NAME KEY **SP436 Quiz 4**

1. If an acoustic wave travelling in a medium (of density 1000 kg/m^3) has acoustic pressure given by

$$p(x,t) = (3\text{x}10^2\ \text{Pa})\cos[(2.50\ \text{m}^{-1})\text{x} - (3700\ \text{s}^{-1})\text{t}]$$

where x and t are in meters and seconds respectively, determine the following (ensure you show all work and the proper units):

a) **(1 Point)** Wave speed or speed of sound in the medium, c?

$$c = \frac{\omega}{k} = \frac{3700\ \text{s}^{-1}}{2.5\ \text{m}^{-1}} = \boxed{1480\ \text{m/s}}$$

b) **(1 Point)** What is the peak acoustic pressure of the wave, $P_{a\ peak}$?

$$P_o = \boxed{300\ \text{Pa}}$$

c) **(2 Points)** What is the medium's peak particle velocity, U_{peak}?

$$U_o = \frac{P_o}{\rho_o c} = \frac{300\ \text{Pa}}{(1000\ \text{kg/m}^3)(1480\ \text{m/s})} = \boxed{2.0 \times 10^{-4}\ \text{m/s}}$$

d) **(1 Point)** What is the effective or rms pressure?

$$P_{rms} = \frac{300\ \text{Pa}}{\sqrt{2}} = 212\ \text{Pa} \approx \boxed{210\ \text{Pa}}$$

e) **(1 Point)** What is the effective or rms velocity?

$$U_{rms} = \frac{2.03\text{x}10^{-4}\ \text{m/s}}{\sqrt{2}} = \boxed{1.4 \times 10^{-4}\ \text{m/s}}$$

f) **(2 Point)** What is the time averaged **intensity** of the wave, <I>?

$$\langle I \rangle = \frac{P_{rms}^2}{\rho_o c} = \frac{(212\ \text{Pa})^2}{(1000\ \text{kg/m}^3)(1480\ \text{m/s})} = \boxed{.030\ \text{W/m}^2}$$

g) **(2 Points)** The **intensity level** of the wave, IL?

$$IL = 10 \log\left(\frac{.0304\ \text{W/m}^2}{6.67\text{x}10^{-19}\ \text{W/m}^2}\right) = 166.6\ \text{dB} \approx \boxed{167\ \text{dB}}$$

OR

$$SPL = 20 \log\left(\frac{212\ \text{Pa}}{1\ \mu\text{Pa}}\right) = 166.5\ \text{dB} \approx \boxed{167\ \text{dB}}$$

$$k = \frac{2\pi}{\lambda} \qquad \omega = \frac{2\pi}{T} = 2\pi f \qquad c = \frac{\lambda}{T} = f\lambda = \frac{\omega}{k} = \sqrt{\frac{B}{\rho}}$$

$$z \equiv \frac{p(x,t)}{u(x,t)} = \rho c \qquad \langle I \rangle = \frac{1}{2} z U_{peak}^2 = \frac{1}{2}\frac{P_{a\ peak}^2}{z} = \frac{1}{2} P_{a\ peak} U_{peak} \qquad F_{rms} = \frac{F_{peak}}{\sqrt{2}}$$

$$IL = 10 \log \frac{\langle I \rangle}{I_{ref}} = SPL = 20 \log \frac{P_{rms}}{P_{ref}}$$

In water: p_{ref}=1 uPa, I_{ref}= 6.67x10^{-19} W/m^2