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Gas Laws Worksheet

atm = 760.0 mm Hg = 101.3 kPa= 760 .0 torr

Boyle's Law Problems: $P_1V_1 = P_2V_2$

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

$$(748\ mmHg)(22.5L) = (725\ mmHg)V_2$$

$$V_2 = \frac{(748\ mmHg)(22.5L)}{(725\ mmHg)}$$

$$V_2 = 23.2L$$

2. A gas with a volume of 4.0L at a pressure of 205kPa is allowed to expand to a volume of 12.0L. What is the pressure in the container if the temperature remains constant?

$$(4.0L)(205\ kPa) = (12.0L)P_2$$

$$P_2 = \frac{(4.0L)(205kPa)}{12.0L}$$

$$P_2 = 68.3\ kPa$$

3. What pressure is required to compress 196.0 liters of air at 1.00 atmosphere into a cylinder whose volume is 26.0 liters?

$$(196.0L)(1.00atm) = (26.0L)P_2$$

$$P_2 = \frac{(196.0L)(1.00\ atm)}{26.0L}$$

$$P_2 = 7.54\ atm$$

4. A 40.0 L tank of ammonia has a pressure of 12.7 kPa. Calculate the volume of the ammonia if its pressure is changed to 8.4 kPa while its temperature remains constant.

$$(40.0L)(12.7\ kPa) = (8.4\ kPa)V_2$$

$$V_2 = \frac{(40.0L)(12.7\ kPa)}{8.4\ kPa}$$

$$V_2 = 60.5L$$

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Charles' Law Problems: $\frac{V_1}{T_1} = \frac{V_2}{T_2}$

1. Calculate the decrease in temperature when 6.00 L at 20.0 °C is compressed to 4.00 L.

$$\frac{6.00L}{293K} = \frac{4.00L}{T_2}$$

$$T_2 = 4.00L\left(\frac{293K}{6.00L}\right)$$

$$\boxed{T_2 = 195.3\ K}$$

2. A container containing 5.00 L of a gas is collected at 100 K and then allowed to expand to 20.0 L. What must the new temperature be in order to maintain the same pressure (as required by Charles' Law)?

$$\frac{5.00L}{100K} = \frac{20.0L}{T_2}$$

$$T_2 = 20.0L\left(\frac{100K}{5.00L}\right)$$

$$\boxed{T_2 = 400K}$$

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

$$\frac{900.0mL}{300K} = \frac{V_2}{405K}$$

$$\boxed{V_2 = 1215mL}$$

$$V_2 = \left(\frac{900.0mL}{300K}\right)405K$$

4. If 15.0 liters of neon at 25.0 °C is allowed to expand to 45.0 liters, what must the new temperature be to maintain constant pressure?

$$\frac{15L}{298K} = \frac{45.0L}{T_2}$$

$$T_2 = 45.0L\left(\frac{298K}{15.0L}\right)$$

$$\boxed{T_2 = 894\ K}$$

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Guy-Lussac's Law $\frac{P_1}{T_1} = \frac{P_2}{V_2}$

The gases in a hair spray can are at a temperature of 27°C and a pressure of 30 lbs/in^2. If the gases in the can reach a pressure of 90 lbs/in^2, the can will explode. To what temperature must the gases be raised in order for the can to explode? Assume constant volume. (630 °C)

$$\frac{30 \text{ lb/in}^2}{300 \text{ K}} = \frac{90 \text{ lb/in}^2}{T_2}$$

$$T_2 = 90 \text{ lb/in}^2 \left(\frac{300 \text{ K}}{30 \text{ lb/in}^2}\right)$$

$$\boxed{T_2 = 900 \text{ K}}$$

2. Maybelline Cousteau's backup oxygen tank reads 900 mmHg while on her boat, where the temperature is 27°C. When she dives down to the bottom of an unexplored methane lake on a recently-discovered moon of Neptune, the temperature will drop down to –183°C. What will the pressure in her backup tank be at that temperature? (270 mmHg)

$$\frac{900 \text{ mmHg}}{300 \text{ K}} = \frac{P_2}{90 \text{ K}}$$

$$P_2 = 90 \text{ K} \left(\frac{900 \text{ mmHg}}{300 \text{ K}}\right)$$

$$\boxed{P_2 = 270 \text{ mmHg}}$$

Avogadros Law and Molar Volume at STP

(1 mole of any gas = 22.4 L at STP)

1. 50 g of nitrogen (N_2) has a volume of ___ liters at STP. (40 L)

$$50 \text{ g} \times \frac{1 \text{ mol}}{28.14 \text{ g}} \times \frac{22.4 \text{ L}}{1 \text{ mol}} = 39.8 \text{ L} = \boxed{40 \text{ L}}$$

2. 100 g of oxygen(O_2) is added to the gas in Question 16. What is the volume of the combined gases at STP. (110 L)

$$100 \text{ g} \times \frac{1 \text{ mol}}{32.00 \text{ g}} \times \frac{22.4 \text{ L}}{1 \text{ mol}} = 70 \text{ L of } O_2$$

$$70 \text{ L} + 40 \text{ L} = \boxed{110 \text{ L}}$$

3. What is the density of carbon dioxide at STP? (2.0 g/L)

$$\frac{44.01 \text{ g}}{1 \text{ mol}} \times \frac{1 \text{ mol}}{22.4 \text{ L}} = 1.96 \text{ g/L} = \boxed{2.0 \text{ g/L}}$$

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Combined Gas Law Problems: $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

1. A gas balloon has a volume of 106.0 liters when the temperature is 45.0 °C and the pressure is 740.0 mm of mercury. What will its volume be at 20.0 °C and 780 .0 mm of mercury pressure?

$$\frac{(106.0L)(740.0mmHg)}{315K} = \frac{V_2(780.0mmHg)}{293K}$$

$$V_2 = \left(\frac{293K}{780.0mmHg}\right)\left(\frac{106.0L \cdot 740.0mmHg}{315K}\right) \qquad \boxed{V_2 = 93.5L}$$

2. If 10.0 liters of oxygen at STP are heated to 512 °C, what will be the new volume of gas if the pressure is also increased to 1520.0 mm of mercury?

$$\frac{(10.0L)(760mmHg)}{298K} = \frac{V_2(1520.0mmHg)}{785K}$$

$$V_2 = \left(\frac{785K}{1520.0mmHg}\right)\left(\frac{10.0L \cdot 760mmHg}{298K}\right)$$

$$\boxed{V_2 = 13.2L}$$

3. A gas is heated from 263.0 K to 298.0 K and the volume is increased from 24.0 liters to 35.0 liters by moving a large piston within a cylinder. If the original pressure was 1.00 atm, what would the final pressure be?

$$\frac{(24.0L)(1atm)}{263.0K} = \frac{P_2(35.0L)}{298K}$$

$$P_2 = \left(\frac{298K}{35.0L}\right)\left(\frac{24.0L \cdot 1atm}{263.0K}\right)$$

$$\boxed{P_2 = 0.777\ atm}$$

4. The pressure of a gas is reduced from 1200.0 mm Hg to 850.0 mm Hg as the volume of its container is increased by moving a piston from 85.0 mL to 350.0 mL. What would the final temperature be if the original temperature was 90.0 °C?

$$\frac{(1200.0mmHg)(85.0mL)}{363K} = \left(\frac{(850mmHg)(350.0mL)}{T_2}\right)$$

$$T_2 = (850mmHg \cdot 350.0mL)\left(\frac{363K}{1200.0mmHg \cdot 85.0mL}\right)$$

$$\boxed{T_2 = 1058.75\ K}$$