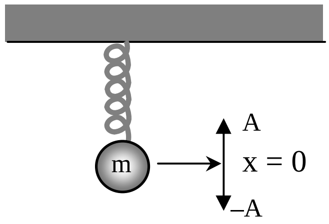
Classical Harmonic Oscillator

Simple Harmonic Motion: Hooke's Law

$F = -kx$

$x(t) = \text{fcn}(t)$ i.e. x is a function of time

$F = ma$



$$m\frac{d^2x(t)}{dt^2} = -kx(t)$$

guess a solution: $x(t) = A \sin ct$

LHS: $\dfrac{dx(t)}{dt} = A(\cos ct)\,c$

$$\frac{d^2x(t)}{dt^2} = -c^2 A \sin ct$$

$$m\frac{d^2x(t)}{dt^2} = -m c^2 A \sin ct$$

RHS: $-kx(t) = -kA \sin ct$

LHS=RHS $-m c^2 A \sin ct = -kA \sin ct$

$$mc^2 = k$$

$c = (k/m)^{1/2}$ $\quad$ $x(t) = A \sin((k/m)^{1/2}\, t)$

$x(t) = A \sin(2\pi\nu\, t)$ $\quad$ $\nu = \dfrac{1}{2\pi}\sqrt{k/m}$

Potential: $\left(\dfrac{\partial V}{\partial x}\right) = -F$ $\quad$ $V = -\int F\, dx$

$V = \int kx\, dx = \frac{1}{2}kx^2$

Total Energy : $E = E_K + V = \frac{1}{2} mv^2 + \frac{1}{2}kx^2 = ?$

when $x(t) = A$ $\quad$ $E_K = 0$ $\quad$ then $E = \frac{1}{2}kA^2$

For diatomic molecules replace m by $\mu = \dfrac{m_1 m_2}{m_1 + m_2}$