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Gas Laws Practice Problems

Pressure Conversions: 1.00 atm = 760.0 torr = 760.0 mmHg = 29.9 in Hg = 101.325 kPa
Volume Conversions: 1000 ml = 1 Liter
Mole Conversions: grams ÷ molar mass = moles
Temperature Conversions: °C + 273 = Kelvin
STP = Standard Temperature (0˚C or 273K) and Pressure (1 atm or 101.325 kPa)
R = 8.314 kPa·L/mol K or R = 0.082057 atm·L/mol K

BOYLE'S LAW: $P_1V_1 = P_2V_2$

V1 P1 V2

1. A gas occupies 12.3 liters at a pressure of 40.0 mmHg. What is the volume when the pressure is increased to 60.0 mmHg?
P2

$$\frac{40.0 \text{ mmHg} \times 12.3 \text{ L}}{60.0 \text{ mm Hg}} = V2$$

V2 = 8.2 L

2. If a gas at 25.0 °C occupies 3.60 liters at a pressure of 1.00 atm, what will be its volume at a pressure of 2.50 atm? So if only 1 temp, then ignore it.

$$\frac{P1 \times V1}{P2} = V2$$

3. A gas occupies 1.56 L at 1.325 kPa. What will be the pressure of this gas if the volume becomes 3.00 L?

4. A gas occupies 5.2 L at 680 torr. What is the pressure if the volume becomes 1.5 L?

5. A 500.0 mL sample of a gas is collected at 745.0 mmHg. What will the volume be at standard pressure?

CHARLES' LAW $\frac{V_1}{T_1} = \frac{V_2}{T_2}$ ***Must convert to Kelvin using # °C +273 = Kelvin***

1. Calculate the final temperature when 2.00 L at 20.0 °C is compressed to 1.00 L.

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2. A 600.0 mL sample of air is at 20.0 °C. What is the volume at 60.0 °C?

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

4. What change in volume results if 60.0 mL of gas is cooled from 33.0 °C to 5.00 °C?

5. Given 300.0 mL of a gas at 17.0 °C, what is its volume at 10.0 °C?

GAY LUSSAC'S LAW $\frac{P_1}{T_1} = \frac{P_2}{T_2}$ ***Must convert to Kelvin using # °C +273 = Kelvin***

1. Determine the pressure change when a constant volume of gas at 1.00 atm is heated from 20.0 °C to 30.0 °C.

2. A gas has a pressure of 0.370 atm at 50.0 °C. What is the pressure at standard temperature?

3. A gas has a pressure of 699.0 mmHg at 40.0 °C. What is the temperature at standard pressure?

4. If a gas is cooled from 323.0 K to 273.15 K and the volume is kept constant what final pressure would result if the original pressure was 750.0 mmHg?

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5. A 30.0 L sample of nitrogen at 3.00 atm is inside a metal container at 20.0 °C. If it is placed inside an oven whose temperature is 50.0 °C, what is the final pressure inside the container?

AVOGADRO'S LAW $\frac{V_1}{n_1} = \frac{V_2}{n_2}$ moles added = $n_2 - n_1$ moles escaped = $n_1 - n_2$

1. If a 10.0 L tank can hold 3.4 moles of nitrogen gas, how many moles of gas can be contained in a 15.0 L tank?

2. A 3.0 L sample of oxygen gas contains 2.68 moles. How many liters of gas are required to contain 3.15 moles of oxygen at the same temperature?

3. A piston chamber contains 5.25 moles of propane. Assuming pressure and temperature are constant, how many moles of propane gas will remain in the piston chamber, if the volume is reduced from 500 ml to 200 ml?

4. A 250 ml piston chamber contains 0.045 moles of oxygen gas. More gas is added so that the volume increases to 735 ml. How many moles of oxygen gas ***were added***?

5. A 2.5 L balloon contained 0.83 moles of helium gas. The balloon has a tiny hole allowing some of the gas to escape. How much gas ***has escaped***, if the volume is now only 1.8 L?

Name ____________________________ P1 V1 T2 = P2 V2 T1 Block ____

COMBINED GAS LAW $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$ ***Must convert to Kelvin using # °C +273 = Kelvin***

1. A gas has a volume of 800.0 mL at –23.00 °C and 300.0 torr. What would the volume of the gas be at 227.0 °C and 600.0 torr of pressure?

2. A 500.0 L sample of a gas is prepared at 700.0 mmHg and 200.0 °C. The gas is placed into a tank under high pressure. When the tank cools to 20.0 °C, the pressure of the gas is 30.0 atm. What is the volume of the gas?

3. What is the final volume of a 400.0 mL gas sample that is subjected to a temperature change from 22.0 °C to 30.0 °C and a pressure change from 760.0 mmHg to 360.0 mmHg?

4. At a pressure of 780.0 mmHg and 24.2 °C, a certain gas has a volume of 350.0 mL. What will be the volume of this gas under STP?

5. A 73.0 mL sample of nitrogen at STP is heated to 80.0 °C and the volume increase to 4.53 L. What is the new pressure?

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IDEAL GAS LAW: PV = nRT (R = 8.314 for kPa or 0.082057 for atm)

1. What is the volume occupied by 1.24 moles of gas at 35°C if the pressure is 96.2 kPa?

2. A 5.00 L flask at 25°C contains 0.200 moles of chlorine gas. What is the pressure in the flask?

3. What volume will be occupied by 2.45 moles of oxygen gas at STP?

4. The current room temperature is approximately 72 °F (22 °C). If the atmospheric pressure today is 754 mm Hg, and the volume of your lungs is approximately 6.0 L, how many moles of air can your lungs hold?

5. The density of a gas is measured at 1.853 g / L at 745.5 mmHg and 23.8 °C. What is its molar mass? (Hint: Molar mass has units of grams/mole.)

DALTON'S LAWS OF PARTIAL PRESSURE

1. A container holds three gases: oxygen, carbon dioxide, and helium. The partial pressures of the three gases are 2.00 atm O_2, 3.00 atm CO_2, 4.00 atm He. What is the total pressure inside the container?

$$P_{total} = P_1 + P_2 + \text{etc.}$$

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2. A mixture of gases contains 3.0 moles of oxygen, 5.0 moles of nitrogen, and 1.0 mole of neon gas. What is the mole fraction of each component in the mixture?

$$\text{Mole fraction} = \frac{n_1}{n_{total}}$$

3. A gas mixture contains 40 g CO_2 and 10 g NO_2. If the total pressure of the mixture is 1.2 atms, what is the partial pressure of each gas? ***(Hint: Turn grams into moles first!)***

$$\frac{P_1}{P_{total}} = \frac{n_1}{n_{total}}$$

4. A gas mixture contains 456 torr O_2, 112 torr of CO_2, and 501 torr N_2. What is the mole fraction of each component in the mixture?

$$\frac{P_1}{P_{total}} = \frac{n_1}{n_{total}}$$

GRAHAM'S LAWS ***(The basic concept is that heavy gases move slower)***

1. If equal amounts of helium and argon are placed in a porous container and allowed to escape, which gas will escape faster and how much faster?

2. Which of the following gases will diffuse the fastest: water vapor, oxygen, ammonia, or methane?

3. A sample of helium gas travels at 400 m/s. How fast will a sample of oxygen gas travel?

$$\frac{\text{speed of light gas}}{\text{speed of heavy gas}} = \sqrt{\frac{\text{molar mass of heavy gas}}{\text{molar mass of light gas}}}$$

4. A sample of argon gas travels at 300 m/s. What is the molar mass of a gas that travels at 150 m/s?

$$\frac{\text{speed of light gas}}{\text{speed of heavy gas}} = \sqrt{\frac{\text{molar mass of heavy gas}}{\text{molar mass of light gas}}}$$