Name ____ CHM 1046
Spring 2017
February 10

EXAMINATION ONE

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I _______ II _______ III _______ IV _______ V _______ Total __________

Glance over the entire exam, and then attempt the problems in the order of your choice. Rough point values are given for each problem. The total will be scaled to ***50 points*** after the exams are marked. For questions with multiple parts, you do not necessarily need the answer to part A in order to work part B, etc. For calculations, give your answer to the correct number of ***significant figures***, and be sure to include the ***correct units*** for your answer. ***You must show your work to receive any credit for a calculated answer.*** Additional information is provided in a separate information packet; you can use the back for scratch work. Good luck!

I. (1 point) The marked exams will be returned in recitation next week. Please circle the recitation section that you attend.

Tate Engstrand	2:00-2:50 pm in HTL 213	3:00-3:50 pm in HTL 214	4:00-4:50 pm in HTL 213
Zhicheng Jin	2:00-2:50 pm in HTL 214	3:00-3:50 pm in HTL 219	4:00-4:50 pm in HTL 219
Okten Ungor	4:00-4:50 pm in HTL 520	5:00-5:50 pm in HTL 219	6:00-6:50 pm in HTL 219

I. (17 points) Karo Syrup (corn syrup) is a popular baking ingredient, especially down here in the south, but it can also be used as drug-delivery system by dissolving medication in the syrup. The concentration of sugar in Karo Syrup is difficult to quantify, as opposed to the "simple syrups" used by pharmacists to prepare certain oral medications. Wikipedia gave the following recipe for one such simple pharmacological syrup:

Add 1 kg of refined sugar (assumed to be sucrose, $C_{12}H_{22}O_{11}$) to 500 mL of boiling distilled water, heating until it is dissolved and add boiling distilled water until the weight of the whole is 1.5 kg. The specific gravity of the syrup should be 1.33. (Note that two-thirds of the syrup's mass comes from the sugar.)

Based on the information given, you can calculate the concentration of sucrose in mol/L, but I did it for you (you're welcome) and obtained 2.6 M.

A. Calculate the osmotic pressure of this syrup at 25°C.

B. Suppose the solution was 2.6 M NaCl instead of 2.6 M sucrose. Would the osmotic pressure be greater, less, or the same?

____

Why?

C. Suppose that in the recipe 1 kg of glucose ($C_6H_{12}O_6$) was used instead of 1 kg of sucrose. Would the osmotic pressure be greater, less, or the same?

____

Why?

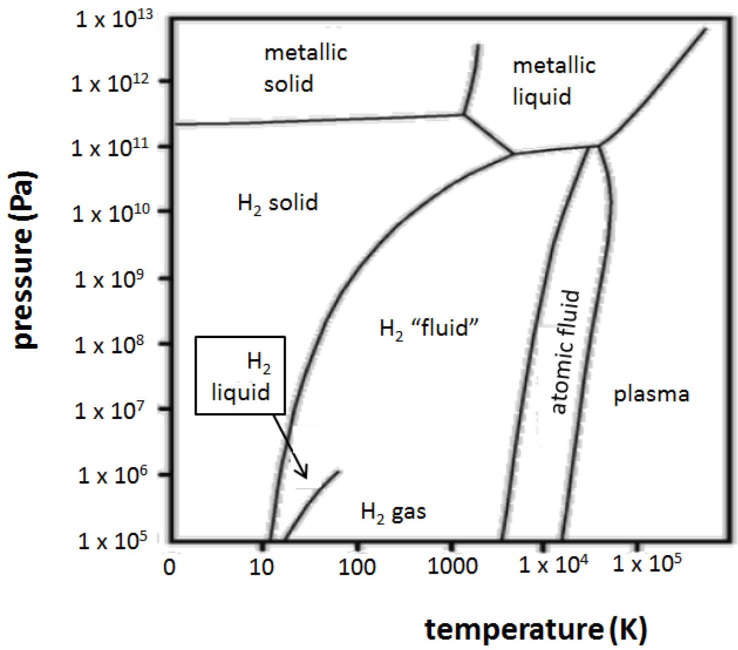
D. How will the freezing point, boiling point, and vapor pressure of water for the syrup compare to that of pure water? (Circle your answers.)

1. The freezing point of the syrup will be.... less the same greater
2. The boiling point of the syrup will be.... less the same greater
3. The vapor pressure of water for the syrup will be.... less the same greater

II. (continued) Karo Syrup (corn syrup) is a popular...

E. Honey (another sweet syrup) can be used along with salt to preserve meats; e.g. honey-cured hams. In this process, a cut of meat is soaked in a honey solution for days to weeks, killing any harmful organisms such as bacteria by dehydration. Explain how this process works. A complete answer will include a drawing showing the direction of the solvent and/or solute.

III. (18 points) Last year *Science News* published an article with the clever title "The pressure is on to make metallic hydrogen" (*ScienceNews Online*, Emily Conover, August 10, 2016). The possibility of metallic hydrogen deep within Saturn is discussed in our text (Chapter 22), but most of that information is dated. The *Science News* article describes the race back here on Earth to be the first research group to prepare the metallic hydrogen in a laboratory.



Use phase diagram for hydrogen shown on the right to answer the following questions

A. What is the minimum pressure required to form metallic hydrogen at room temperature (25°C)?

Convert your answer from Pa to atm.

What phase of metallic hydrogen is formed at that pressure: solid or liquid?

Which phase is denser: solid metallic hydrogen or liquid metallic hydrogen?

C. Currently the best device for achieving high pressures in the lab "can potentially obtain pressures above 50 GPa" (*Journal of High Pressure Research*, **2012**, *32*, 195-207).

Convert your first answer in Part A to GPa.
(show your work.)

Could this device be used to make metallic hydrogen at room temperature (25°C)? ______

Write an "X" on the phase diagram showing the region corresponding to 50 GPa and 25°C.

D. How many triple points are shown on the phase diagram? ______

Why isn't the H_2 solid-liquid-gas triple point shown on the phase diagram?

E. Circle the critical point.

IV. (16 points) We used Henry's law to consider the concentration of oxygen in water in terms of its availability for fish. Using Henry's law to explain the concentration of oxygen in our blood stream, however, would be playing a little fast and loose with Henry's law because the binding of O_2 to hemoglobin increases the apparent solubility of oxygen in our blood.

That complication disappears when we use Henry's law to account for the solubility of N_2 in our body and how that solubility increases with pressure. The classic example is deep sea diving, where the high pressures can lead to nitrogen narcosis and rapid ascent can cause nitrogen gas to form in the bloodstream, leading to the condition known as "the bends."

A. Turns out nitrogen is considerably more soluble in lipid (fatty) tissue than it is aqueous solutions (e.g. blood). Lipid tissue is mostly hydrocarbons.

Why is N_2 more soluble in lipid tissue? (Don't just say a buzz word or phrase. Walk us through the logical progression based on the properties of nitrogen and lipids.)

B. Our brains contain a significant amount of lipid tissue (yes, we are all "fat heads" on a way), and the nitrogen dissolved in the brain at a higher pressure can be a great concern for divers. The Henry's law constant for $N_2(g)$ in fatty tissue is around 2×10^{-3} mol/L·atm at 25°C (as opposed to 6.8×10^{-4} mol/L·atm in water at that same temperature). Calculate the concentration of $N_2(g)$ in fatty tissue if the air pressure is 2.5 atm (that would correspond to a depth of about 50 feet). Remember the air is roughly 80% nitrogen.

C. The average brain volume for humans is around 1200 cm^3. Given that the brain is mostly lipid tissue, use your answer to Part B above to calculate the moles of nitrogen dissolved in your brain under the conditions given.

D. Convert your answer to Part B from (mol N_2/L brain) to (mg N_2/100 mL) brain tissue.

V. (1 point)