Name _____

Last 5 digits of Student Number: XXX – X ___ – ___ ___ ___ ___

Chem 116
Sample Examination #1

This exam consists of seven (7) pages, including this cover page. Be sure your copy is complete before beginning your work. If this test packet is defective, ask for another one.

A copy of the Periodic Table is attached at the back of the exam. You may remove it and use the back side of the Periodic Table as scratch paper. No work on scratch paper will be graded or collected.

The following information may be useful:

Constants of nature

$$R = 8.314\ \frac{J}{mol \bullet K} = 0.08206\ \frac{L \bullet atm}{mol \bullet K}$$

Conversions/Metric Prefixes
1 mol of an ideal gas at STP occupies 22.4 L
1 atm = 760 mmHg

Equations

$$v_{rms} = \sqrt{\frac{3RT}{M}}$$

$$\frac{\text{rate of effusion of gas A}}{\text{rate of effusion of gas B}} = \sqrt{\frac{M_B}{M_A}}$$

DO NOT WRITE BELOW THIS LINE

Part I:

Questions 1-8	_____	(maximum 40)
Question 9	_____	(maximum 8)
Question 10	_____	(maximum 12)

Part II:

Question 1	_____	(maximum 20)
Question 2	_____	(maximum 20)
Extra credit	_____	(maximum 3)

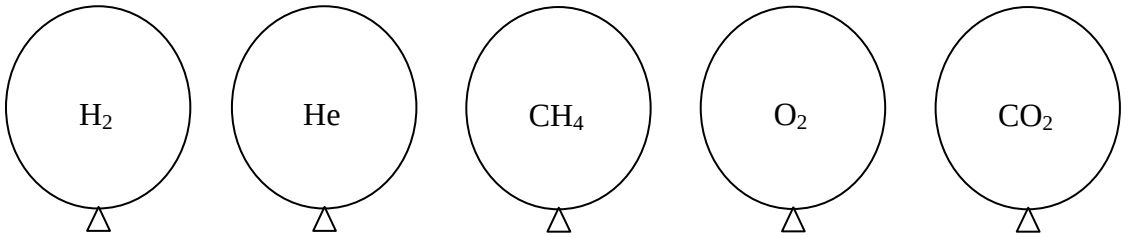
Total (out of 100) [ ]

Disclaimer:
This is a copy of a typical Exam 1 given in Chem 116 during the academic year. Your test will be different. This test is being posted to give you a sense of the format, style, scope and level of a typical test on this material. This test may have questions on topics that may not be covered on your exam. Moreover, your test may have questions on topics not covered in this practice exam. Posting this test in no way limits the format, style, scope and level of the test that you will take. Do not limit your preparation to the material in this practice exam.

Part I. Multiple-Choice or Short Response

There are 10 questions. Questions 1-8 are multiple-choice and are each worth 5 points. Question 9 looks like multiple-choice but there is more than one correct answer (you must indicate all correct answers on this question), and is worth 8 points. Question 10 requires a brief response and is worth 12 points.

1. The five balloons shown are at the same volume and temperature. Which of the following gases does hydrogen effuse four times faster than?

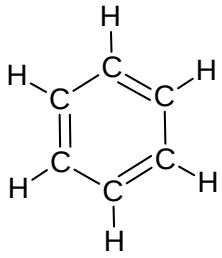


2. What type of intermolecular forces must be overcome to convert CCl_4 from a liquid to a gas?
   A) ion-ion attractions
   B) dipole-dipole attractions
   C) hydrogen bonding
   D) London dispersion forces
   E) dipole – induced dipole attractions

3. A gas sample at 45 ºC and 0.80 atm occupies 3.20 L. At what temperature in degrees Celsius is the volume of the gas 1.80 L if the pressure is kept constant?
   A) -94 ºC
   B) -48 ºC
   C) 25 ºC
   D) 80. ºC
   E) 290 ºC

4. Which of the following aqueous solutions freezes at the lowest temperature? Assume ideal behavior.
   A) 0.030 *m* sucrose ($C_{12}H_{22}O_{11}$)
   B) 0.015 *m* NaCl
   C) 0.012 *m* K_2CO_3
   D) 0.010 *m* $(NH_4)_3PO_4$
   E) 0.0010 *m* methanol (CH_3OH)

5. The vapor pressure of benzene (shown at right) is 79.8 mmHg in a flask at 20 ºC. What is the density of the vapor?



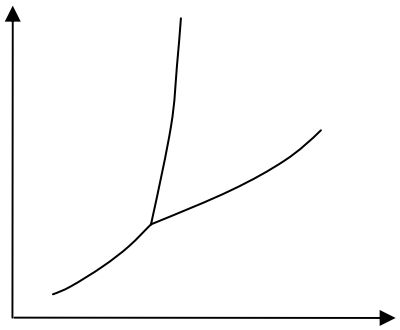
A) 0.341 g/L
B) 0.929 g/L
C) 3.14 g/L
D) 4.99 g/L
E) 28.0 g/L

6. Equal numbers of moles of He (g), CO_2 (g) and N_2 (g) are placed in a single glass container at room temperature. The gases do not react with each other. If the container has a small pinhole leak, which of the following will be true after some of the gas mixture has effused?

A) $P_{N_2} < P_{CO_2} < P_{He}$
B) $P_{CO_2} < P_{He} < P_{N_2}$
C) $P_{He} < P_{N_2} < P_{CO_2}$
D) $P_{He} < P_{CO_2} < P_{N_2}$
E) $P_{He} = P_{N_2} = P_{CO_2}$

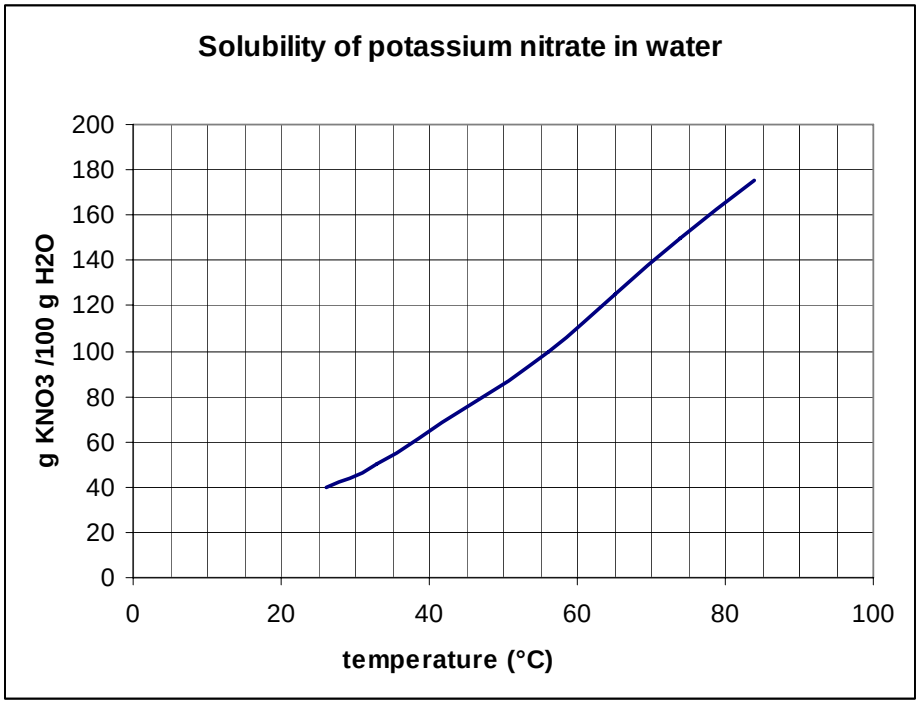
7. The phase diagram of oxygen (O_2) includes the following points:

- Critical point: T_c = 154.5 K, P_c = 49.3 atm
- Triple point: $T_{t.p.}$ = 54.33 K, $P_{t.p.}$ = 0.00150 atm
- Normal melting point: T_{fus} = 54.8 K
- Normal boiling point: T_{vap} = 90.2 K



You may wish to use the sketch at the right to help you answer the question. Under which one of the following conditions is oxygen a liquid?

A) T = 50. K, P = 0.80 atm
B) T = 60. K, P = 0.50 atm
C) T = 90. K, P = 0.20 atm
D) T = 100. K, P = 0.050 atm
E) T = 150. K, P = 1.0 atm



8. The chart above shows the solubility of potassium nitrate (KNO_3) in water. You are given a 7.93-molal KNO_3 solution in the laboratory at 60 ºC. What is true about this solution?
   A) It is below saturation
   B) It is exactly at saturation
   C) It is supersaturated
   D) There is not enough information to tell

9. Compare 1.00 mol of pure carbon dioxide (CO_2) in the gas state with 1.00 mol of CO_2 in a condensed phase (liquid). Indicate all statements below that are true (this is not multiple-choice, there is more than one correct answer to indicate).

___ The gas particles have less kinetic energy on average than particles in the condensed phase.

___ The gas particles are very far apart from each other compared to particles in the condensed phase.

___ The gas occupies all space available to it while the condensed phase occupies a specific volume.

___ The gas is more dense than the condensed phase.

___ The gas is much more compressible than the condensed phase.

10. Identify which of the following gases deviates most from ideal behavior and provide a brief explanation of why. Make sure to identify which assumption or assumptions break down. (Note: geometry of SO_2 molecule is bent, geometry of CH_4 molecule is tetrahedral.)

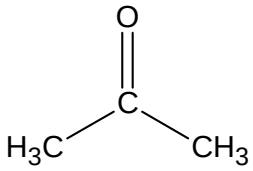
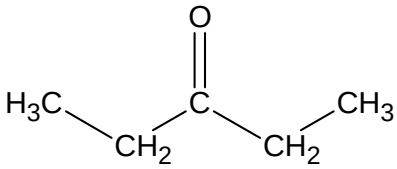
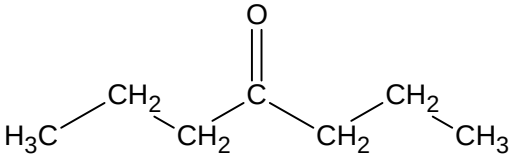
SO_2 Ne CH_4 N_2 H_2

Part II. Problems

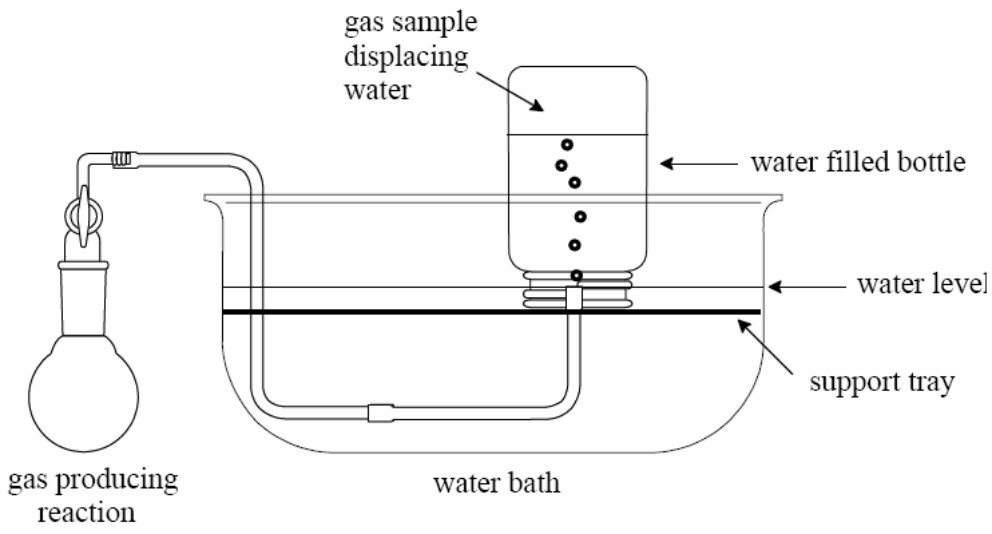
Each problem is worth 20 points.

1. In the table below is shown a series of ketones, their molecular structures, and their boiling points. Provide an explanation for the following trend.

As the number of carbons in the ketones increases, the boiling points increase.

Name of compound	Molecular structure	Boiling point (ºC)
dimethyl ketone (acetone)		56.3
diethyl ketone (3-pentatone)		102.1
dipropyl ketone (4-heptanone)		144.0

2. The apparatus shown here is used to collect carbon dioxide (CO_2) gas over water.



Calcium carbonate ($CaCO_3$, molar mass 100.1 g/mol) is heated in the flask, and decomposes to form CO_2 gas according to the following reaction:

$$CaCO_3\,(s) \rightarrow CaO\,(s) + CO_2\,(g)$$

On this day in the laboratory, atmospheric pressure is 758 torr. The water temperature is 27ºC, and the vapor pressure of water at this temperature is 26.7 torr. If the total volume of gas collected is 143 mL, and if all of the $CaCO_3$ reacted, what original mass of $CaCO_3$ must have been present?

Extra credit (up to 3 points):

Provide one reason why the total volume of gas actually collected is less than theoretically possible.