Combined Gas Law: Solution Sheet

Tamira Laki

April 20, Wednesday

1. A gas has a volume of 3.0 L at 2.0 atm. What will be its volume if the pressure increases to 4.0 atm?

$$V_1 = 3.0\,\text{L}$$
$$P_1 = 2.0\,\text{atm}$$
$$P_2 = 4.0\,\text{atm}$$
$$V_2 = ?$$

$$V_2 = \frac{2\,\text{atm} \times 3.0\,\text{L}}{4.0\,\text{atm}}$$

$$\boxed{V_2 = 1.5\,\text{L}}$$

2. Not all Gas Law problems have Kelvin (K) as the unit of temperature. They can be expressed in Celsius (°C) and Fahrenheit(°F). So, convert 123°C to K.

$$123\,^\circ\text{C} + 273.15\,\text{K} = 396.15\,\text{K}$$

3. An ideal gas exerts a pressure of 3.0 atm in a 3.0 L container. The container is at a temperature of 298 K. What will be the final pressure if the volume of the container changes to 2.0 L?

$$P_1 = 3.0\,\text{atm}$$
$$V_1 = 3.0\,\text{L}$$
$$T_1 = 298\,\text{K}$$
$$V_2 = 2.0\,\text{L}$$
$$T_2 = 298\,\text{K}$$
$$P_2 = ?$$

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

$$P_2 = \frac{3.0\,\text{L} \times 298\,\text{K} \times 3.0\,\text{atm}}{298\,\text{K} \times 2.0\,\text{L}}$$

$$\boxed{P_2 = 4.5\,\text{atm}}$$

4. Xenon gas was measured to have a volume of 15.5 L. If the volume changes to 0.6 L and the initial pressure is 44 Pa, what is the final pressure?

$$V_1 = 15.5\,\text{L}$$
$$V_2 = 0.6\,\text{L}$$
$$P_1 = 44.0\,\text{Pa}$$
$$P_2 = ?$$

$$P_2 = \frac{P_1 V_1}{V_2}$$

$$P_2 = \frac{44.0\,\text{Pa} \times 15.5\,\text{L}}{0.6\,\text{L}}$$

$$\boxed{P_2 = 1136.67\,\text{Pa}}$$

5. A gas is an environment that has a volume of 16.8 L and a pressure of 3.2 atm. If the volume changes to 10.6 L, what will be the new pressure?

$$V_1 = 16.8\,\text{L}$$
$$P_1 = 3.2\,\text{atm}$$
$$V_2 = 10.6\,\text{L}$$
$$P_2 = ?$$

$$P_2 = \frac{P_1 V_1}{V_2}$$

$$P_2 = \frac{3.2\,\text{atm} \times 16.8\,\text{L}}{10.6\,\text{L}}$$

$$\boxed{P_2 = 5.07\,\text{atm}}$$

6. A sample of Argon has a volume of 0.43 mL at 299 K. At what temperature in degrees celsius will it have a volume of 1 mL.

$$V_1 = 0.43\,\text{mL}$$
$$T_1 = 299.0\,\text{K}$$
$$V_2 = 1.0\,\text{mL}$$
$$T_2 = ?$$

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

$$T_2 = \frac{1.0\,\text{mL} \times 299.0\,\text{K}}{0.43\,\text{mL}}$$

$$T_2 = 695.34\,\text{K} - 273.15\,\text{K} = \boxed{422.20\,^\circ\text{C}}$$

7. At a pressure of 5.0 atmospheres, a sample of gas occupies 40 ls. What volume will the same sample hold at 1.0 atmosphere?

$$P_1 = 5.0\,\text{atm}$$
$$V_1 = 40.0\,\text{L}$$
$$P_2 = 1.0\,\text{atm}$$
$$V_2 = ?$$

$$V_2 = \frac{P_1 V_1}{P_2}$$

$$V_2 = \frac{5.0\,\text{atm} \times 40.0\,\text{L}}{1.0\,\text{atm}}$$

$$\boxed{V_2 = 200.0\,\text{L}}$$

8. In a closed container at 1.0 atmosphere, the temperature of a sample of gas is raised from 300 K to 400 K. What will be the final pressure of the gas?

$$P_1 = 1.0\,\text{atm}$$
$$T_1 = 300.0\,\text{K}$$
$$T_2 = 400.0\,\text{K}$$
$$P_2 = ?$$

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

$$P_2 = \frac{1.0\,\text{atm} \times 400.0\,\text{K}}{300.0\,\text{K}}$$

$$\boxed{P_2 = 1.33\,\text{atm}}$$

9. When a supply of hydrogen gas is held in a 4-liter container at 320 K, it exerts a pressure of 800 torrs. The supply is moved to a 2-liter container and cooled to 160 K. What is the new pressure of the confined gas?

$$V_1 = 4.0\,\text{L}$$
$$T_1 = 320.0\,\text{K}$$
$$P_1 = 800.0\,\text{torr}$$
$$V_2 = 2.0\,\text{L}$$
$$T_2 = 160.0\,\text{K}$$
$$P_2 = ?$$

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

$$P_2 = \frac{800.0\,\text{torr} \times 160.0\,\text{K} \times 4.0\,\text{L}}{320.0\,\text{K} \times 2.0\,\text{L}}$$

$$\boxed{P_2 = 800.0\,\text{torr}}$$

10. A small sample of helium gas occupies 6 mL at a temperature of 250 K. At what temperature does the volume expand to 9 mL?

$$V_1 = 6.0\,\text{mL}$$
$$T_1 = 250.0\,\text{K}$$
$$V_2 = 9.0\,\text{mL}$$
$$T_2 = ?$$

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

$$T_2 = \frac{9.0\,\text{mL} \times 250.0\,\text{K}}{6.0\,\text{mL}}$$

$$\boxed{T_2 = 375.0\,\text{K}}$$

11. Neon gas has a volume of 2,000 ml with a pressure of 1.8atm however, the pressure decreased to 1.3 atm; what is now the volume of the neon gas?

$$V_1 = 2000.0\,\text{mL}$$
$$P_1 = 1.8\,\text{atm}$$
$$P_2 = 1.3\,\text{atm}$$
$$V_2 = ?$$

$$V_2 = \frac{P_1 V_1}{P_2}$$

$$V_2 = \frac{1.8\,\text{atm} \times 2000.0\,\text{mL}}{1.3\,\text{atm}}$$

$$\boxed{V_2 = 2769.23\,\text{mL}}$$

12. If 22.5 L of nitrogen at 748 mmHg are compressed to 725 mmHg at constant temperature. What is the new volume?

$$V_1 = 22.5\,\text{L}$$
$$P_1 = 748.0\,\text{mmHg}$$
$$P_2 = 725.0\,\text{mmHg}$$
$$V_2 = ?$$

$$V_2 = \frac{P_1 V_1}{P_2}$$

$$V_2 = \frac{748.0\,\text{mmHg} \times 22.8\,\text{L}}{725.0\,\text{mmHg}}$$

$$\boxed{V_2 = 23.21\,\text{L}}$$

13. A gas has a volume of 3.0 L at 127°C. What will be its volume if the temperature increases to 227°C?

$$V_1 = 3.0\,\text{L}$$
$$T_1 = 127.0\,^\circ\text{C} + 273.15\,\text{K} = 400.15\,\text{K}$$
$$T_2 = 227.0\,^\circ\text{C} + 273.15\,\text{K} = 500.15\,\text{K}$$
$$V_2 = ?$$

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

$$V_2 = \frac{3.0\,\text{L} \times 500.25\,\text{K}}{400.15\,\text{K}}$$

$$\boxed{V_2 = 3.75\,\text{L}}$$

14. 600.0 mL of air is at 20.0°C. What is the volume at 60.0°C?

$$V_1 = 600.0\,\text{mL}$$
$$T_1 = 20.0\,^\circ\text{C} + 273.15\,\text{K} = 293.15\,\text{K}$$
$$T_2 = 60.0\,^\circ\text{C} + 273.15\,\text{K} = 333.15\,\text{K}$$
$$V_2 = ?$$

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

$$V_2 = \frac{600.0\,\text{mL} \times 333.15\,\text{K}}{293.15\,\text{K}}$$

$$\boxed{V_2 = 681.87\,\text{mL}}$$

15. A gas occupies 12.3 L at a pressure of 40.0 mmHg. What is the volume when the pressure is increased to 60.0 mmHg?

$$V_1 = 12.3\,\text{L}$$
$$P_1 = 40.0\,\text{mmHg}$$
$$P_2 = 60.0\,\text{mmHg}$$
$$V_2 = ?$$

$$V_2 = \frac{P_1 V_1}{P_2}$$

$$V_2 = \frac{40.0\,\text{mmHg} \times 12.3\,\text{L}}{60.0\,\text{mmHg}}$$

$$\boxed{V_2 = 8.2\,\text{L}}$$

16. What is the temperature of an 11.2 L sample of carbon monoxide (CO) at 744 torr if it occupies 13.3 L at 55 °C and 744 torr?

$$V_2 = 11.2\,\text{L}$$
$$P_2 = 744.0\,\text{torr}$$
$$V_1 = 13.3\,\text{L}$$
$$T_1 = 55.0\,^\circ\text{C} + 273.15\,\text{K} = 328.15\,\text{K}$$
$$P_1 = 744.0\,\text{torr}$$
$$T_2 = ?$$

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

$$T_2 = \frac{744.0\,\text{torr} \times 328.15\,\text{K} \times 11.2\,\text{L}}{744.0\,\text{torr} \times 13.3\,\text{L}}$$

$$\boxed{T_2 = 276.34\,\text{K}}$$