VANCOUVER COMMUNITY COLLEGE

Gas Law Problems

USEFUL FIGURES AND FORMULAS

Temperature Conversion: K = °C + 273

Always use absolute temperatures for these problems.

Standard Temperature and Pressure: T = 0°C = 273 K; P = 1 atm = 760 mm Hg

Gas Constant: $R = 0.08206\ \frac{L \cdot atm}{mol \cdot K} = 62.4\ \frac{L \cdot mm\ Hg}{mol \cdot K}$

Ideal Gas Law: $PV = nRT$

General Gas Law: $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$, (n held constant)

Charles' Law: $\frac{V_1}{T_1} = \frac{V_2}{T_2}$, (n, P held constant)

Boyle's Law: $P_1V_1 = P_2V_2$, (n, T held constant)

Gay-Lussac's Law: $\frac{P_1}{T_1} = \frac{P_2}{T_2}$, (n, V held constant)

Dalton's Law of Partial Pressures: $P_{total} = P_1 + P_2 + P_3 + \ldots$

Collection of Gases Over Water: $P_{gas} = P_{total} - P_{water}$

Moles Formula: $n = \frac{m}{MW}$

Avogadro's Principle: Under conditions of *constant temperature and pressure*, equal volumes of gas contain equal numbers of molecules (and therefore equal numbers of moles of gas). In other words, volume is proportional to the number of moles ($V \propto n$).

Molar Volume: 1 mole of a gas at STP occupies _____ L.

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EXERCISES

A. Express the following temperatures in kelvins:

1) 23°C
2) −15°C
3) 0°C
4) −273°C

B. A classmate's lab states a temperature as −10 K.

1) What does this mean?

C. Solve the following:

1) the pressure of 0.150 mol of nitrogen gas at 27°C occupying a volume of 2.00 L

2) the volume of a gas at STP if the same quantity of the gas occupies 1.00 L at 0.655 atm and 27°C

D. A gas occupies 5.75 L at 760 mm Hg and 27.0°C. Determine the volume:

1) when the temperature is raised to 77.5°C

2) at STP

E. A gas occupies 4.50 L at 25.0°C and 760 mm Hg. Determine the volume at:

1) 25.0°C and 395 mm Hg

2) 35.0°C and 1.15 atm

F. A tank with a capacity of 2.55 L has helium, a monatomic gas, pumped into it.

1) How many moles of gas are contained in the tank at 0°C and 760 mm Hg?

2) How many molecules are there in the tank in part 1?

3) If hydrogen, a diatomic gas, had been pumped in instead, how many molecules would there be in the tank?

G. Air in a steel chamber is heated from 19.0°C to 42.5°C.

1) If the initial pressure was 4.15 atm, what is the final pressure?

H. A volume of 0.820 L of a gas at 300 K and 760 mm Hg weighs 2.88 g.
 1) What is its molecular weight?

I. Complete the last entry in the "Useful Figures and Formulas" section one the first page of this worksheet by calculating the missing value in "Molar Volume".

J. The total pressure of hydrogen, helium and argon is 755 mm Hg in a mixture of the three gases.
 1) If P_{He} = 320 mm Hg and P_{Ar} = 405 mm Hg, determine P_{H_2}.

K. A mass of 8.52 g of nitrogen gas is collected over water at a barometric pressure of 752 mm Hg and a temperature of 26.0° C. At this temperature, $P_{H_2O} = 25.2\text{ mm Hg}$.
 1) What volume of nitrogen is collected?

L. Consider the decomposition of potassium chlorate:

$$\underset{\text{potassium chlorate}}{2\,KClO_3} \rightarrow \underset{\text{potassium chloride}}{2\,KCl} + \underset{\text{oxygen}}{3\,O_2}$$

2.36 g of potassium chlorate is decomposed, and the oxygen is measured at 32.5°C and at 715 mm Hg.
 1) What volume of oxygen results?

SOLUTIONS

A. (1) 296 K (2) 258 K (3) 273 K (4) 0 K
B. It means something is wrong. Temperatures in kelvins cannot be negative.
C. (1) 1.85 atm or 1.40 × 10^3 mm Hg (2) 0.596 L
D. (1) 6.72 L (2) 5.23 L
E. (1) 8.66 L (2) 4.04 L
F. (1) 0.114 mol (2) 6.85 × 10^{22} molecules (3) 6.85 × 10^{22} molecules
G. (1) 4.48 atm
H. (1) 86.5 g/mol
I. (1) 22.4 L
J. (1) 30 mm Hg
K. (1) 7.81 L
L. (1) .771 L