University of Alabama
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PH 105 LeClair Summer 2012

Quiz 7: Misc

1. Two objects, A and B, are submersed in a liquid of density ρ_s at depths of h_A and h_B, respectively. The pressure above the liquid's surface is P_0. What is the difference in pressure experienced by the two objects?

- □ $\rho_s g(h_A - h_B) + \frac{1}{2}P_0$
- □ $\rho_s g(h_A - h_B) + 2P_0$
- ■ $\rho_s g(h_A - h_B)$
- □ $P_0 + \rho_s g(h_A - h_B)$

The pressure *difference* between the two points depends only on their difference in depth. The pressure above the liquid's surface is the same for both objects, and cancels when finding the pressure difference. At a given depth h_A below the surface, the pressure would be

$$P = P_0 + \rho_s g h_A \tag{1}$$

while at depth h_B we would have

$$P = P_0 + \rho_s g h_B \tag{2}$$

The difference is then

$$\Delta P = \rho_s g \left(h_A - h_b\right) \tag{3}$$

2. Estimate the pressure exerted on your eardrum due to the water above when you are swimming at the bottom of a pool that is 5.0 m deep. (Note $\rho_{\text{water}} = 1000\,\text{kg/m}^3$).

- ■ 4.9×10^4 Pa
- □ 1.88×10^5 Pa
- □ 2.73×10^6 Pa
- □ 3.76×10^5 Pa

The pressure difference will be due to the weight above you, or $\rho_s gh$ as in the example above.

$$P - P_0 = \rho_s gh \approx 4.9 \times 10^4\,\mathrm{Pa} \tag{4}$$

3. Simple molecules can be modeled reasonably well as mass-spring systems. For a CO molecule, one would deduce experimentally $k \approx 1800\,\mathrm{N/m}$. If a CO molecule vibrates with an amplitude of $8.3 \times 10^{-12}\,\mathrm{m}$, what is its maximal kinetic energy?

- ■ $6.2{\times}10^{-20}\,\mathrm{J}$
- □ $1.7{\times}10^{-16}\,\mathrm{J}$
- □ $6.2{\times}10^{-14}\,\mathrm{J}$
- □ $1.7{\times}10^{-31}\,\mathrm{J}$

The total energy of a harmonic oscillator is $E = \frac{1}{2}kA^2$, where A is the amplitude. The maximum kinetic energy is all of it:

$$K_{\mathrm{max}} = E = \frac{1}{2}kA^2 \approx 6.2 \times 10^{-20}\,\mathrm{J} \tag{5}$$

4. Two cylinders A and B have the same volume and contain the same number of moles of a monatomic ideal gas. It is found that the pressure in vessel A is twice the pressure in vessel B. What is the relation between the temperatures of the vessels?

- ■ $T_A = 2T_B$
- □ $T_A = T_B$
- □ $T_A = 0.5T_B$
- □ $T_A = 4T_B$

The ideal gas law states that $PV = Nk_BT$. For the present purposes, it is enough to say that $P \propto T$ if V is constant. This tells us that if the two cylinders have the same volume, pressure and temperature are proportional. The vessel with twice the pressure must have twice the temperature, so it must be true that $T_A = 2T_B$.