I. Kinetic Molecular Theory
   a. Assumptions
      i.
      ii.
      iii.
      iv.

b. Diffusion vs Effusion
   i. Graham’s Law
      1. Equation:
      2. Examples
         a. Under the same conditions of temperature and pressure, how many times faster will helium diffuse compared to nitrogen?

         b. What is the relative rate of diffusion of carbon dioxide compared to hydrogen? Does carbon dioxide effuse faster or slower than hydrogen?

         c. An unknown gas diffuses 0.25 times faster than helium. What is molar mass of the unknown gas?

II. Physical Characteristics
   a.
   b.
   c.
   d.
   e.

III. Temperature
   a. Scales
   b. Standard temperature
   c. Absolute zero
IV. Pressure
   a. Equation:
   b. Units
      i. Dimensional analysis
         1. Convert 2.5 atm into torr, mmHg and kPa.

c. Gas Pressure
   i. Gas vs vapor
   ii. Manometer
d. Atmospheric pressure
   i. Barometer
      ii. Standard atmospheric pressure
e. Vacuum
f. Partial Pressure
   i. Dalton's Law
      1. Examples
         a. A mixture of oxygen, carbon dioxide, and nitrogen has a total pressure of 0.97 atm. What is the partial pressure of oxygen if the partial pressures of carbon dioxide and nitrogen are 0.70 atm and 0.12 atm respectively.

   b. There is a mixture of carbon dioxide, oxygen, and carbon monoxide in a container. What is the total pressure in atm if the partial pressures are as follows: oxygen is 0.563 atm, carbon dioxide is 235 kPa, and carbon monoxide is 455 torr.

V. The Gas Laws
   a. Boyle's Law
      i. Equation:
      ii. Examples
         1. A helium balloon was compressed from 4.0 L to 2.5 L at a constant temperature. If the pressure of the gas in the 4.0 L balloon is 210 kPa, what will the pressure be at 2.5 L?
2. A sample of neon gas occupies 0.200 L at 0.860 atm. What will be its volume at 29.2 kPa of pressure?

b. Charles Law

i. Equation:

ii. Examples
   1. A gas sample at 40.0°C occupies a volume of 2.32 L. If the temperature is raised to 75.0°C, what will the volume be, assuming the pressure remains constant?

   2. A gas sample at 55.0°C occupies a volume of 3.50 L. At what new temperature in Celsius, will the volume increase to 8.00 L?

c. Gay-Lussac’s Law

i. Equation:

ii. Examples
   1. The pressure of a gas in a tank is 3.20 atm at 22.0°C. If the temperature rises to 60.0°C, what will be the gas pressure in the tank?

   2. A rigid container has a gas at 22.0°C with 665 torr of pressure. What will the pressure be if the temperature is raised to 44.6°C?

d. Avogadro’s Law

i. Examples
   1. 5.00 L of a gas is known to contain 0.965 mol. If the amount of gas is increased to 1.80 mol, what will be the new volume? *Assume constant temperature and pressure.*
2. Calculate the volume that 0.881 mol of gas at STP will occupy.

3. How many grams of carbon dioxide gas are in a 0.75 L balloon at STP?

4. What volume of oxygen gas is needed for the complete combustion of 4.00 L of propane gas \( \text{C}_3\text{H}_8 \)? Assume constant temperature and pressure.

e. Combined Gas Law
   i. Equation:
   ii. Examples
      1. A gas at 110 kPa and 30.0°C fill a flexible container with an initial volume of 2.00 L. If the temperature is raised to 80.0°C and the pressure increases to 440 kPa, what is the new volume?
      2. An unopened bottle of soda contains 46.0 mL of gas confined at a pressure of 1.30 atm and a temperature of 5.00°C. If the bottle is dropped into a lake and sinks to a depth at which the pressure and temperature change to 1.52 atm and 2.90°C, what will be the volume of gas in the bottle?

f. Ideal Gas Law
   i. Ideal vs Real gas
   ii. Equation:
   iii. Ideal Gas Constant
   iv. Density*
   v. Examples
      1. Calculate the number of moles of gas contained in a 3.00L vessel at 298K with a pressure of 1.50 atm.
2. What will the pressure (in kPa) be when there are 0.400 mol of gas in a 5.00L container at 17.0˚C?

g. Gas stoichiometry
   i. Examples
      1. If 5.00 L of nitrogen reacts completely with excess hydrogen at a constant pressure and temperature of 3.00 atm and 298K, how many grams of ammonia are produced.

2. How many grams of calcium carbonate will be needed to form 6.75 L of carbon dioxide at a pressure of 2.00 atm and 298 K?
   \[
   \text{CaCO}_3(s) \rightarrow \text{CO}_2(g) + \text{CaO}(s)
   \]

3. How many liters of chlorine will be needed to make 95.0 grams of C\textsubscript{2}H\textsubscript{2}Cl\textsubscript{4} at 3.50 atm and 225K?
   \[
   \text{Cl}_2(g) + \text{C}_2\text{H}_4(g) \rightarrow \text{C}_2\text{H}_2\text{Cl}_4(l)
   \]

h. Density Calculations

\[
\text{d} = \frac{P \cdot M}{RT}
\]
\[
M = \frac{dRT}{P}
\]

1. What is the molar mass of a pure gas that has a density of 1.40 g/L at STP?

2. Calculate the density a gas will have at STP if its molar mass is 39.9 g/mol.