EXAM FIVE **CHM 203 (Dr. Mattson)** **4 DECEMBER 2009**	***Academic Integrity Pledge:*** *In keeping with Creighton University's ideals and with the Academic Integrity Code adopted by the College of Arts and Sciences, I pledge that this work is my own and that I have neither given nor received inappropriate assistance in preparing it.* *Signature:*

Instructions: Show all work whenever a calculation is required! You will receive credit for <u>how</u> you worked each problem as well as for the correct answer. If you need more space, you may use the back of your periodic table — Write: "See PT" in box and then attach the periodic table. BOX YOUR ANSWERS! Write legibly.

1. (4 pts) Convert a pressure of 120 kPa into units of mmHg. [Given: 1atm = 101.325 kPa]

2. (4 pts) What is the volume occupied by 52 g neon at 1.40 atm at 300 K?

3. (4 pts) How many moles of carbon dioxide are in a sample with a pressure of 2.5 atm in a 4.40 L vessel at 100 ^{o}C?

4. (4 pts) Suppose a gas sample occupies 14.9 L at STP. What is its volume at 400 K and 0.87 atm?

5a. (4 pts) Starting with $PV = nRT$, derive the formula that you will need to answer the question that follows.

5b. (4 pts) What is the MM of a gas with a mass of 1.73 g and occupying 1017 mL at 98 ^{o}C and 744 mmHg?

6a. (4 pts) Derive the formula you would use to answer the following question.

6b. (4 pts) Suppose a gas sample has a density of 3.68 g/L at STP. What is its density at 25 ^{o}C and 19.0 atm?

7. (3 pts) In the preparation of $ClF_3(g)$ according to the equation below, what volume of $F_2(g)$ would you need to react completely with 5.0 L of $Cl_2(g)$?

$$Cl_2(g) + 3\ F_2(g) \rightarrow 2\ ClF_3(g)$$

8. (4 pts) What is the ratio of rates of effusion of $CH_4(g)$ and $CO_2(g)$? Express your answer as a number equal to $rate_{fast}/rate_{slow}$.

9. (5 pts) T/F In our discussion of gases, we learned that gases can be modeled using kinetic molecular theory.

T F All gas molecules in a sample have the same kinetic energy at constant temperature.
T F The average kinetic energy of molecules increases with an increase in temperature.
T F At any given temperature, the average velocity of large MM gases will be less than the average velocity of lighter gases.
T F At any given temperature, the average kinetic energy of large MM gases will be less than the average KE of lighter gases.
T F At any given temperature, some molecules will have little or no kinetic energy.

10. (2 pts) What is the mole fraction of oxygen in a sample containing 17 % by volume oxygen?

11. (4 pts) What is the partial pressure of nitrogen in a sample containing 4.0 mol N_2 and 16.0 mol CO_2 at a total pressure of 735 mmHg?

12. (4 pts) Which of these molecules is/are polar?

CS_2 NCl_3 OF_2 CF_4

13. (6 pts) Which of the following molecules is/are predicted to have hydrogen-bonding? Circle all that apply.

OH_2 CH_3OCH_3 CH_3CH_2OH
CH_3NCl_2 CH_3NH_2 CH_3F

14. (4 pts) Within each pair of molecules, circle the one with the greatest London dispersion forces.

SF_2 or SF_4 CH_3Cl or CH_3I
CCl_4 or CH_4 $SiCl_4$ or CCl_4

15. In class we saw that ethanol (MM = 46 g/mol) evaporated faster than isopropanol (MM = 60 g/mol) and isopropanol evaporated faster than water (MM = 18 g/mol.

15a. (2 pts) Which has the strongest total intermolecular forces?
ethanol isopropanol water

15b. (2 pts) Which has the largest amount of hydrogen-bonding forces?
ethanol isopropanol water

15c. (2 pts) Which has the largest amount of London dispersion forces?
ethanol isopropanol water

16. Both copper and nickel form face-centered cubic solids.

16a. (2 pts) How many atoms are within each unit cell?

16b. (4 pts) What unit cell positions are occupied by the metal atoms?

corners face-centers
edge-centers body-centers

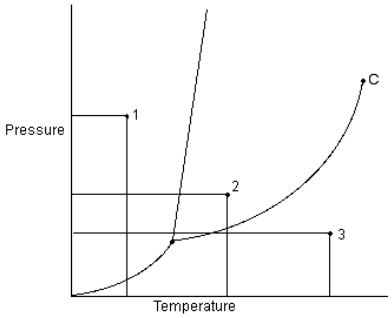
17. (2 pts) A metal arsenide, M_xAs_y features the arsenide ions in a body-centered unit cell arrangement and the metal ions located at all edge centers. What is the empirical formula of the compound?

18. (6 pts) Suppose you were to calculate how much heat was required to warm a sample of water at room temperature to $H_2O(g)$ 100 ^oC. Which of the following values would you need? Circle all that apply. [Note: SH = Specific heat.]

ΔH_{fus} ΔH_{vap} ΔH_{subl}

$SH_{H_2O(s)}$ $SH_{H_2O(l)}$ $SH_{H_2O(g)}$

19. Consider the phase diagram below:



19a. (3 pt) Label the diagram with "solid," "liquid," and "gas."

19b. (1 pt) Starting at Point "2" can one cause the substance to sublime by adjusting only the temperature or the pressure? YES or NO

19d. (1 pt) What phase exists at temperatures greater than that of Point C?

20. (4 pts) Circle all of these phase changes that are exothermic?

$NH_3(l) \rightarrow NH_3(g)$ $CH_4(g) \rightarrow CH_4(l)$

$CO_2(s) \rightarrow CO_2(g)$ $H_2O(l) \rightarrow H_2O(s)$

Print your name in the box below and sign academic integrity statement above.

Answers:

1. 900 mmHg

2. 45.4 L

3. 0.36 mol

4. 25.7 L

5a. show the steps of the derivation:

$$PV = nRT$$

$$PV = \frac{m}{MM}RT$$

$$MM = \frac{mRT}{PV}$$

5b. 52.9 g/mol

6a. Show the steps of the derivation:

$$\frac{P_i V_i}{n_i T_i} = \frac{P_f V_f}{n_f T_f}$$

substitute in $n = \frac{m}{MM}$:

$$\frac{P_i V_i MM_i}{m_i T_i} = \frac{P_f V_f MM_f}{m_f T_f}$$

Molar masses cancel (the MM does not change)

and then substitute $d = \frac{m}{V}$:

$$\frac{P_i}{d_i T_i} = \frac{P_f}{d_f T_f}$$

6b. 64 g/L

7. 15 L

8. $rate_{fast}/rate_{slow} = 1.66$

9. F T T F T

10. 0.17

11. 147 mmHg?

12. NCl_3 OF_2

13. OH_2 CH_3CH_2OH CH_3NH_2

14. SF_4 CH_3I CCl_4 $SiCl_4$

15a. water

15b. water

15c. isopropanol

16a. 4

16b. corners face-centers

17. M_3As_2

18. ΔH_{vap} $SH_{H_2O(l)}$

19. Consider the phase diagram below:

19a. The region with the "1" should be labeled "solid," region 2 labeled "liquid," and region 3 labeled "gas."

19b. NO

19d. gas

20. $CH_4(g) \rightarrow CH_4(l)$ $H_2O(l) \rightarrow H_2O(s)$