**The Ideal and Combined Gas Laws**  \[ PV = nRT \]  or  \[ \frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2} \]

Use your knowledge of the ideal and combined gas laws to solve the following problems. If it involves moles or grams, it must be \( PV = nRT \)

1) If four moles of a gas at a pressure of 5.4 atmospheres have a volume of 120 liters, what is the temperature?

\[
(5.4)(120) = 4(0.0821)T
\]

\[
T = 1973.2 \text{ K}
\]

2) If I initially have a gas with a pressure of 84 kPa and a temperature of 35.0°C and I heat it an additional 230 degrees, what will the new pressure be? Assume the volume of the container is constant.

\[
\frac{84}{(35+273)} = \frac{P_2}{(35+230+273)}
\]

\[
P_2 = 146.7 \text{ kPa}
\]

3) My car has an internal volume of 2600 liters. If the sun heats my car from a temperature of 20.0°C to a temperature of 55.0°C, what will the pressure inside my car be? Assume the pressure was initially 760 mm Hg.

\[
\frac{760 \text{ mm Hg}}{(20+273)} = \frac{P_2}{(55+273)}
\]

\[
P_2 = 850 \text{ mm Hg}
\]

4) How many moles of gas are in my car in problem #3?

\[
\frac{850 \text{ mm Hg}}{760 \text{ mm Hg}} = 1.13 \text{ atm}
\]

\[
\frac{2600(1.13)}{n(0.0821)(55+273)} = n = 107.1 \text{ mole}
\]

5) A toy balloon filled with air has an internal pressure of 1.25 atm and a volume of 2.50 L. If I take the balloon to the bottom of the ocean where the pressure is 95 atmospheres, what will the new volume of the balloon be? How many moles of gas does the balloon hold? (Assume \( T = 285 \text{ K} \))

\[
1.25(2.50) = 95(V_2)
\]

\[
V_2 = 0.032 \text{ L}
\]

\[
95(0.032) = n(285)(0.821)
\]

\[
n = 0.1299 \text{ moles}
\]
MIXED GAS LAWS WORKSHEET

Created by Tara L. Moore at www.learning.mgcc.cc.ms.us/pk/sciencedocs/gaslawwksheet.htm

Directions: Answer each question below. Then write the name of the gas law used to solve each question in the left margin next to each question.

1. A gas occupies 3.5L at 2.5 mm Hg pressure. What is the volume at 10 mm Hg at the same temperature?

   \[
   V = \frac{P_1 V_1}{P_2}
   \]

   \[
   V_2 = 0.875 \text{ L}
   \]

Boyle

2. A constant volume of oxygen is heated from 100°C to 185°C. The initial pressure is 4.1 atm. What is the final pressure?

   \[
   \frac{P_1}{T_1} = \frac{P_2}{T_2}
   \]

   \[
   P_2 = 5.03 \text{ atm}
   \]

Gay-Lussac

3. A sample of 25L of NH₃ gas at 10°C is heated at constant pressure until it fills a volume of 50L. What is the new temperature in °C?

   \[
   \frac{V_1}{T_1} = \frac{V_2}{T_2}
   \]

   \[
   T = 566 \text{ K}
   \]

   \[
   T = 293 \text{ °C}
   \]

Charles

4. A certain quantity of argon gas is under 16 torr pressure at 253K in a 12L vessel. How many moles of argon are present?

   \[
   n = \frac{PV}{RT}
   \]

   \[
   n = 0.012 \text{ mol}
   \]

Ideal

5. An unknown gas weighs 34g and occupies 6.7L at 2 atm and 245K. What is its molecular weight?

   \[
   \frac{PV}{nRT} = \frac{mP}{RT}
   \]

   \[
   \frac{34}{0.67 \text{ mol}} = \frac{0.67 \text{ mol}}{1 \text{ mol}}
   \]

   \[
   \frac{23}{18.58 \text{ g/mol}} = \frac{X \text{ mol}}{1 \text{ mol}}
   \]

   \[
   X = 1.13 \text{ mol}
   \]

Ideal

6. An ideal gas occupies 400ml at 270 mm Hg and 65°C. If the pressure is changed to 1.4 atm and the temperature is increased to 100°C, what is the new volume?

   \[
   \frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}
   \]

   \[
   V_2 = 11.2 \text{ mL}
   \]

   \[
   0.112 \text{ L}
   \]

Combined

7. What is the volume of 23g of neon gas at 1°C and a pressure of 2 atm?

   \[
   \frac{x}{20.18 \text{ g/mol}} = \frac{X \text{ mol}}{1 \text{ mol}}
   \]

   \[
   X = 1.13 \text{ mol}
   \]

   \[
   \frac{PV}{nRT} = \frac{mP}{RT}
   \]

   \[
   V = 12.8 \text{ L}
   \]

Ideal

8. If 11 moles of HCl gas occupies 15L at 300°C, what is the pressure in torr?

   \[
   \frac{PV}{nRT} = \frac{mP}{RT}
   \]

   \[
   P = 34.4 \text{ atm} \times \frac{760 \text{ torr}}{1 \text{ atm}} \approx 26,144 \text{ torr}
   \]

Ideal

9. The pressure is 6.5 atm, 2.3 mole of Br₂ gas occupies 9.3 L. What is the temperature in °C?

   \[
   \frac{PV}{nRT} = \frac{mP}{RT}
   \]

   \[
   T = 320 \text{ K} \approx 47.1 \text{ °C}
   \]

Ideal
10. A 600mL balloon is filled with helium at 700mm Hg barometric pressure. The balloon is released and climbs to an altitude where the barometric pressure is 400mm Hg. What will the volume of the balloon be if, during the ascent, the temperature drops from 24 to 5°C?

\[
\frac{(600)(700)}{(297)} = \frac{400V_2}{273} \quad V_2 = 982.8\text{mL} \quad 0.983\text{L}
\]

11. An unknown gas has a volume of 200L at 5 atm and -140°C. What is its volume at STP?

\[
\frac{(200)(5)}{133} = \frac{V_2 \text{ atm}}{273} \quad V_2 = 2052.6\text{L}
\]

12. In an autoclave, a constant amount of steam is generated at a constant volume. Under 1.00 atm pressure the steam temperature is 100°C. What pressure setting should be used to obtain a 165°C steam temperature for the sterilization of surgical instruments?

\[
\frac{1\text{ atm}}{373} = \frac{P_2}{48} \quad P = 1.17\text{ atm}
\]

13. Air contains oxygen, nitrogen, carbon dioxide, and trace amounts of other gases. What is the partial pressure of oxygen \(P_{O_2}\) at 101.3kPa of total pressure if it’s known that the partial pressures of nitrogen, carbon dioxide, and other gases are 79.1kPa, 0.040kPa, and 0.94kPa, respectively? What is the name of the gas law used for this?

\[P_{O_2} + 79.1 + .040 + .94 = 101.3 \quad P_{O_2} = 21.2\text{ kPa}\]

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

almost identical atomic masses

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

See notes

talk about gases moving

16. Which of the gases effuses faster at the same temperature: molecular chlorine, nitrogen dioxide, ammonia or molecular nitrogen gas? And why?

\(N_2\) smallest atomic mass

17. Explain what each of the following changes would do to the pressure in a closed container (increase or decrease pressure). A) Part of the gas is removed, B) The container size (volume) is decreased, and C)Temperature is increased.

\[\text{A)} \downarrow P \quad \text{B)} \uparrow P \quad \text{C)} \uparrow P\]

18. Determine the total pressure of a gas mixture that contains oxygen, nitrogen and helium in the following partial pressures of 2.0atm for oxygen, 4.7atm for nitrogen and 253.25kPa for helium.

\[P_{O_2} + P_{N_2} + P_{He} = \frac{9.199\text{ atm}}{\text{convert}}\]