Pre-exam Homework Questions

1. The specific heat of silver is 0.05 cal/(g °C) and the specific heat of water is 1 cal/(g °C)

If a certain amount of heat is added to a sample of water, the water temperature raises 5 degrees Celsius. If an equal amount of heat is added to an equal mass of silver, what would be the change in temperature of the silver?

2. One of the remarkable scientific discoveries in the past twenty-five years is the discovery of creatures that live on the floor of the ocean about 200 miles west of Washington under 2300 meters of ocean water. (1 kg = 2.2 lbs and 39.37 inches = 1 meter)

   a. The density of seawater is about 1027 kg/m$^3$. What is the pressure of the ocean on these creatures in psi? Show your work.

   b. In class, we did some calculations of the pressure of the atmosphere at sea level. Since these creatures are under the ocean and the atmosphere, what is the total pressure they experience?

   c. Even if we (humans) have a source of air, we could not survive the pressure at this depth of the ocean without a submarine. How do these organisms survive this pressure?

3. The following statement was found on a web site. Review the statement and decide if the statement is correct as written. (Note: there may or may not be errors.) Show your work/explain your reasoning.

   “How much pressure are you under? Earth's atmosphere is pressing against each square inch of you with a force of 1 kilogram per square centimeter (14.7 pounds per square inch). The force on 1,000 square centimeters (a little larger than a square foot) is about a ton!”

4. Imagine two tall glass tubes filled with water. Both tubes are 50 inches high, but one tube has a diameter of 2 in, while the other has a diameter of 4 in. Compare the pressure exerted by the water in each of these tubes. Clearly explain your reasoning.

5. An architect is designing a building and needs your help. She is designing a structure that will have numerous 24-inch diameter columns that are 20 feet high. She is concerned about the pressure each column will exert on the marble floor. She is thinking about making the columns out of three different materials, wood, granite, and water (in our calculations we will ignore the pressure created by the container which will hold the water).

   a. Determine the pressure of each type of material in pounds per square inch. (The density of wood is about 0.5 grams/cm$^3$, granite is 2.6 grams/cm$^3$,
and the water is 1.0 gram/cm³ and the formula for the volume of a cylinder is \(\pi r^2 h\).

b. After you calculated part a above, she wants to know what the pressure (in psi) would be if the columns are 12 inches in diameter instead of 24 inches.

6. A slab of bedrock lies underneath 40 meters of soil and 100 meters of ice. The density of the soil is 2.3 grams per cubic centimeter. The density of ice is 0.9 grams per cubic centimeter. The situation is shown in the diagram below.

\[\text{ice} \quad \text{soil} \quad \text{rock}\]

a) Find the pressure exerted on the slab of rock. (It is probably easiest to answer in units of “bars” where one bar is one “kg per square centimeter” which is approximately atmospheric pressure.)

b) Did you use atmospheric pressure to find the answer to part “a”? Should you? Why or why not? Explain your reasoning.

c) How much of the pressure that you found in part “a” was due to the soil? How much was due to the ice?

d) Imagine that the situation were somewhat different. Imagine that instead of a layer of pure soil 10 meters thick below a layer of pure ice 20 meters thick, the actual situation was that there was the same amount of ice and the same amount of soil but they were all mixed together. Would there be any difference in the total pressure exerted on the slab of rock? Would there be any difference in the fraction of that pressure that was exerted by ice? by soil? Explain your reasoning.

e) Now think of the atmosphere. The atmospheric pressure on your body right now is about 14.7 pounds per square inch. The atmosphere around you is about 79% nitrogen, 20% oxygen, and 1% water vapor (this last number is a guess – the other two don’t change much). How much of the pressure that is exerted on your body right now is due to nitrogen?

f) How much of the pressure that is exerted on your body right now is due to oxygen?

g) How much of the pressure that is exerted on your body right now is due to water vapor?
7. On a July day in Seattle, the temperature is 32 °C and the relative humidity is 40 %. The forecast calls for the nighttime temperature to drop to 14 °C. Will dew form overnight? Show your work/explain your reasoning.

8. During the winter months, houses that are heated by drawing in and heating outside air often end up feeling especially dry. What is it about both (a) the weather conditions outside and (b) the heating of the air that causes these dry conditions indoors? Explain clearly.

9. In a simple experiment, a can full of room temperature water (21 °C) is cooled by adding ice to the water. When the water temperature reaches 6 °C, condensation is observed on the outside of the can.

(a) Based on the results of this experiment, what is the dew point? Explain.

(b) Based on the results of this experiment, what is the relative humidity? Explain/show work.

(c) Why is it necessary that this experiment be carried out in a metal can? Explain.

10. The weather forecast for Acapulco Mexico on February 15, 2001 called for a daytime high of 33 °C (92 °F) and a relative humidity of 47%. What is the dew point?

11. On a summer day in Florida, the temperature is 35 °C (95 °F) and the relative humidity is 100 %. What is the vapor pressure of water in the air that day? Explain.