Simple Harmonic Motion, Waves, and Sound Equation Review

$$F_s = -kx$$

SHM

To determine if a motion is simple harmonic find out of the force is proportional to the displacement (then it follows Hooke's law and is simple harmonic)

$$a = -\frac{k}{m}x$$

$$PE_s \equiv \frac{1}{2}kx^2$$

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

$$v_0 = \frac{2\pi A}{T}$$

Note: v_0= maximum velocity

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

$$f = \frac{1}{T}$$

$$f = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$$

Motion of a Pendulum

- s = displacement
- For a pendulum $s = L\theta$
- $F_t = -ma_g \sin\theta$
- If θ < ~15° (this is because if θ = 12° = 0.209rad and sin(12.0°)=0.208)
    - $F_t = -ma_g\theta$ (restoring force)
    - $F_t = -\left(\frac{ma_g}{L}\right)s$
- Period of pendulum
    - $T = 2\pi\sqrt{\frac{L}{a_g}}$

Waves

$$v = f * \lambda$$

Wave Velocity:

$$v = \sqrt{\frac{F_T}{\mu}}$$

Note: $\mu = mass/unit\ \ length$

- Velocity is determined by medium
- Frequency is determined by frequency of source
- Wavelength will change to accommodate the change of f and v

Sound

Doppler effect:

$$f' = f\left(\frac{v \pm v_o}{v \mp v_s}\right)$$

f – sound frequency
f' – perceived frequency
v – sound speed
v_o – observer speed
v_s – source speed

Beat frequency: $f_b = |f_2 - f_1|$
Speed of sound: $v = 330 + .6(T)$
T = temperature in C°

Resonance:

- String: $f_n = nf_1 = \frac{nv}{2L} = \frac{n}{2L}\sqrt{\frac{F_T}{\mu}}$
- Open tube: $f_n = nf_1 = \frac{nv}{2L}$
    - Open tube: $L = \frac{\lambda}{2}\, then\, L = \frac{2}{2}\lambda$
- Closed tube: $f_n = nf_1 = \frac{nv}{4L}$
    - Closed tube: $L = \frac{\lambda}{4}\, then\, L = \frac{3}{4}\lambda$