CH1020 Practice Problems for KMT, Effusion. Diffusion, Van der Waals equation

1. Suppose you have two 1-L flasks, one containing N_2 at STP, the other containing CH_4 at STP. How do these systems compare with respect to
   a. number of molecules
   b. density
   c. average kinetic energy
   d. rate of effusion through a pinhole leak?

2. Vessel A contains CO_2 gas at 0^oC and 1 atm. Vessel B contains HCl gas at 20^oC and 0.5 atm. The two vessels have the same volume.
   a. which vessel contains more molecules?
   b. Which contains more mass?
   c. In which vessel is the average kinetic energy of molecules higher?
   d. In which vessel is the rms speed of molecules higher?

3. What change or changes in the state of a gas bring about each of the following effects?
   a. the number of impacts per unit time on a given container wall increases.

   b. The average energy of impact of molecules with the wall of the container decreases

   c. The average distance between gas molecules increases

   d. The average speed of molecules in the gas mixture is increased

4. Indicate which of the following statements regarding kinetic molecular theory of gases are correct. For those that are false, formulate a correct version of the statement
   a. the average kinetic energy of a collection of gas molecules at a given temperature is proportional to root of molar mass.

   b. The gas molecules are assumed to exert no forces on each other

   c. All the molecules of a gas at a given temperature have the same kinetic energy

   d. The volume of the gas molecules is negligible in comparison to the total volume in which the gas is contained.

5. Consider a 1.0 L container of neon gas at STP. Will the average kinetic energy, average velocity, and frequency of collisions of gas molecules with the walls of the container increase, decrease, or remain the same under each of the following conditions?
   a. the temperature is increased to 100°C

   b. the temperature is decreased to –50°C

   c. the volume is decreased to 0.5 L

   d. the number of moles of neon is doubled

6. Consider separate 1.0 L gaseous samples of H_2, Xe, Cl_2 and O_2 all at STP
   a. rank the gases in order of increasing average kinetic energy

   b. rank the gases in order of increasing average velocity

   c. How can separate 1.0-L samples of O_2 and H_2 each have the same average velocity?

7. Place the following gases in order of increasing molecular speed at 300 K: CO_2, N_2O, HF, F_2, H_2. Calculate and compare the rms speeds of H_2 and CO_2 at 300 K.

8. Calculate the average kinetic energy of the N_2 gas at 273 K and 546 K

9. Calculate the root mean square velocity of the CH_4 and N_2 molecules at 273 K and 546 K

10. The rate of effusion of a particular gas was measured and found to be 24.0 mL/min. Under the same conditions, the rate of effusion of pure methane (CH_4) gas is 47.8 mL/min. What is the molar mass of the unknown gas?

11. It took 4.5 minutes for 1.0 L helium to effuse through a porous barrier. How long will it take for 1.0 L Cl_2 gas to effuse under identical conditions?

12. Under what experimental conditions of temperature and pressure do gases usually behave non-ideally? What two properties or characteristics of gas molecules cause them to behave ideally?

13. Calculate the pressure exerted by 0.5000 mol N_2 in a 1.0000-L container at 25°C
    a. using the ideal gas law
    b. using the Van der Waals equation
    c. compare the results.

14. Calculate the pressure exerted by 0.5000 mol N_2 in a 10.0000-L container at 25°C
    a. using the ideal gas law
    b. using the Van der Waals equation
    c. compare the results.
    d. Compare the results with those in Exercise 13.