

## Gas Law Formulas

$$R = 0.082058 \frac{\text{L} \cdot \text{atm}}{\text{mol} \cdot \text{K}} = 8.3145 \frac{\text{J}}{\text{mol} \cdot \text{K}} = 62.4 \frac{\text{L} \cdot \text{mm Hg}}{\text{mol} \cdot \text{K}}$$

$$T(\text{K}) = T(^{\circ}\text{C}) + 273.15$$

Formula	When to be applied
$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$	<b>Combined gas law</b> Use when there is a <i>change</i> in conditions, but not in number of moles.
$PV = nRT$	<b>Ideal gas law</b> Must match the units with the value of R!
$d = \frac{m}{V} = \frac{PM}{RT}$	<b>Density of an ideal gas</b> Must know the molar mass ( $M_m$ ) of the gas.
$\chi_a = \frac{n_a}{n_{\text{total}}}$	<b>Mole fraction</b> of component a in a mixture Use in gas mixture problems.
$P_{\text{total}} = P_a + P_b + \dots$ $P_a = \chi_a \times P_{\text{total}}$	<b>Dalton's law of partial pressures</b> Use to find the pressure exerted by one gas component in a mixture of ideal gases.
$\frac{3}{2}RT = \frac{1}{2}mu^2$	<b>Kinetic energy of an ideal gas</b> Shows that average kinetic energy is measured by temperature.
$u = \sqrt{\frac{3RT}{M_m}}$	<b>RMS speed of an ideal gas</b> Molar mass ( $M_m$ ) must be in kg/mol in this formula to yield speed in m/s.
$\frac{\text{rate of a effusion}}{\text{rate of b effusion}} = \sqrt{\frac{M_b}{M_a}}$	<b>Graham's Law of Effusion</b> Use to find the relative rate of effusion of gases a & b at a given temperature.

- 1) Consider a gas mixture of Ne and Ar ( $x_{\text{Ne}} = 0.40$ ) is in a rigid, 50-L vessel at 10 atm and at 22°C.

- What is the partial pressure of Ar in kPa?
- What is the mass of the gas in the container?
- If the temperature were to rise to 88°C, what would the gas pressure be?

- 2) At STP, 700. mL of a gas has a mass of 1.452 g.

- What is the molar mass of the gas?
- If the temperature and pressure increased by 25%, what is the new gas volume?

- 3) Consider dry air at STP with the following composition:

N <sub>2</sub>	78.00% (by volume)
O <sub>2</sub>	21.00%
Ar	0.800%
CO <sub>2</sub>	0.200%

- What is the *molar* density (mol/L) of air at STP?
- What is the density of air at STP in g/L?