downward acceleration

$$\frac{F}{-x} = \frac{-kx}{-x} \longrightarrow k = -F/x = \frac{-m \cdot a}{x} = \frac{-200\,kg \cdot -9.806\,m/s^2}{0.030\,m} =$$

$$65373.\bar{3} = 65000 = \boxed{6.5 \times 10^4\ kg/s^2}$$

Section 2 - Energy in Simple Harmonic Motion

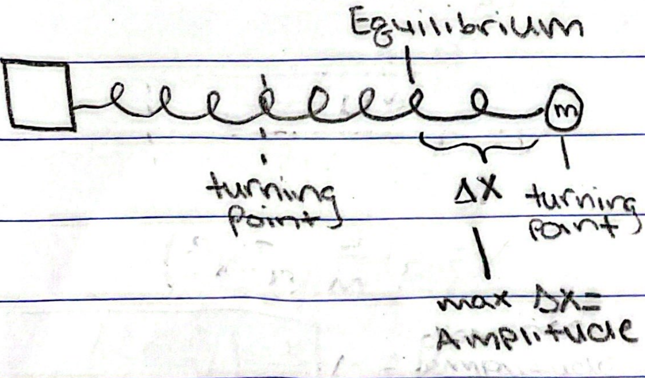
Potential Energy (PE) $= \frac{1}{2}kx^2$ — spring constant (k); displacement from equilibrium (x)

↳ spring stretched; wants to move back

Kinetic Energy (KE) $= \frac{1}{2}mv^2$ — mass (m); velocity of the mass/end of spring (v)

↳ motion

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



if ΔX = Amplitude then

$$E = \frac{1}{2}m(0)^2 + \frac{1}{2}k(A)^2$$

no movement ($v = 0$); max ΔX (A)

*stops moving @ ends for a second

$$E = \frac{1}{2}k(A)^2 \quad \text{(at edges / turning point)}$$

least amount of force trying to move it back.

if $\Delta x = 0$ (at the equilibrium)

$$E = \frac{1}{2} m (v_{max})^2 + \frac{1}{2} k(0)^2$$

max velocity

no Δx

$$E = \frac{1}{2} m v_{max}^2$$

Conservation of Energy:

$$\frac{1}{2} kA^2 = \frac{1}{2} mv^2 + \frac{1}{2} kx^2$$

$\cdot 2 \qquad \cdot 2 \qquad \cdot 2$

$$kA^2 = mv^2 + kx^2$$

$-kx^2 \qquad -kx^2$

$$\frac{kA^2 - kx^2}{m} = \frac{mv^2}{m}$$

$$\sqrt{\frac{kA^2 - kx^2}{m}} = \sqrt{v^2}$$

$$v = \sqrt{\frac{kA^2 - kx^2}{m}}$$

$$v = \sqrt{\frac{k(A^2 - x^2)}{m}}$$

$$v = \sqrt{\frac{k}{m}(A^2 - x^2)}$$

$$v = \sqrt{\frac{k}{m}\left(1 - \frac{x^2}{A^2}\right)A^2}$$

$$v = A\sqrt{\frac{k}{m}\left(1 - \frac{x^2}{A^2}\right)}$$

Max Velocity

$$V_{max} = A \cdot \sqrt{\frac{k}{m}\left(1-\frac{0}{A^2}\right)}$$

$$\boxed{V_{max} = A\sqrt{\frac{k}{m}}}$$

$$\boxed{T = 2\pi\sqrt{m/k}}$$