1 General Stuff

- Density - $\rho = \frac{\Delta m}{\Delta V}$
  - Uniform Density - $\rho = \frac{m}{V}$
- Pressure - $p = \frac{\Delta F}{\Delta A}$
  - Uniform Force on Flat Area - $\rho = \frac{F}{A}$
  - Conversions - $1atm = 1.01 \times 10^5 Pa = 760torr = 14.7lb/in^2$
- Trig Relations are in Trigonometric Formulas, Section 6.1.

2 Fluids

We must satisfy several parameters to make life easier, and to use most of these formulae.

1. Incompressible - Density of the fluid is constant
2. Non-turbulent Flow - Think of fluids swirling around an object
3. Isostatic Pressure - Pressure inside the fluid is the same in all directions

- Pressure at Some Depth - $p_2 = p_1 + \rho g \left(y_1 - y_2\right)$
  - Pressure at Depth $h \rightarrow p = p_0 + \rho g h$
- Pascal's Principle - 2 Parts
  1. $\vec{F_o} = \vec{F_i}\ \frac{A_o}{A_i}$
  2. $d_o = d_i \frac{A_i}{A_o}$
- Archimede's Principle - $\vec{F}_{Up} = \vec{F}_{Down}$
  - $\vec{F}_{Bouyant} = m_{Floating} g$
- Continuity - $A_1 v_1 = A_2 v_2$
- Bernoulli's Equation - $p_1 + \frac{1}{2}\rho v_1^2 + \rho g y_1 = p_2 + \frac{1}{2}\rho v_2^2 + \rho g y_2$
  - Fluids at Rest - $p_2 = p_1 + \rho g \left(y_1 - y_2\right)$
  - Fluids not Changing Height - $p_1 + \frac{1}{2}\rho v_1^2 = p_2 + \frac{1}{2}\rho v_2^2$

3 Waves

Usually of form $y = y_m \sin\left(kx \pm \omega t\right)$

- y_m - Amplitude, m
- k - Angular Wave Number, rad/m
  - $k = \frac{2\pi}{\lambda}$
  - λ is wavelength, m
- ω - Angular Frequency, rad/s
  - $\omega = 2\pi f$
  - f is frequency, Hz
  - Sign of this goes the opposite the direction the wave is going
    1. Wave going in positive direction $(+)$, then the sign should be negative $(-)$
    2. Wave going in negative direction $(-)$, then the sign should be positive $(+)$
- $v = \lambda f$, Wave Velocity, m/s
  - $v = \frac{\omega}{2\pi} * \frac{2\pi}{k} = \frac{\omega}{k}$

Wave Interference

Waves are nice, and they just sum when they interfere. Let:

$$y_1\left(x,t\right) = y \sin\left(kx - \omega t\right) \tag{3.1}$$
$$y_2\left(x,t\right) = y \sin\left(kx + \omega t + \varphi\right) \tag{3.2}$$
$$Y\left(x,t\right) = y\left[\sin\left(kx - \omega t\right) + \sin\left(kx + \omega t + \varphi\right)\right] \tag{3.3}$$

You can usually use Equation 6.1 to simplify Equation 3.3.

Constructive/Destructive Interference

$$\phi = 2\pi \frac{PathLengthDiff}{\lambda} = 2\pi \frac{\Delta d}{\lambda}$$
$$n = \frac{2}{\pi}\phi = 4\frac{PathLengthDiff}{\lambda}$$

- $PathLengthDiff$ - Is the Difference in path lengths that the waves must travel
- phi - Angular Location of points of Complete Constructive/Destructive Interference
- n - Number of locations where there is Complete Constructive/Destructive Interference

Standing Waves

This is actually the superposition of 2 waves, traveling in opposite directions, on a medium that is fixed at both ends, i.e. a taut string held by a wall.

Location of Nodes and Antinodes

- Nodes - $x = n\frac{\lambda}{2}$ for $n = 0, 1, 2, \ldots$
- Antinodes - $x = \left(n + \frac{1}{2}\right)\frac{\lambda}{2}$ for $n = 0, 1, 2, \ldots$

Resonant Frequencies/Harmonics

These can also be called harmonics. There is a resonant frequency for every number of nodes/antinodes on tthe standing wave.
$f = \frac{v}{\lambda} = n\frac{v}{2L}$

- L is the length of the medium (The String).
- λ is the wavelength of the wave formed.

This can be extended to find the base resonant frequency, if you know how many node levels are between the two resonant frequencies given, i.e. they say that the **NEXT** frequency, means $n+1$.
$f_{n+m} - f_n = (n+m)\frac{v}{2L} - n\frac{v}{2L} = m\frac{v}{2L}$

Reflecting Sound

- $D = (n+1)\,d = vt$
  - n is the number of reflections that occurred

Doppler Effect

$$f' = f\frac{v \pm v_D}{v \pm v_S}$$

- Moving ***TOWARDS*** each other: Frequency Increase
- Moving ***AWAY*** from each other: Frequency Decrease
- f - Initial Frequency, Hz
- v - Sound Speed, m/s
- v_D - Detector Speed, m/s
- v_S - Source Speed, m/s
- **For Numerator**:
  - If detector is moving towards the source, $+$
  - If detector is moving away from the source, $-$
- **For Denominator**:
  - If source is moving away from detector, $+$
  - If source is moving towards the detector, $-$

4 Thermodynamics

5 Quantum Mechanics

6 Reference Material

6.1 Trigonometric Formulas

$$\sin(\alpha) + \sin(\beta) = 2\sin\left(\frac{\alpha+\beta}{2}\right)\cos\left(\frac{\alpha-\beta}{2}\right) \tag{6.1}$$