Name ___Key___
(Please Print)

Chem 104 - Section 1
Hour Examination I
Sample Test

This test consists of six (6) 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.

☞ **You must show work in the spaces provided that leads to your answers to problems 2, 3, and 4. Answers without such work receive no credit.**

Ideal Gas Law Constant = $R$ = 0.08206 L·atm/K·mol = 8.314 J/K·mol
Molar volume of an ideal gas at STP = 22.4 L/mol
K = °C + 273.15

## DO NOT WRITE BELOW THIS LINE

This is a copy of a typical first test in Chem 104. 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 will not be covered on the test you take. Moreover, your test may have questions on topics that are not covered on this test. Posting this test in no way limits the format, style, scope, or level of the test that you will take. **Do not limit your preparation to the material on this sample test.**

Name ___K_e_y_____

1. (60 points; 4 points each)  Circle the best answer to each of the following.

a.  If $c$ is a constant, the equation that represents both Avogadro's Hypothesis and the Law of Gay-Lussac is
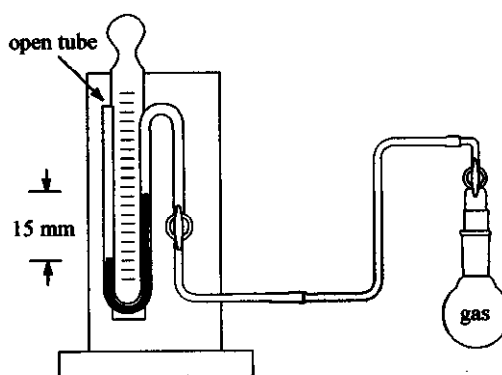
   $V = c/P$      $\boxed{V = cn}$      $P = cT$      $V = cP$      $V = cT$

b.  The pressure of a gas sample is measured with an open-ended manometer, as shown below.



   The mercury level in the outer arm is lower than the level of the inner arm by 15 mm.  A barometer in the laboratory reads 756 mm Hg.  What is the pressure of the gas sample in mm Hg?

   15 mm Hg    $\boxed{741\ mm\ Hg}$    756 mm Hg    771 mm Hg    760 mm Hg

c.  A gas sample in a piston chamber at 25 °C and 1.20 atm occupies 8.00 L.  What is the pressure if the piston is moved inward to make the volume 3.20 L?

   0.333 atm      0.450 atm      $\boxed{3.00\ atm}$      4.80 atm      21.3 atm

d.  A sample of gas in a steel tank at 25 °C has a pressure of 2.80 atm.  The tank is submerged in boiling water and attains a temperature of 100 °C.  What is the pressure inside the heated tank?

   0.700 atm      2.24 atm      $\boxed{3.50\ atm}$      3.83 atm      11.2 atm

Name _____ Key _____

e. In 3.00 hours, 0.400 mol $CH_4(g)$ (m.w. = 16.0) effuses from a certain apparatus. How many moles of $SO_2(g)$ (m.w. = 64.0) should effuse in the same time under identical conditions?

  1.60 mol     0.800 mol     0.100 mol     ⟨0.200 mol⟩     0.400 mol

f. Of the following gases, which would be expected to behave *least* like an ideal gas?

  He     ⟨$H_2O$⟩     $CH_4$     Ne     $N_2$

g. Which of the following is most likely to be soluble in carbon tetrachloride, $CCl_4(l)$?

  HF     $H_2O$     $Na_2CO_3$     $CH_3CO_2H$     ⟨$I_2$⟩

h. The molar mass of $CF_4(g)$ is 88.0 g/mol. Assuming ideal behavior, what is the expected density of $CF_4(g)$ at STP?

  0.255 g/L     1.00 g/L     3.60 g/L     ⟨3.93 g/L⟩     88 g/L

i. Which of the following is *not* a factor in producing the pressure of a gas sample?

  Temperature

  Molecular collisions with the container walls

  ⟨The identity of the gas⟩

  The amount of gas

  Volume of the container

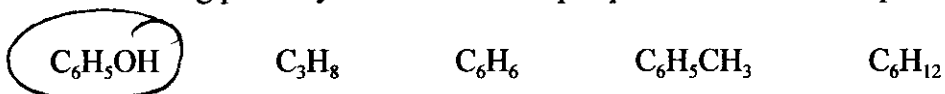j. Which of the following has the highest boiling point?

  $H_2$     ⟨HF⟩     HCl     HBr     HI

k. Which of the following solids has the lowest melting point?

  $SiO_2$     NaCl     Fe     $Al_2O_3$     ⟨Na⟩

Name __Key__

l.  Which of the following probably has the lowest vapor pressure at room temperature?

$C_6H_5OH$  (circled)     $C_3H_8$     $C_6H_6$     $C_6H_5CH_3$     $C_6H_{12}$

m.  At 20 °C the vapor pressure of pure benzene is 74.7 torr.  What is the expected vapor pressure in torr above a solution prepared by mixing 0.232 mol of a nonvolatile organic compound with 0.928 mol of benzene?

14.9 torr        17.3 torr        18.7 torr        59.8 torr (circled)        69.3 torr

n.  At 25 °C, what is the osmotic pressure in atmospheres of a 0.0125 M solution of $CaCl_2(aq)$?

0.306 atm        0.611 atm        0.917 atm (circled)        31.0 atm        92.9 atm

o.  Consider the phase diagram shown below.
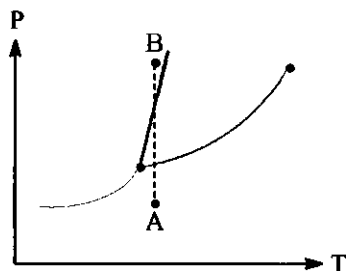


Which one of the following describes the sequence of phase changes that would occur when raising the pressure at constant temperature, as indicated by the dotted line from A to B?

liquid→solid→vapor          liquid→vapor→solid          vapor→liquid→solid (circled)

solid→liquid→vapor          vapor→solid→liquid

Name $\underline{\text{Key}}$

2. (10 points) Calculate the molality ($m$) of a solution prepared by dissolving 0.356 g of glucose, $C_6H_{12}O_6$ (m.w. = 180.2 u) in 96.0 g of water?

$$\underline{m} = \left(\frac{0.356 \text{ g glucose}}{96.0 \text{ g } H_2O}\right)\left(\frac{\text{mol glucose}}{180.2 \text{ g glucose}}\right)\left(\frac{10^3 \text{ g } H_2O}{\text{kg } H_2O}\right)$$

$$= 0.0205_{79} \text{ mol glucose / kg } H_2O$$

$$= \boxed{0.0206 \underline{m}}$$

3. (12 points) A 1.15-g sample of an unknown organic compound is dissolved in 62.0 g of carbon tetrachloride. The resulting solution freezes at –25.4 °C. What is the molecular weight of the unknown compound? Pure $CCl_4(l)$ freezes at –22.3 °C and has a freezing-point-depression constant of 29.8 °C/$m$.

$$\Delta T = K_f m \implies m = \Delta T / K_f \qquad \Delta T = -25.4 - (-22.3)$$
$$= -3.1 °C$$

$$m = \frac{3.1 °C}{29.8 °C/m} = 0.10_4 \underline{m} = 0.10_4 \text{ mol } X / \text{kg } CCl_4$$

$$m.w. = \left(\frac{1.15 \text{ g } X}{62.0 \text{ g } CCl_4}\right)\left(\frac{10^3 \text{ g } CCl_4}{0.104 \text{ mol } X}\right) = 178 \text{ g } X/\text{mol } X$$

$$= \boxed{1.8 \times 10^2 \text{ g } X/\text{mol } X} \quad 2 \text{ sig. figs.}$$

Name __Key__

4. (18 points) While on a field trip, Ms. Smith's seventh-grade science class notices a gas bubbling up through the water near the edge of a pond. Using an empty mayonnaise jar from their lunch, they collect the gas by water displacement and seal the sample with the jar's lid. They bring the sealed jar to the University's Chemistry Department, where it is determined that the mass of the collected gas sample is 0.3088 g and that the volume of the mayonnaise jar is 477 mL. From the weather report, it is known that the temperature at the pond was 29.0 °C and that the barometric pressure was 756 torr. The vapor pressure of water at 29.0 °C is 30.0 torr.

a. (12 points) How many moles of the unknown gas does the sample contain?

$$P_{gas} = P_{atm} - P_{H_2O} = (756 - 30.0) torr = 726\ torr$$

$$n = \frac{PV}{RT} = \frac{(726\ torr / 760\ torr \cdot atm^{-1})(0.477\ L)}{(0.08206\ L \cdot atm / K \cdot mol)(302.15\ K)}$$

$$= 0.6183_{78}\ mol = 0.0184\ mol$$

b. (6 points) From the given data, you could calculate that the amount of water vapor in the jar is 0.0137 g. Given this and the mass of the gas sample, calculate the molecular weight of the unknown gas.

$$m_{gas} = m_t - m_{H_2O} = 0.3088\ g - 0.0137\ g = 0.2951\ g$$

$$m.w. = \frac{0.2951\ g}{0.0184\ mol} = 16.0\ g/mol$$

BONUS (5 points) Identify the unknown gas, justifying your answer on the basis of the results of your calculations above.

$$CH_4\ m.w. = 16\ g/mol\ Methane, a\ common\ swamp\ gas.$$