Notes: Gas Laws

4 Variables to Describe a Gas:

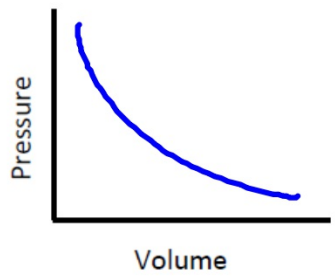
1. **P** = pressure (atmospheres) ← collisions w/container
   1 atm = 760 mmHg = 101.3 kPa
2. **V** = volume (Liters)
   space occupied
3. **n** = moles
4. **T** = temperature (Kelvin)
   K = °C + 273
   average kinetic E

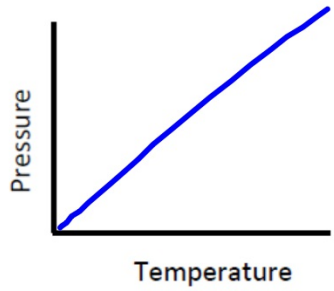
Ideal Gas Law: **PV = nRT** R = gas constant = 0.0821 $\frac{atm*L}{mol*K}$

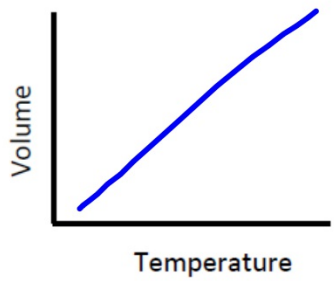
If you know 3 of the 4 variables you can solve for the missing variable.

Other Gas Laws:

How does changing one variable affect another variable? e.g. how does an increase in temperature affect the pressure of a gas?

Variables	Relationship	Graph	Law	Formula
Pressure & Volume	inverse		Boyles	$P_1V_1 = P_2V_2$

Pressure & Temperature	Direct		Lussac	$\frac{P_1}{T_1} = \frac{P_2}{T_2}$

Volume & Temperature	Direct		Charles	$\frac{V_1}{T_1} = \frac{V_2}{T_2}$

Pressure, Volume, & Temperature	XXXX	XXXX	Combined	$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

Lussac volume constant

Bath **T**ime **L**eaves **V**ery **C**lean **P**eople

Boyles

Temperature is constant

Charles

pressure constant

Gas Law Examples:

1. What is the pressure in atmospheres exerted by a 0.500 mol sample of nitrogen gas in a 10.0 L container at 298 K?

? P

n

V

T

$$PV = nRT$$

$$P(10\ L) = (0.5\ mol)\left(0.0821\ \frac{L \cdot atm}{mol \cdot K}\right)(298\ K)$$

$$\frac{P(10\ L)}{10} = \frac{12.2329}{10}$$

$$P = 1.22329 = \boxed{1.22\ atm}$$

2. A sample of oxygen gas has a volume of 150.0 mL when its pressure is 0.947 atm. What will the volume of the gas be at a pressure of 0.847 atm if the temperature remains constant?

V_1 P_1 P_2 V_2

$V_1 = 150$ mL

$P_1 = 0.947$ atm

$V_2 = ?$ mL

$P_2 = 0.847$ atm

$$P_1 V_1 = P_2 V_2$$

$$(0.947 \text{ atm})(150 \text{ mL}) = (0.847 \text{ atm}) V_2$$

$$142.05 = (0.847) V_2$$

$$V_2 = 167.7$$

$$\boxed{V_2 = 168 \text{ mL}}$$

3. A sample of neon gas occupies a volume of 752 mL at 25°C. What volume will the gas occupy at 50°C if the pressure remains constant?

V_1 T_1 T_2 $? V_2$

$V_1 = 752$ mL

$T_1 = 25\,°C + 273 = 298K$

$V_2 = ?$ mL

$T_2 = 50\,°C + 273 = 323K$

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

$$V_1 T_2 = V_2 T_1$$

$$V_2 = \frac{V_1 T_2}{T_1}$$

$$\frac{752 \text{ mL}}{298K} = \frac{V_2}{323K}$$

$$V_2 = 815$$

$$\boxed{V_2 = 820 \text{ mL}}$$

4. The gas in a container is at a pressure of 3.00 atm at 25°C. What would the gas pressure in the container be at 52°C?

P_1 T_1 ? P_2 T_2

$P_1 = 3$ atm

$T_1 = 25°C + 273 = 298$ K

$P_2 = ?$ atm

$T_2 = 52°C + 273 = 325$ K

$$\frac{P_1}{T_1} = \frac{P_2}{T_2} \qquad \frac{3 \text{ atm}}{298 \text{ K}} = \frac{P_2}{325 \text{ K}}$$

$P_2 = 3.27 = \boxed{3.3 \text{ atm}}$

5. A helium-filled balloon has a volume of 50.0 L at 25°C and 1.08 atm. What volume will it have at 0.855 atm and 10.0°C?

V_1 T_1 P_1 ? V_2 P_2 T_2

$V_1 = 50$ L

$T_1 = 25°C + 273 = 298$ K

$P_1 = 1.08$ atm

$V_2 = ?$ L

$P_2 = 0.855$ atm

$T_2 = 10°C + 273 = 283$ K

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$$\frac{(1.08)(50)}{(298)} = \frac{(0.855)V_2}{(283)}$$

$V_2 = 59.9788$

$\boxed{V_2 = 60. \text{ L}}$