CH 222 Practice Problem Set #4

*This is a **practice problem set** and not the actual graded problem set that you will turn in for credit. Answers to each problem can be found at the end of this assignment.*

Covering: **Chapter Nine, Chapter Ten** *and* **Chapter Guide Four**

Important Tables and/or Constants: **R = 0.082057 L atm mol^{-1} K^{-1}, 760 mm Hg = 1 atm = 1013 mbar, 1 mbar = 1 hPa, 1 torr = 1 mm Hg**

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1. A sample of nitrogen gas has a pressure of 67.5 mm Hg in a 500. mL flask. What is the pressure of this gas sample when it is transferred to a 125 mL flask at the same temperature?
2. You have 3.5 L of NO at a temperature of 22.0 °C. What volume would the NO occupy at 37 °C? (Assume the pressure is constant.)
3. One of the cylinders of an automobile engine has a volume of 400. cm^3. The engine takes in air at a pressure of 1.00 atm and a temperature of 15 °C and compresses the air to a volume of 50.0 cm^3 at 77 °C. What is the final pressure of the gas in the cylinder?
4. A 1.25 g sample of CO_2 is contained in a 750. mL flask at 22.5 °C. What is the pressure of the gas?
5. A gaseous organofluorine compound has a density of 0.355 g/L at 17 °C and 189 mm Hg. What is the molar mass of the compound?
6. Acetaldehyde is a common liquid compound that vaporizes readily. Determine the molar mass of acetaldehyde from the following data:
   Sample mass = 0.107 g Volume of gas = 125 mL
   Temperature = 0.0 °C Pressure = 331 mm Hg
7. Iron reacts with hydrochloric acid to produce iron(II) chloride and hydrogen gas:
   $Fe(s) + 2\ HCl(aq) \rightarrow FeCl_2(aq) + H_2(g)$
   The H_2 gas from the reaction of 2.2 g of iron with excess acid is collected in a 10.0-L flask at 25 °C. What is the pressure of the H_2 gas in this flask?
8. Sodium azide, the explosive compound in automobile air bags, decomposes according to the following equation:
   $2\ NaN_3(s) \rightarrow 2\ Na(s) + 3\ N_2(g)$
   What mass of sodium azide is required to provide the nitrogen needed to inflate a 75.0 L bag to a pressure of 1.3 atm at 25 °C?
9. What is the total pressure in atmospheres of a gas mixture that contains 1.0 g of H_2 and 8.0 g of Ar in a 3.0 L container at 27 °C? What are the partial pressures of the two gases?
10. You have two flasks of equal volume. Flask A contains H_2 at 0 °C and 1 atm pressure. Flask B contains CO_2 gas at 25 °C and 2 atm pressure. Compare these two gases with respect to each of the following:
    a. average kinetic energy per molecule
    b. average molecular velocity
    c. number of molecules
    d. mass of gas
11. Place the following gases in order of increasing average molecular speed at 25 °C: Ar, CH_4, N_2, CH_2F_2.

12. There are five compounds in the family of sulfur–fluorine compounds with the general formula S_xF_y. One of these compounds is 25.23% S. If you place 0.0955 g of the compound in a 89 mL flask at 45 °C, the pressure of the gas is 83.8 mm Hg. What is the molecular formula of S_xF_y?
13. A miniature volcano can be made in the laboratory with ammonium dichromate. When ignited, it decomposes in a fiery display.

    $(NH_4)_2Cr_2O_7(s) \rightarrow N_2(g) + 4\ H_2O(g) + Cr_2O_3(s)$

    If 0.95 g of ammonium dichromate is used, and if the gases from this reaction are trapped in a 15.0 L flask at 23 °C, what is the total pressure of the gas in the flask? What are the partial pressures of N_2 and H_2O?
14. What type of intermolecular force must be overcome in converting each of the following from a liquid to a gas?

    a. liquid O_2 b. H_2O c. CH_3I d. CH_3CH_2OH
15. Rank the following atoms or molecules in order of increasing strength of intermolecular forces in the pure substance. Which exist as gases at 25 °C and 1 atm?

    a. Ne b. CH_4 c. CO d. CCl_4
16. In each pair of ionic compounds, which is more likely to have the greater heat of hydration? Briefly explain your reasoning in each case.

    a. LiCl or CsCl

    b. $NaNO_3$ or $Mg(NO_3)_2$

    c. RbCl or $NiCl_2$
17. Ethanol, CH_3CH_2OH, has a vapor pressure of 59 mm Hg at 25 °C. What quantity of heat energy is required to evaporate 125 mL of the alcohol at 25 °C? The enthalpy of vaporization of the alcohol at 25 °C is 42.32 kJ/mol. The density of the liquid is 0.7849 g/mL.

Answers to the Practice Problem Set:

1. 270. mm Hg
2. 3.7 L
3. 9.72 atm
4. 0.919 atm
5. 34.0 g/mol
6. 44.1 g/mol
7. 0.096 atm
8. 170 g
9. 5.7 atm; 4.1 atm (H_2), 1.6 atm (Ar)
10. a. B > A b. A > B c. B > A d. B > A
11. $CH_2F_2 < Ar < N_2 < CH_4$
12. S_2F_{10}
13. 0.031 atm; 0.0061 atm (N_2), 0.024 atm (H_2O)
14. a. induced dipole - induced dipole b. hydrogen bonding c. dipole-dipole d. hydrogen bonding
15. $CH_4 < Ne < CO < CCl_4$ First three are gases
16. a. LiCl b. $Mg(NO_3)_2$ c. $NiCl_2$
17. 90.1 kJ