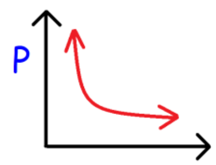
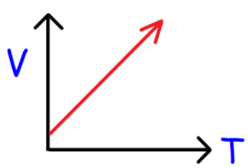
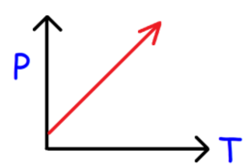
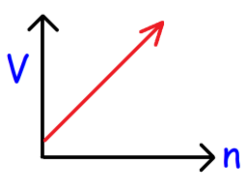
Gas Laws Formula Sheet:

Pressure: 1 atm = 760 torr = 760 mm Hg 1 atm = 101.3 kPa = 14.7 psi	$\boldsymbol{P} = \frac{F}{A}$ $\quad$ $1\ Pa = 1N/m^2$ $\boldsymbol{T_K} = T_C + 273.15$ $\quad$ $\boldsymbol{T_F} = 1.8T_C + 32$
Ideal Gas Law: T → Temperature (K) V → Volume (L) n → Moles P → Pressure (atm)	$PV = nRT$ $\quad$ $\boldsymbol{R} = 0.08206\ \frac{L * atm}{mol * K}$ **Note:** The units in the equation must match the units of **R**.
Combined Gas Law: T → Temperature (K) V → Volume (L or mL) n → Moles P → Pressure (atm, torr, mm Hg) Units of P_1 must match with P_2.	**If n is constant:** $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$ **If n is not constant:** $\frac{P_1V_1}{n_1T_1} = \frac{P_2V_2}{n_2T_2} = \boldsymbol{R}$
	**Boyle's Law:** $P_1V_1 = P_2V_2$ $V \uparrow P \downarrow$
	**Charles Law:** $\frac{V_1}{T_1} = \frac{V_2}{T_2}$ $T \uparrow V \uparrow$
	**Gay Lussac's Law:** $\frac{P_1}{T_1} = \frac{P_2}{T_2}$ $T \uparrow P \uparrow$
	**Avogadro's Law:** $\frac{V_1}{n_1} = \frac{V_2}{n_2}$ $n \uparrow V \uparrow$
STP: $\boldsymbol{1\ mole\ gas \rightarrow 22.4\ L}$	**Standard Temperature and Pressure:** $\boldsymbol{T} = 273.15\ K \quad and \quad \boldsymbol{P} = 1atm$

Average Kinetic Energy: (J/mol) T → Temperature (K)	$\boldsymbol{KE_{avg}} = \frac{3}{2}RT \qquad \boldsymbol{R} = 8.3145 \frac{J}{mol * K}$
Ideal Gas Law Variant: m → mass (g) M_w → molar mass (g/mol) P → Pressure (atm) V → Volume (L)	$PVM_w = mRT$ $\boldsymbol{R} = 0.08206\ L * atm/(mol * K)$ **Note:** The units in the equation must match the units of **R**.
Gas Density: (g/L) M_w → molar mass (g/mol) P → Pressure (atm) T → Temperature (K)	$\boldsymbol{d} = \frac{PM_w}{RT} \qquad \boldsymbol{R} = 0.08206\ L * atm/(mol * K)$ $\frac{d_2}{d_1} = \frac{T_1}{T_2} \qquad \frac{d_2}{d_1} = \frac{P_2}{P_1} \qquad \frac{d_2}{d_1} = \frac{M_{w2}}{M_{w1}}$
Gas Density at STP:	$\boldsymbol{d} = \frac{M_w}{22.4}$
Molar Mass of a Gas: P → Pressure (atm) T → Temperature (K) V → Volume (L)	$\boldsymbol{M_w} = \frac{mRT}{PV} \qquad \boldsymbol{M_w} = \frac{dRT}{P}$ $\boldsymbol{R} = 0.08206\ L * atm/(mol * K)$
Average Molar Mass of a Gaseous Mixture:	$\boldsymbol{\bar{M}_w} = M_{w1}P_1 + M_{w2}P_2$ $P \rightarrow Percentage \qquad 35\% \rightarrow P = 0.35$
Dalton's Law of Partial Pressures:	$\boldsymbol{P_T} = P_A + P_B + P_C$ $\boldsymbol{P_T} = X_AP_T + X_BP_T + X_CP_T$ $\boldsymbol{P_A} = \frac{n_ART}{V} \qquad \boldsymbol{P_B} = \frac{n_BRT}{V} \qquad \boldsymbol{P_C} = \frac{n_cRT}{V}$
Collecting Gas Over Water:	$\boldsymbol{P_T} = P_{Gas} + P_{H2O}$ $\boldsymbol{P_{H2O}} = 23.76\ torr\ at\ 25\ ℃$

Mole Fraction:	$$\boldsymbol{X_A} = \frac{n_A}{n_T} \qquad \boldsymbol{X_A} = \frac{P_A}{P_T} \qquad \boldsymbol{P_A} = X_A P_T$$ $$X_A + X_B + X_C = 1$$
Root Mean Square Velocity: (m/s) M_w → molar mass (**kg/mol**) T → Temperature (K)	$$\boldsymbol{v_{rms}} = \sqrt{\frac{3RT}{M_w}} \qquad \boldsymbol{R} = 8.3145 \frac{J}{mol * K}$$ $$\frac{v_2}{v_1} = \sqrt{\frac{T_2}{T_1}} \qquad \frac{v_2}{v_1} = \sqrt{\frac{M_{w1}}{M_{w2}}}$$
Graham's Law of Effusion:	$$\frac{R_2}{R_1} = \sqrt{\frac{M_{w1}}{M_{w2}}} = \frac{t_1}{t_2}$$
Van Der Waals Equation:	$$\left[P + a\left(\frac{n}{v}\right)^2\right][v - nb] = nRT$$

Substance:	$\boldsymbol{a}\ (\boldsymbol{L^2 * atm/mol^2})$	$\boldsymbol{b}\ (\boldsymbol{L/mol})$
H_2	0.244	0.0266
He	0.0341	0.0237
CH_4	2.25	0.0428
H_2O	5.46	0.0305
Ne	0.211	0.0171
N_2	1.39	0.0391
O_2	1.36	0.0318
Ar	1.34	0.0322
CO_2	3.59	0.0427