Name _____

PLEASE READ THIS FIRST: Work the problems on separate sheets of paper and staple this sheet to the front. Read each problem carefully. Show your work and/or give brief explanations for *all* answers. (But there is *no* need to be as "wordy" or formal as on the homework.) Make sure that all numerical answers are given with a reasonable number of sig figs and that you have included appropriate units. Check your answers for physical *reasonableness* whenever possible. I do give partial credit, but *only* if I can figure out what you are doing, so be as clear as possible.

1. Equal amounts of ice at 0°C and water at 100°C are mixed in a thermos of negligible heat capacity. [Some data: $c_{H_2O}^{solid} = 0.50$ cal/g °C, $c_{H_2O}^{liquid} = 1.00$ cal/g °C, $L_{H_2O}^{fusion} = 80$ cal/g, $L_{H_2O}^{vap} = 540$ cal/g .]

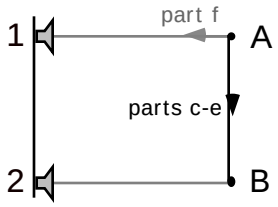
   a) [5 *easy* pts] How many calories are required to melt each gram of ice at 0°C?

   b) [5 *easy* pts] How many calories are released for each gram of water that cools from 100°C to 20°C?

   c) [5 *easy* pts] What is the final temperature of the mixture? [As *always*, explain or show your work.]

   d) [5 pts] What would your answer to part c have been if there had been *twice* as much water as ice?

2. Two speakers are set 30.0 m apart on a wall. They operate in phase and produce sinusoidal sound waves at a frequency of 57.2 Hz. A woman starts at position A—40.0 m directly in front of speaker 1—and walks along a straight line to position B—40.0 meters directly in front of speaker 2 as shown in the diagram at right (which is a view from *above*.). Take the speed of sound to be 343 m/s.



   a) [5 *easy* pts] When the woman is at position A, *how much farther* is she from speaker 2 than she is from speaker 1—i.e., what is the path difference $r_2 - r_1$?

   b) [5 *easy* pts] *How many wavelengths* of the sound being produced would fit in that path difference?

   c) [5 *easy* pts] As she walks toward position B, what happens to the path difference $r_2 - r_1$?

   d) [5 pts] At *how many positions* along the path will the woman hear a relative maximum in intensity?

   e) [5 pts] Draw a sketch showing each place along the path where she hears a relative maximum in intensity and labeling each one with the value of $r_2 - r_1$.

   f) [5 pts EXTRA CREDIT] Suppose *instead* that she began walking directly toward the nearest speaker. How far would she have to walk to get to the first position of maximum intensity?

3. a) [5 pts] Explain why it is very hard to get a beach ball (a large flimsy air-filled ball) to be *completely submerged* under water. [No big surprises here, but be *specific.* What *happens* as it becomes more and more submerged?]

   b) [5 pts] Once the ball *is* completely submerged, explain what would happen to the buoyant force on the ball—and especially *why*—if it were taken deeper under the water? [The correct answer *here* might be a bit surprising!]

   Now, consider a beach ball of radius 20 cm that is filled with oxygen at atmospheric pressure and a temperature of 27°C. The flimsy plastic shell of the beach ball has a mass of 100 g. Consider the nitrogen to behave essentially like an ideal gas for the purpose of this problem.

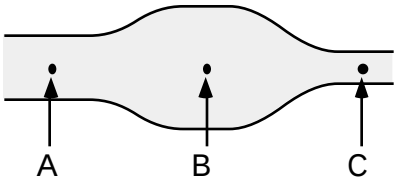
   c) [7 pts] What is the *mass* of the oxygen in the beach ball? [Hint: Find the number of moles and recall that a mole of oxygen gas has a mass of 32 g because the molecules are diatomic.]

   d) [8 pts] Suppose this beach ball is taken down to a depth of 20 m under the surface of a freshwater lake ($\rho_{water} = 1.00$ g/cm^3) where the temperature is 4°C. What would be the buoyant force on the beach ball at this depth?

   e) [5 pts EXTRA CREDIT] Assuming the temperature remains at 4°C, at what depth would the buoyant force equal the weight of the beach ball and what would happen if the ball were released just *below* this depth?

[over]

4. [6 pts] Water flows from left to right through a pipe as shown at right. Rank the *pressures* at the indicated positions from *highest to lowest* and *explain* the reasons for your ranking order in terms of physical principles.



5. [6 pts] Suppose we are listening to sound being radiated isotropically from a source at some distance and find that the intensity at our position is 360 $\mu W/m^2$. What will the new intensity be if we move to a new position that is three times as far away from the source *and* the power of the source is increased by a factor of five?

6. [6 pts] One chain saw operating at a distance of about 30 m produces a sound intensity level of 80 dB. Suppose an *additional* 15 identical chain saws begin operating at about the same distance. What is the new sound intensity level?

7. [6 pts] An open-open tube has a *fundamental* frequency of 100 Hz. If one end is now closed and the air in the resulting closed-open tube oscillates in its *third* normal mode, what is the frequency of those oscillations?

8. [6 pts] The ring and the rod shown at right are made of materials with linear thermal coefficients of expansion such that $\alpha_{rod} = 2\alpha_{ring}$. The ring has an inner diameter that is 0.1% smaller than the outer diameter of the rod. If we want to slip the ring onto the rod which of the following could work, which couldn't, and (of course) *why*?

   a) Cool the ring.

   b) Heat the ring.

   c) Heat both the ring *and* the rod by the same amount.