Gas State of Matter

"Nothing will ever equal that moment of joyous excitement when I felt myself flying away from the earth."

— Jacques Charles, after making man's first ascent by hydrogen balloon, Dec 1st 1783.

Name: _____

Student ID: _____

Date: _____

1. Using KMT: (a) explain why pressure increases when the volume of a gas is decreased (at constant temperature); (b) explain why as temperature increases, so does pressure.

2. A gas sample occupies 1.20 L at 652 torr. What volume does the gas occupy at each of the following pressures?

(a) 970 mmHg

(b) 2.7 atm

3. If 16.5 L of hydrogen gas is cooled from 125° C to 10.0 °C at a constant pressure, what volume will it occupy?

4. A sealed container of nitrogen gas is heated from 17° C to 55° C. If the container was initially at a pressure of 565 torr, what is the pressure after heating?

5. In a sealed container, 14.0 moles of nitrogen gas is combined with 20.0 moles of oxygen gas. The total pressure is 4.2 atm. What is the partial pressure of the nitrogen gas?

6. The atmosphere of Earth is mostly nitrogen gas (N_2), on Venus the atmosphere is almost entirely carbon dioxide gas (CO_2).

   a. What is the density of carbon dioxide at STP?

   b. Will a balloon filled with chlorine gas float on Venus? Show your reason.

   c. Venus has a surface temperature of 467 °C and pressure of 91.8 atm. What is the density of CO_2 under these conditions?

   d. If you heat a chlorine gas balloon to 975°C and release it on Venus, will it float?

7. A sample of 17.5 L of chlorine gas is collected at STP. How many molecules of chlorine gas are in the sample?

8. A mixture of 4.00 moles of Cl_2 gas and 1.50 moles of H_2 gas is collected at 25 ˚C and 1.20 atm. What volume does the mixture occupy?

9. Around 1802 Alessandro Volta demonstrated light could be produced by running electricity through a wire until it heats up and glows. But if you do that around oxygen, the wire quickly combusts (burns up). Other chemists, like the Menlo Park Chemist Thomas Edison, made it last longer by sealing the wire in a glass bulb containing an inert gas, like argon (Ar).

(a) When it's on, the argon gas in a 60W light bulb is under 1.03 atm and 125 °C. When the bulb is off, the gas cools to 25°C. What is the pressure is a light bulb when it's off?

(b) Recently, chemists found they could extend the life of light bulbs if they mixed a small amount of chlorine gas (Cl_2) with the argon gas (Ar). The chlorine-argon mixture in these halogen lights is about 1.7% (a Cl_2 mole fraction of 0.017). Lit, these bulbs still have a pressure of 1.03 atm. What is the partial pressure of chlorine and argon in a halogen light bulb that's on?

(assume the total pressure is the same as a regular light bulb)

10.At STP 5.4 L of ammonia gas reacts with excess oxygen gas in the following reaction. How many liters of oxygen are consumed?

$$4\ NH_{3\ (g)} + 5\ O_{2\ (g)} \rightarrow 4\ NO_{\ (g)} + 6\ H_2O$$
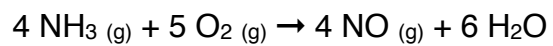
11.A unknown as is collected and 0.827 grams is put into a 0.270 L container. The pressure and temperature are measured as 88˚C and 975 mmHg. Is this substance or carbon dioxide? (hint: what is the molar mass of each substance.)

12. There's been a submarine accident. The sealed hallway between you and the exit is about 27,200 L volume. It's filled with pure helium gas at 22.05 atm pressure.

You estimate it will take you 6 minutes to get through the hallway, you can only hold your breath for 2 minutes. To breathe you need oxygen pressure of at least 0.16 atm, but more than 1.6 atm of oxygen hitting your lungs results in oxygen poisoning.

  (a) You find a 30.0 L tank of oxygen under 285 atm pressure. If you open the tank into the 27,200 L hallway what will be the partial pressure of oxygen?
  (b) What is the total pressure in the hall after you do?
  (c) If you bleed off the oxygen helium mixture from the hallway to drop the total pressure to 12.0 atm, what is the new partial pressure of oxygen?
(hint: find the mole fraction of oxygen!)

13. A sample of $KClO_3$ is decomposed over water to produce potassium chloride and oxygen gas. The gas collected over 26 ˚C water was 0.250 L at 765 torr.

How many grams of $KClO_3$ were decomposed? The vapor pressure of water at 26˚ C is 25 torr. The molar mass of $KClO_3$ is 122.6 g/mol.

(hint: the gas collected is a mixture of water and oxygen gas, use Dalton's law of partial pressures to find the partial pressure of the oxygen gas.)

$$2\ KClO_{3\ (s)} \rightarrow 2\ KCl_{(s)} + 3\ O_{2\ (g)}$$