Chemistry II

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1 Gases and Kinetic Theory

The following are a list of definitions in Gases and Kinetic Theory:

Gas - The state of matter that has the weakest attraction forces among its components (atoms or molecules). It occupies the whole volume of its container. Gases expand and/or contract with temperature and pressure

Pressure - The distribution of a force over a given area. Or Force per unit of area. SI unit is the Pascal, but in Chemistry we use atmospheres (atm.)

Barometer - Measures the pressure of air. (Developed by Torricelli in 1643). Other pressures by manometers. 1 standard atm = 760 mm Hg

Pascal - (Pa) SI Unit 1 atm = 101.325 katm

Properties of Gases - Can be modeled using math. Depends on V = Volume of gas(L) and T = Temperature (K) and n = amount (moles)
Directly Proportional - If one quantity is increased or decreased then the other quantity increases or decreases.
Indirectly Proportional - If one quantity increases then the other quantity decreases and vice-versa.
Avogadro's Hypothesis - V and n are directly proportional at constant P and T.

2 Boyle's Law

1. P and V are inversely proportional when n and T are constant.
2. Must convert temperatures to Kelvin

$$Boyle's Law = Volume * Pressure = Constant \tag{1}$$

$$V_1 P_1 = P_2 V_2 \tag{2}$$

3 Charles' Law

1. V and T are directly proportional when n and P are constant.
2. Must convert temperatures to Kelvin

$$Charles' Law = \frac{Volume}{Temperature} = Constant \tag{3}$$

$$\frac{V_1}{T_1} = \frac{V_2}{T_2} \tag{4}$$

4 Combined Gas Law

1. Must convert temperatures to Kelvin

$$CombinedGasLaw = \frac{Volume * Pressure}{Temperature} = Constant \tag{5}$$

$$\frac{V_1 P_1}{T_1} = \frac{V_2 P_2}{T_2} \tag{6}$$

5 Ideal Gas Law

1. Pressure must always be in atmospheres (atm) for Ideal Gas Law
2. Must convert temperatures to Kelvin

$$IdealGasLaw = (Volume * Pressure) = n * R * T \tag{7}$$

$$VP = nRT \tag{8}$$

6 Universal Gas Constant

$$R = 0.08206 \frac{L * atm}{mol * K} \tag{9}$$

7 Standard Temperature and Pressure (STP)

$$273K, 0°C, 1atm \tag{10}$$

8 Pressure Conversions

$$1atm = 760Torr = 760mmHg = 1.013bar = 101.3kPa = 14.7psi \tag{11}$$

9 Gas Law Practice

1. A gas a pressure of 3800 mmHg what is the pressure in units of atm and bar?

$$\frac{3800mmHg}{760mmHg} = 5atm \tag{12}$$

$$5atm * 1.013bar = 5.065bar \tag{13}$$

2. A gas has a pressure of 2.5 atm and a volume of 33L. What will be the volume of the gas when the pressure increases to 7.5 atm (while the temperature remains constant)?

$$P_1V_1 = P_2V_2 \tag{14}$$

$$2.5atm * 33L = 7.5atm * V_2 \tag{15}$$

$$\frac{2.5atm * 33L}{7.5atm} = V_2 \tag{16}$$

$$11L = V_2 \tag{17}$$

3. A gas occupies 900.0 mL at a temperature of 27.0°C. What is the volume at 132.0°C?

$$\frac{V_1}{T_1} = \frac{V_2}{T_2} \tag{18}$$

$$T_1 = 27°C + 273K = 300K \tag{19}$$

$$T_2 = 132°C + 273K = 405K \tag{20}$$

$$\frac{900mL}{300K} = \frac{V_2}{405K} \tag{21}$$

$$1,215mL = V_2 \tag{22}$$

$$1,215mL * .001 = 1.215L = V_2 \tag{23}$$

4. A gas has an initial volume of 2.5 L and an initial temperature of -20°C. What will the final pressure be if the volume increases to 12.0 L and the temperature increases to 65°C?

$$\frac{V_1 P_1}{T_1} = \frac{V_2 P_2}{T_2} \tag{24}$$

$$\frac{2.5L * 0.134atm}{253K} = \frac{12.0L * P_2}{338K} \tag{25}$$

$$P_2 = 0.03729578atm \approx 0.0373atm \tag{26}$$

5. How many moles of gas occupy 98 L at a pressure of 2.8 atmospheres and a temperature of 292 K?

$$VP = nRT \tag{27}$$

$$98L * 2.8atm = n * (0.08206 \frac{L * atm}{mol * K}) * 292K \tag{28}$$

$$\frac{98L * 2.8atm}{(0.08206 \frac{L*atm}{mol*K}) * 292K} = n \tag{29}$$

$$n = 11.45169mols \approx 11.45mols \tag{30}$$

10 Tidbits

1. Double the moles, double the volume.
2. O Kelvin is the lowest possible temperature in the Universe. There is no maximum temperature.
3. 1 mole of any ideal gas has a volume of 22.4L.
4. If P doubles, V will Halve ?
5. If P doubles, T will Double ?
6. If P doubles, n will Double ?