1 **DIMENSIONS OF THE SINE WAVE**

- **dimensions of sine waves**
  - **Amplitude**
  - **Phase**
  - **Frequency/Period: f = 1 / T or T = 1 / f**

**Note: when a sine wave represents something in space, wavelength is used instead of period.**

2 **Amplitude**

- **rms = A / √ 2 = A (0.707)**
- **mean square = $rms^2$**
- **Full-Wave Rectified Average ($FW_{avg}$)**
  - **$FW_{avg}$ = 2A / π = A (.636)**
- **Half-Wave Rectified Average ($HW_{avg}$)**
  - **$HW_{avg}$ = A / π = A (.318)**

3 **DIMENSIONS OF THE SINE WAVE**

- **FREQUENCY (f)**
  - **The rate, in Hz, at which a sinusoid repeats itself**
- **PERIOD (T)**
  - **The time required to complete one cycle**

- **T of X = .001 s: f = ? ☑ f = 1000 Hz**
- **T of Y = .0005 s: f = ? ☑ f = 2000 Hz**

4 **Determinants of Frequency**

- **Frequency depends on <u>properties of the source</u> of sound**
- **Spring-mass system: <u>mass</u> (m) and <u>stiffness</u> (s) of system**
- ***Natural Frequency* is the frequency with which a system oscillates freely ($f_{nat}$)**
- **$f_{nat} = \sqrt{s / m}$**
- **Remember: f = 1 / T; T = 1 / f**

5 **Comments on the Radian**

- **1 radian = 57.3°**
  - **360° / 57.3° = 2π Or 360° = 2π r**
- **Snip a circle: unroll it. So for circles of all size, length = 2π (6.2832) times radius of circle (2πr)**
- **One cycle = 360°**
  - **360° = 2π radians**

6 **Angular Velocity (ω)**

- **Alternative ways to express frequency**
  - **degrees / s; circle divided into 360 equal parts**
    - **>> 1 Hz = 360° / s; 10 Hz = 3600° / s**
- **The measure of choice**
  - **2π radians / s; circle divided into 2π (6.2832) equal parts**
    - **>> 1 Hz = 2π radians / s**

7 **DIMENSIONS OF THE SINE WAVE**

- **PHASE**

**Four reference points: A, B, C, & D**

- ♦ **At moment rotation begins, what is displacement in degrees for each of four points?**
  - ☑ **A = 0**
  - ☑ **B = 90**
  - ☑ **C = 180**
  - ☑ **D = 270**

## 8 Starting Phase

- **That defines the starting phase; the angle, in degrees, at the moment rotation begins .**
- **Starting phase relations**

**B leads A by?** ☑ **90°**
**C leads B by?** ☑ **90°**
**C leads A by?** ☑ **180°**
**D leads B by?** ☑ **180°**
**B lags C by?** ☑ **90°**

## 9 Phase Angles in Radians

- **Radians replace degrees on abscissa**
- **$360^{O} = 2\pi$ radians**
- **$0^{O}$ = ?**
  - ☑ **0 radians**
- **$90^{O}$ = ?**
  - ☑ **$\pi / 2$ radians**
- **$180^{O}$ = ?**
  - ☑ **$\pi$ radians**
- **$270^{O}$ = ?**
  - ☑ **$3\pi / 2$ radians**

## 10 Simple Harmonic Motion and Sound Waves

- **At $0^{O}$, balloon is partially inflated**
- **At $90^{O}$, balloon maximally inflated**
- **At $270^{O}$, balloon minimally inflated**
- **Compressions and rarefactions are propagated through medium**
- **The result is a sound wave**

## 11 Amplitude

- **Particle velocity leads particle displacement by 90°: Why?**
  - ☑ **c is maximal at equilibrium where x is 0; c is 0 at $x_{max}$ where motion is momentarily halted**
- **Instantaneous sound pressure "mirrors" particle velocity and leads particle displacement by 90°**

## 12 Amplitude

- **Particle acceleration leads particle displacement by $180^{O}$: Why?**
  - ♦ **$F_i = ma$ (2nd Law)**
  - ♦ **$F_r = -kx$ (Hooke's)**
  - ♦ **$F_i = F_r$ (3rd Law)**
  - ♦ **$ma = -kx$**

**where: m and -k are constants and a and x are variables, so a and x must be opposites**