Exams and Quizzes for Chem 121/122

*Thomas C. O'Haver**

Esta sección recoge diversos instrumentos de evaluación de la docencia. En esta ocasión hemos tomado de la red de Internet un examen que se utiliza en la Universidad de Maryland para evaluar el curso *Chemistry in Context*. Este curso desarrolla los conocimientos de química que se recomienda que posean los estudiantes que no están inscritos a una carrera científica o técnica. En tal sentido, como corresponden a conocimientos de química para ciudadanos, este examen puede ser empleado como guía para los cursos de química del bachillerato que deseen proporcionar una educación química orientada a aspectos de química cotidiana.
Fuente: O'Haver, T.C., Exams and Quizes for Chem 121/122, (1994). HTTP disponible: http://www.inform.umd.edu/UofMd-System_and_State_of_Maryland/UMD-Projects/Courses/PhysicalScience/Chem121Exams.txt

Final Exam

1) A beaker contains a certain mass of water. Another beaker contains the same mass of ethanol (C_2H_5OH). Which beaker contains the greater number of molecules? Explain your answer.

2) a. Why were lead compounds (*e.g.* tetraethyl lead) added to most automotive gasoline that was sold in the United States before 1975?

b. What is the primary purpose of catalytic converters in automobiles?

c. How did the introduction of catalytic converters in U.S. automobiles in 1975 indirectly reduce the level of lead pollution in the air of large cities?

3) Propene is an unsaturated hydrocarbon with the formula $CH_2{=}CHCH_3$. Draw the structure of this molecule in the following forms:

a. Lewis dot structure, showing all outer-shell electrons.

b. Line segment (wireframe) model

c. Ball-and-stick model (show hydrogen atoms as white and carbon as black)

4) a. What do all elements in one vertical column of the periodic table (for example: fluorine, chlorine, bromine, and iodine) have in common?

b. H_2S (hydrogen sulfide) is a gas that smells like rotten eggs. Predict the shape of this molecule, based on your knowledge of the periodic table, and explain how you made that prediction.

4) Why do the instructions on a package of spaghetti suggest a longer cooking time if you are in Denver (altitude approx. one mile) compared to the cooking time in locations near sea level?

5) Hydrogen gas has a heat of combustion of –240 kJoules per mole (that is, 240 kJoules are released when a mole of hydrogen gas is completely burned in oxygen). Methane (CH_4) gas has a heat of combustion of –802 kJoules per mole. Why is it, then, that NASA uses hydrogen rather than methane as a liquid fuel for the space shuttle?

6) If you could somehow see a single molecule of water, could you tell whether it was a molecule of gas (steam), liquid, or solid (ice)? How or why not?

7) Do you think it is likely that someone could ever invent an automotive engine that would burn nitrogen (N_2) as a fuel? Write a chemical equation for a possible combustion reaction and explain on the basis on bond energies in the table below why this reaction could never be used to propel a car.

Bond	Bond energy	Number of bonds broken	Energy required	Number of bonds formed	Energy released
H–H	432				
H–C	411				
C–C	346				
H–O	459				
C–O	359				
C=O	799				
O=O	494				
N#N	942				
C–N	305				
N–O	201				
O–O	142				
		Total (kJ/mole)			

8) a. What is so unusual about the hydrogen ion (H^+), compared to other positive ions commonly found in solution such as Na^+ and $Ca^{+2.}$

b. Calculate the hydrogen ion concentration, moles per liter, of a solution whose pH is 4.

* Department of Chemistry and Biochemistry, University of Maryland, College Park, MD 20742, (301) 4051831
to2@umail.umd.edu

9) In container A, 10 mL of 0.1 moles/liter hydrochloric acid (HCl) solution is mixed with 10 mL of 0.1 moles/liter lithium hydroxide (LiOH) solution (lithium hydroxide is a strong base, similar to sodium hydroxide). In container B, 10 mL of 1 gram/liter HCl solution is mixed with 10 mL of 1 gram/liter LiOH solution. If you tested the pH of the resulting solutions after mixing, your would expect to find: (Circle one for each solution)

Solution in container A: acid, approximately neutral, basic, or not possible to estimate.

Solution in container B: acid, approximately neutral, basic, or not possible to estimate.

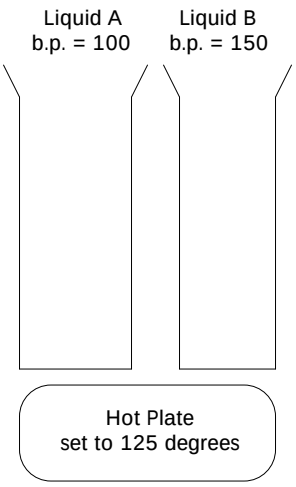
Explain your reasoning.

10) Suppose you have two open containers on a hot plate, one containing a liquid A with a boiling point of 100 degrees C and the other containing liquid B with a boiling point of 150 degrees C.
The hot plate is set to a temperature of about 125 degrees C.

a. What would you expect to observe?

b. Would one liquid have a higher temperature than the other? Which one? Why?

c. Would one liquid have faster microscopic molecular motion than the other? Which one? Why?



11) The energy required to decompose water vapor into hydrogen and oxygen gas

$$2H_2O\ (g) \rightarrow 2H_2(\ g) + O_2\ (g)$$

is approximately 480 kJoules/mole. The (g) means that the material is in the gas phase. The heat of vaporization of water

$$H_2O\ (l) \rightarrow H_2O\ (g)$$

as 0.972 kcal/mole. The (l) means that the material is in the liquid phase.

a. Which is greater, the energy required to decompose a gram of water or the energy required to vaporize a gram of water?

b. What kind of bonds exist between water molecules in liquid water?

c. Compare the kind and strength of the bonds which are broken when water is decomposed and when it is vaporized.

12) Suppose you want to make a liter of hot tea, but all you have is a wood-burning stove. Assuming that wood has a fuel value of 12 kJoules/gram, how many grams of wood would you have to burn in order to produce enough heat energy to heat one liter (1000 grams) of water from room temperature (20 degrees C) to its boiling temperature? The specific heat of water is 4.2 Joules/gram.

13) a. Give examples of the molecular structure of a saturated organic compound and an unsaturated one.

b. Why is the word saturated used here? What is a saturated molecule saturated with?

14) Why might the unabated large-scale use of CFCs (chlorofluorocarbons) in refrigeration units and aerosol can propellants be expected to result in an increase in the incidence of skin cancer?

15) If an ice cube is placed in the freezing compartment of a refrigerator which is at –20 degrees C what will the temperature of the ice cube become? Why?

16) Suppose you have two polarizing filters (like the ones you took home to play with), a polarized light source (like the little laser pointers we worked with), and a clear glass bottle containing an unknown transparent substance. How could you use this equipment to determine whether this substance has the property of rotating the plane of polarized light? Sketch the arrangement of the equipment, label clearly each part, and explain exactly what you would do and what you would look for. (You need not use all of the equipment available if you don't need it).

17) When consumed with one-half cup of skim milk, a 1 oz. serving of raisin bran provides 7 grams of protein, which amounts to 15% of the Recommended Daily Allowance for protein, according to the nutrition information on the box. What must therefore be the Recommended Daily Allowance for protein, in grams? (Show your work clearly, please).

18) In one experiment you performed, you dipped an operating lightstick into hot water and into ice water. What did you observe when you did this? What might be going on at the molecular level that could explain this observation?

19) a. Why were anabolic steroids first developed?
b. What does the molecular structure of these compounds have in common with the male sex hormone testosterone?

20) Take one of the large envelopes from the front desk. In there you will find some molecular model parts. From those parts, construct any chemically reasonable molecule containing at least 6 atoms which is not superimposable with its mirror image. Also construct the mirror image of that molecule. Place your completed models in the large envelope and write your name clearly on the outside of the envelope. ◩