Chapter 14 Outline

Gas Laws

- **Section 14.1 – Properties of Gases**
- _____ is a measure of how much the _____ of matter _____ under pressure.
- _____ are compressible because the particles are _____. Solids and liquids are _____ compressible.
- The _____ _____ are factors that affect gas pressure.
- _____ is based on the speed and frequency of _____ between the particles and the _____ of a container.
- As the amount of gas in a closed container _____, the gas pressure _____ because there are more _____. (directly proportional)
- As the volume of a closed container _____, the gas pressure _____ because there is more room for the particles, so they experience _____ collisions. (indirectly proportional)
- As the temperature of a closed container _____, the gas pressure _____ because the particles speed up causing more _____. (directly proportional)
- **Section 14.1 Assessment**

1. Why is a gas easy to compress?

2. List three factors that can affect gas pressure.

3. Why does a collision with an air bag cause less damage than a collision with a steering wheel?

4. How does a decrease in temperature affect the pressure of a contained gas?

5. If the temperature is constant, what change in volume would cause the pressure of an enclosed gas to be reduced to one quarter of its original value?

6. Assuming the gas in a container remains at a constant temperature, how could you increase the gas pressure in the container a hundredfold?

- **Section 14.2 – The Gas Laws**
- Poem I wrote to help you remember the gas laws:

- _____ states that for a given mass of gas at constant temperature, the _____ of the gas varies _____ (indirectly) with _____.
- If volume goes _____, then pressure goes _____.

$$P_1V_1 = P_2V_2$$

- **Sample Problem**
- A balloon contains 30.0L of helium gas at 103 kPa. What is the volume of the helium when the balloon rises to an altitude where the pressure is only 25.0 kPa.

- **Practice Problems**
- The pressure on 2.50L of N_2O changes from 105 kPa to 40.5 kPa. If the temperature does not change, what will the new volume be?

- A gas with a volume of 4.00L at a pressure of 205 kPa is allowed to expand to a volume of 12.0L. What is the pressure in the container if the temperature remains constant?

- _____ states that the _____of a fixed mass of gas is _____ proportional to its _____ if the pressure is kept constant.
- If temperature goes _____, then volume goes _____.

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

$$K = {}^{o}C + 273$$

- **Sample Problem**
- A balloon inflated in a room at 24°C has a volume of 4.00L. The balloon is then heated to a temperature of 58°C. What is the new volume if the pressure remains constant?

- **Practice Problems**
- If a sample of gas occupies 6.80L at 325°C, what will its volume be at 25°C if the pressure does not change?

- Exactly 5.00L of air at -50.0°C is warmed to 100.0°C. What is the new volume if the pressure remains constant?

- _____ states that the _____ of a gas is _____ proportional to the _____ _____ if the volume remains constant.
- If temperature goes _____, then pressure goes _____.

$$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$

- **Sample Problem**

- The gas in an aerosol can is at a pressure of 103 kPa at 25°C. If the can is thrown into a fire, what will the pressure be when the temperature reaches 928°C?

- **Practice Problems**
- A sample of nitrogen gas has a pressure of 6.58 kPa at 539K. If the volume does not change, what will the pressure be at 211K?

- The pressure in a car tire is 198 kPa at 27°C. After a long drive, the temperature is 225 kPa. What is the temperature of the air in the tire.

- The _____ includes volume, pressure, and temperature.
- You can use the combined gas law to help you _____ the other gas laws.

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

- **Sample Problem**
- The volume of a gas-filled balloon is 30.0L at 313K and 153 kPa pressure. What would the volume be at standard temperature and pressure (STP)?
- **Practice Problems**

- A gas at 155 kPa and 25°C has an initial volume of 1.00L. The pressure of the gas increases to 605 kPa as the temperature is raised to 125°C. What is the new volume in **mL**?

- A 5.00L air sample has a pressure of 107 kPa at a temperature of -50.0°C. If the temperature is raised to 102°C and the volume expands to 7.00L, what will the new pressure be in **mmHg**?

- **Section 14.2 Assessment**

1. How are the pressure and volume of a gas related at constant temperature?

2. If pressure is constant, how does a change in temperature affect the volume of a gas?

3. What is the relationship between the temperature and pressure of a contained gas at constant volume?

4. In what situations is the combined gas law useful?

5. A given mass of air has a volume of 6.00L at 101 kPa. What volume will it occupy at 25.0 kPa if the temperature does not change?

- **Section 14.3 – Ideal Gas Law**
- The _____ allows us to calculate volume, pressure, temperature, or number of _____ of gas.

$$PV = nRT$$

P =
V =
n =
R =
T =

- **Sample Problem**
- A deep underground cavern contains 2.24 x 10^6 L of methane gas (CH_4) at a pressure of 1.50 x 10^3 kPa and a temperature of 315K. How many grams of CH_4 does the cavern contain?

- **Practice Problems**
- When the temperature of a rigid hollow sphere containing 685L of helium gas is held at 621K, the pressure of the gas is 1.89 x 10^3 kPa. How many moles of helium does the sphere contain?

- A child's lungs can hold 2200 mL. How many grams of air do her lungs hold at a pressure of 1.007 atm and a body temperature of 37°C. (Use 29 g/mol as the molar mass for air.)

- An _____ follows rules that scientists have created and remains in a _____ at any temperature and pressure. (These do _____ exist)
- A _____ changes into a liquid or solid at _____ temperatures and _____ pressures.
- Real gases _____ most from an ideal gas at low _____ and high _____.
- **Section 14.3 Assessment**

1. Under what conditions do real gases deviate most from ideal behavior?

2. What is an ideal gas?

3. Determine the volume occupied by 0.582 mol of a gas at 15°C if the pressure is 81.8 kPa.

4. What pressure is exerted by 0.450 mol of a gas at 25°C if the gas is in a 0.650L container?

- **Section 14.4 – Gases: Mixtures and Movements**
- _____ states that, at constant volume and temperature, the _____ pressure exerted by a mixture of gases is equal to the _____ of the partial pressure of the _____ gases.

$$P_T = P_1 + P_2 + P_3 \ldots$$

- **Sample Problems**
- Air contains oxygen, nitrogen, carbon dioxide, and trace amounts of other gases. What is the partial pressure of oxygen at 101.3 kPa if the partial pressures of nitrogen, carbon dioxide, and other gases are 79.10 kPa, 0.040 kPa, and 0.94 kPa, respectively?

- **Practice Problems**
- Determine the total pressure of a gas mixture that contains oxygen, nitrogen, and helium. The partial pressures are P_{O2} = 20.0 kPa, P_{N2} = 46.7 kPa, and P_{He} = 26.7 kPa.
- A gas mixture containing oxygen, nitrogen, and carbon dioxide has a total pressure of 32.9 kPa. If P_{O2} = 6.6 kPa and P_{N2} = 23.0 kPa, what is P_{CO2}?

- _____ is the tendency of molecules to move toward areas of _____ concentration until concentration is _____ throughout.
- During _____, a gas escapes through a _____ in its container.
- Gases of _____ molar mass diffuse and effuse _____ than gases of _____ molar mass.
- _____ of effusion/diffusion states that the rate of effusion of a gas is _____ proportional to the square root of the gas's _____.

$$\frac{\text{Rate}_A}{\text{Rate}_B} =$$

- B is always the _____ (more massive) gas.
- **Sample Problem**
- Compare the rates of effusion of helium and nitrogen gas.

- **Practice Problems**
- Compare the rates of effusion of sulfur trioxide and bromine gas.

- Compare the rates of effusion of oxygen gas and carbon dioxide gas.

- **Section 14.4 Assessment**

1. In a mixture of gases, how is the total pressure determined?

2. What is the effect of molar mass on rates of diffusion and effusion?

3. What distinguishes effusion from diffusion? How are these processes similar?

4. Explain why the rates of diffusion of nitrogen gas and carbon monoxide are almost identical at the same temperature.