Instructions and Tips

- Assume the speed of sound in air (c_{air}) is = 340 $m \cdot s^{-1}$.
- Assume the speed of sound in water (c_{water}) is = $4 \cdot c_{air}$.
- A calculator is not necessary to answer any of these questions.

1. Why does atmospheric pressure decrease with elevation?

   Pressure = Force/Area & Force = mass·acceleration. Atmospheric pressure is the force of air molecules over the area of the Earth's surface. The force of gravity results in a higher density (ρ = mass/volume) of air molecules at the Earth's surface than at higher elevations and thus a higher static air pressure.

2. Contrast transverse (shear) wave motion with longitudinal wave motion?

   In transverse wave motion, particle displacement is perpendicular to the direction of wave propagation, whereas in longitudinal wave motion particle displacement is parallel to the direction of wave motion.

3. What are the units of measure for Force, Work, Frequency, Wavelength, Period, and Pressure?

   Force = Newton (1 Nt = kg·m·s-2); Work = Nt·m (Force·distance); Frequency = Hz (cycles·s-1); Wavelength = meters (m); Period (T) = seconds (s); Pressure = Pascal (1 Pa = Nt·m-2)

4. Name three physical attributes of sound that are encoded by the peripheral auditory system.

   frequency (f), amplitude (A) (or intensity), time (s)

5. Name the physical attributes of sound that are required to completely describe a sine wave.

   frequency (f), amplitude (A), starting phase angle (θ)

6. A sine wave has a peak-to-peak amplitude ($A_{peak\text{-}to\text{-}peak}$) of 20 Volts. What is its peak (A_{peak}) and rms amplitude (A_{rms})?

   A_{peak} = 10 V ; A_{rms} = 7.07 V

7. A sine wave has a rms amplitude (A_{rms}) of 10 Volts. What is its peak amplitude (A_{peak})?

   $A_{rms} = A_{peak}/\sqrt{2}$; $A_{peak} = A_{rms} \cdot \sqrt{2}$; A_{peak} =14.14 V

8. An object exhibiting uniform circular motion has an angular velocity of 628.318 $radians \cdot s^{-1}$. What is its frequency of oscillation?

   $\omega = 2\pi \cdot f$; $f = \omega/2\pi$; ω = 628 $radians \cdot s^{-1}$; f = 100 $cycles \cdot s^{-1}$ or Hz

9. A frequency of 4 Hz corresponds to what angular velocity?

   $\omega = 2\pi \cdot f$; $\omega = 2\pi \cdot 4$ Hz ; $\omega = 8\pi$ $radians \cdot s^{-1}$ (or ω = 25.13 $radians \cdot s^{-1}$)

10. A phase angle of 90° corresponds to how many radians?

$360° = 2\pi$; $90° = \pi/2$

11. How many millimeters will a sound with a frequency of 1000 Hz travel in air in 2 ms?

$c_{air} = 340\ m \cdot s^{-1}$; $340\ m \cdot s^{-1} \cdot 0.002\ s = 0.68\ m\ (= 680\ mm)$

12. What is the wavelength of a 340 Hz tone propagating in air?

$\lambda = c/f$; $c_{air} = 340\ m \cdot s^{-1}$; $\lambda = 340\ m \cdot s^{-1} / 340\ Hz$; $\lambda = 1$ meter

13. If the period of a sinusoid is 10 ms, what is its frequency?

$f = 1/T$; $f = 1/0.010$; $f = 100$ Hz

14. If the speed of sound in water (c_{water}) is 4 times faster than in air (c_{air}), then the wavelength of a sound with a frequency of 1000 Hz propagating in water is equivalent to the wavelength of what sound frequency propagating in air?

$c_{water} \approx 4 \cdot c_{air}$; $\lambda = c/f$; $c = \lambda \cdot f$

$\lambda_{water} \cdot f_{water} \approx 4 \cdot \lambda_{air} \cdot f_{air}$; $f_{air} \approx [0.25 \cdot (\lambda_{water} \cdot f_{water}) / \lambda_{air}]$; $f_{air} \approx 0.25 \cdot f_{water}$ $f_{air} \approx 250$ Hz

15. An object exhibiting uniform circular motion has a starting phase angle of 90° and a frequency of oscillation of 3 Hz. What is its ending phase angle after 0.5 s of counterclockwise rotation?

$\theta = \omega \cdot t$; $\omega = 2 \cdot \pi \cdot f$; $360° = 2\pi$

$\theta = 2\pi(3\ Hz) \cdot (0.5\ s)$; $\theta = 3\pi$; $3\pi = 540°$; 540° = 1.5 rotations ; $\theta = -90°$ (or 270°), or

$3\pi = 540°$; 90° + 540° = 630° ; 630°/360° = 1.75 (only use remainder) ; $\theta = 0.75 * 360 = 270°$

16. Draw a sinusoidal instantaneous pressure function, P(t), where the frequency is 1000 Hz, the starting phase is 0°, and the rms pressure is 1.414 Pascals (Pa). Label the abscissa and ordinate correctly.

$1.414 = \sqrt{2}$; $A_{peak} = A_{rms} \cdot \sqrt{2}$; $A_{peak} = \sqrt{2} \cdot \sqrt{2}$; $= (\sqrt{2})^2$; $A_{peak} = 2$ Pa ; $\therefore A_{peak\text{-}to\text{-}peak} = 4$ Pa

$T = 1/f$; $T = 1/1000$; $T = 1$ ms (one complete cycle takes 1 ms)