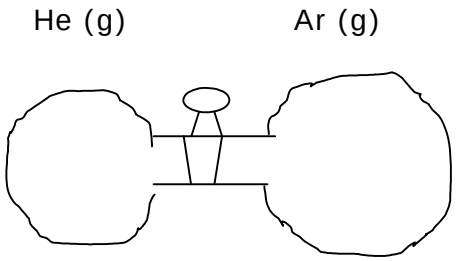
Review - Gases

Name _____

1. A compound contains only hydrogen and nitrogen and is 12.6% hydrogen by mass. A gaseous sample of the compound has density of 0.925 g/L at 690 torr and 110ºC. What is the molecular formula of the compound?

2. A steel cylinder contains 98.0 moles of oxygen gas at a temperature of 38°C and a pressure of 740 torr. After some of the oxygen gas has been used, the pressure is reduced to 332 torr at a temperature of 24°C. What mass of oxygen gas was removed from the cylinder?

3. Consider the flasks diagrammed below. What is the total pressure, in torr, after the stopcock between the two flasks is opened?



V= 1.25 L
P= 0.300 atm

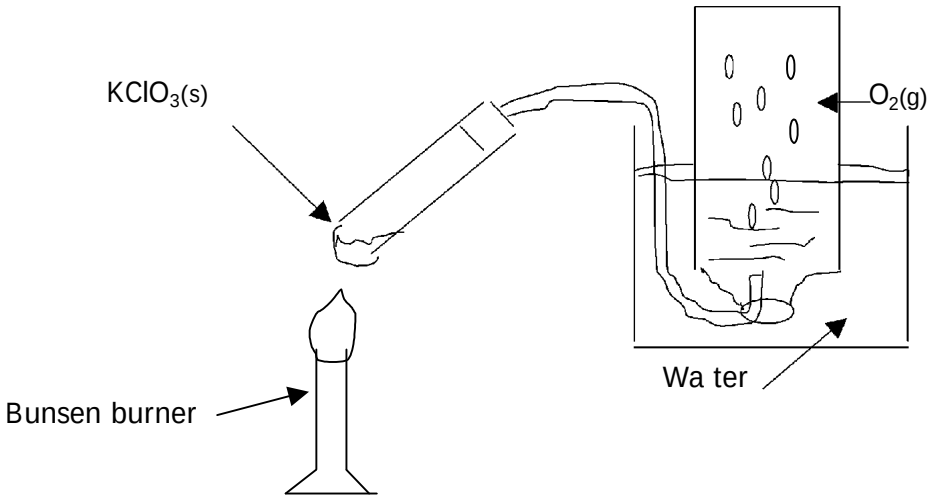
V= 2.50 L
P= 233 torr

4. CaO reacts with SO_2 according to the following equation:

$$CaO(s) + SO_2(g) \longrightarrow CaSO_3(s)$$

A 2.85 g of a mixture containing $CaO_{(s)}$ is placed in a 3.00-L container. The container is filled with SO_2 to a pressure of 749 torr at 20.0°C. After the reaction has gone to completion, the pressure inside the flask is 390 torr, also at 20.0°C. What is the mass of $CaSO_3$ produced? Assume that only CaO in the mixture reacts with SO_2. (Assume that the solids occupy no volume.)

5. A sample of oxygen gas is collected by displacing water from an inverted bottle as shown in the diagram below.



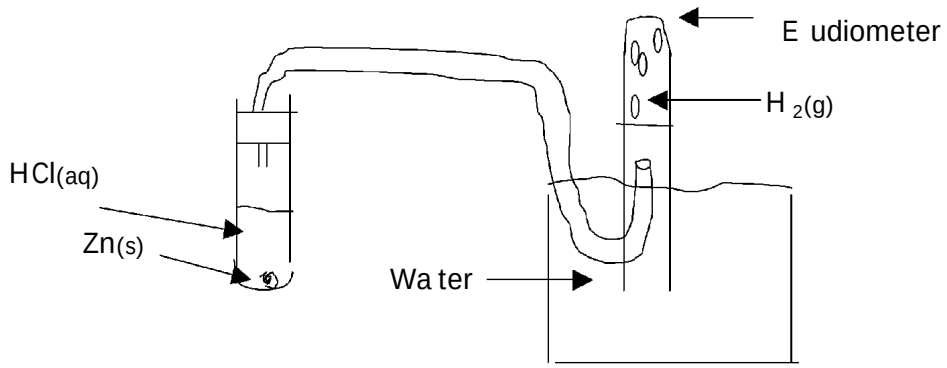
The volume of O_2 collected is 400.0 mL at 25°C. The atmospheric pressure is 680 torr and the vapor pressure of water at 25°C is 23.8 torr.

a. What mass of $O_{2(g)}$ is collected?

b. Calculate the mass of KCO_3 required to produce the amount of O_2 calculated in (a) above.

$$2\ KCO_{3(s)} \longrightarrow 2\ KCl_{(s)} + 3\ O_{2(g)}$$

6. Consider the diagram given below:



a. Write a balanced equation for the reaction taking place when Zn is allowed to react with $HCl_{(aq)}$.

b. 7.10 mL of 6.0 M HCl are added to 0.186 g Zn(s) in a test tube. The liberated $H_{2(g)}$ is collected by displacement of water from an eudiometer, a graduated glass measu ring tube for gas analysis. After the reaction is complete, the volume of $H_{2(g)}$ collected above water is 72.18 mL at 18.8°C. The height of water column in the eudiometer is 21.8 cm and the atmospheric pressure is 753.2 torr. At 18.8°C the density of Hg is 13.6 g/cm^3 and the vapor pressure of water is 17.54 torr. Calculate the experimental ideal gas constant, R, from the information given.

c. Calculate the % error in the experimental value of R.

d. Calculate the molar volume of $H_{2(g)}$ using the data given. (Do not use the theoretical value of R for this problem.)

7. A balloon is filled with helium at 23°C. The balloon expands until the pressure inside the balloon is equal to the atmospheric pressure which is 755 torr. The balloon then rises to an altitude of 6000 ft. where the pressure is 550 torr and the temperature is 5°C. Calculate the percent increase in volume of the balloon as it ascends to 6000 ft.

8. 4.430 g of a mixture containing $CaCO_{3(s)}$ is heated until all $CaCO_3$ decomposed.

$$CaCO_{3(s)} \longrightarrow CaO_{(s)} + CO_{2(g)}$$

The $CO_{2(g)}$ liberated in the reaction is collected over water at 27°C and a total pressure of 750 torr. The volume of $CO_{2(g)}$ is 432 mL and the vapor pressure of water at 27°C is 26.7 torr. Calculate the percent $CaCO_{3(s)}$ in the mixture. (molar masses: $CaCO_3$=100.0 g/mole, CaO=56.1 g/mole, CO_2= 44.0 g/mole)

9. At 0.483 atm and 52°C, the density of gas R is 2.35 g/L. A volume of 45.0 mL of gas R effuses through an apparatus in 3.60 seconds. The rate of effusion of gas Z through the same apparatus and under the same conditions is 18.4 mL/sec. What is the molar mass of Z?

10. Calculate the density of a gas at STP, if a given volume of the gas effuses through an apparatus in 6.60 min and the same volume of nitrogen at the same temperature and pressure, effuses through this apparatus in 8.50 minutes.

11. A 3.00 L sample of gas was collected over water at 45°C. The wet gas exerts pressure (P_{total}) of 1.50 atm. When dried (the water vapor has been removed) the sample occupies 1.80 L and exerts a pressure of 1.77 atm at 80.0°C. What is the vapor pressure of water at 45°C?

12. A compound contains only C, H, and N only. A chemist analyzed it by doing the following experiments. Complete combustion of 84.0 g of the compound converted all its carbon into 80.4 g $CO_{2(g)}$. A 156.5 g sample of the compound was analyzed for nitrogen, giving 85.44 L $N_{2(g)}$ at 740 torr and 25°C. Calculate the empirical formula of the compound.

13. Consider the following reaction:

$$2\ Al_{(s)} + 3\ S_{(g)} \longrightarrow Al_2S_{3(s)}$$

3.66 g of $Al_{(s)}$ is placed in a 7.46 L cylinder in an atmosphere of $S_{(g)}$ at 1.75 atm and a temperature of 160°C. Two minutes later, the pressure has dropped to 1.21 atm and the temperature had dropped to 120°C.

a. Calculate the mass of Al left unreacted.

b. Calculate the mass of Al_2S_3.

14. A cylinder contains $SO_{2(g)}$ and $N_{2(g)}$. Calculate the density of this mixture at 25°C and 722 torr Hg, if the percent of $SO_{2(g)}$ present is 30.4% by mass. (There is no chemical reaction taking place.)

15. 8.33×10^{22} molecules of $SO_{2(g)}$ occupy 12.8 L at a certain temperature and pressure. What will be the volume, in liters, occupied by 31.4 g $NH_{3(g)}$ at the same temperature and pressure? (molar masses: SO_2 = 64.1 g/mole, NH_3 = 17.00 g/mole)

16. A 22.8 liter flask contains 0.420 mole Ar(g), 0.820 mole of $H_2(g)$, and 1.40 mole of Kr(g) at 34.0 °C. What is the partial pressure of $H_{2(g)}$? (There is no reaction taking place.)

17. A chemist wants to find the molecular formula of a compound that contains only carbon, hydrogen, and nitrogen. Complete combustion of 35.0 g of the compound produced 41.1 g H_2O. A 65.2 g sample of the compound was analyzed for nitrogen, giving 35.6 mL $N_{2\,(g)}$ at 740 torr and 25°C. The effusion rate of the compound as a gas was measured and found to be 38.2 mL/min. The effusion rate of argon gas under identical conditions in 58.0 mL/min. Find the molecular formula of the compound.

18. Ammonia is added to an evacuated 6.00 L flask to a pressure of 8.00 atm and a temperature of 25°C. Carbon dioxide is added to the ammonia to give a total pressure of 18.00 atm. The flask is then heated to 110°C. Calculate the total pressure in the flask at the new temperature when the reaction is complete, assuming 100% yield. (Assume that any solids present occupy no volume .)

$$2\ NH_{3(g)} + CO_{2(g)} \longrightarrow H_2NCONH_{2(s)} + H_2O_{(g)}$$

19. A 60.0 mL cylinder is filled with a mixture of an unknown element, $M_{(g)}$, and $Cl_{2(g)}$ to partial pressures of 3.07 atm and 37.2 atm respectively, and a temperature of 30.0 °C. The cylinder is heated to a high temperature at which the binary compound, M_xCl_y is produced. The cylinder is then cooled to a temperature at which Cl_2 is a gas and the binary compound, M_xCl_y, is solid. The remaining Cl_2 gas is transferred to another 60.0 mL cylinder, where the pressure at 30.0 °C is 28.0 atm. Assuming that the unknown element, M, has reacted completely, find the empirical formula of the binary compound, M_xCl_y.

20. A sample of $Ar_{(g)}$ in a flask at 34°C exerts a pressure of 962 torr. When a 0.422 g $N_{2\,(g)}$ is added to this flask, the pressure rises to 1700 torr. The temperature and volume remain constant and there is no reaction between $Ar_{(g)}$ and $N_{2(g)}$. How many grams of $Ar_{(g)}$ are in the flask? (molar masses: Ar = 39.90 g/mole, N_2 = 28.00 g/mole)