cycle) which is related to m and k by $T=2\pi\sqrt{m/k}$, and ϕ_o is the starting phase (ϕ_o =zero if your object starts from rest with a positive displacement).