Chapter 13 Vibrations and Waves

- Hooke's Law F_s=-kx

F_s force of the spring (F_s opposes F applied to stretch/compress spring) (N)

k spring constant (N/m)

x amount of stretch/compression (m)

sign convention/frame of reference: right +, left –

force is directly proportional to the displacement (x)---linear relationship

graphically represented by a line, with slope = k value

- Simple Harmonic Motion-if an object vibrates according to Hooke's Law; ex. object suspended from a vertical spring.

Amplitude (variable A in meters)-maximum amount of displacement from equilibrium position

Period (variable $\mathbb{T}$,tau, in seconds)-the time for one complete cycle, vibration, wave, oscillation, etc.

Frequency (variable f in 1/s, s^{-1} or Hz)-the number of cycles/vibrations/waves in one second

Find the spring constant in lab: use mass suspended vertically from spring, set F=mg, measure spring displacement, collect about 5 sets of data points, graph to a best fit line. The slope of the line corresponds to the k value.

- Elastic Potential Energy

U_s potential energy due to a spring measured in Joules (in class we used $PE_{s,}$ AP uses U_s)

$U_s=1/2kx^2$ U in Joules (J), k in (N/m), x in (m)

Conservation of Energy

Initial Energy=Final Energy

$1/2kx_i^2 + 1/2mv_i^2 + mgh_i = 1/2kx_f^2 + 1/2mv_f^2 + mgh_f$

If all motion is horizontal, ignore mgh on both sides

Stored up spring energy turns into velocity of object once released from rest

$1/2kx_i^2 = 1/2mv_f^2$

- Velocity as a function of position

$V=\pm\sqrt{\ }((k/m)(A^2-x^2))$

Period and Frequency

$T=2\pi\sqrt{\ }(m/k)$ $2\pi f=\sqrt{\ }(k/m)$ $f=1/T$ $T=1/f$

- Position, velocity, and acceleration as a function of time

$X=A\cos(2\pi ft)$

A is amplitude in m; f is frequency in Hz; t is time in seconds; x is position in m

- Motion of a pendulum

$T=2\pi\sqrt{}$ (L/g)   L is length of pendulum in m; g is 9.8 m/s^2 on earth

Types of waves-longitudinal or transverse

Wave speed or v=fλ v in m/s, f in 1/s or Hz, and λ (lambda) is wavelength in m

- Speed of waves in a spring

v=$\sqrt{(F/\mu)}$

v in m/s, F or Tension in Newtons (usually mg), and μ is mass per unit length of string in kg/m

The more tension in the spring, the less freedom for a wave to travel through it.

Constructive Interference- when waves *in-phase* (having same f and A) combine, the resultant wave has same f, but twice the A.

Destructive Interference-when waves are 180^oout of phase, the resultant wave is complete cancellation.

Superposition principle-then two waves combine, the resultant can be found by adding the individual waves together point by point.