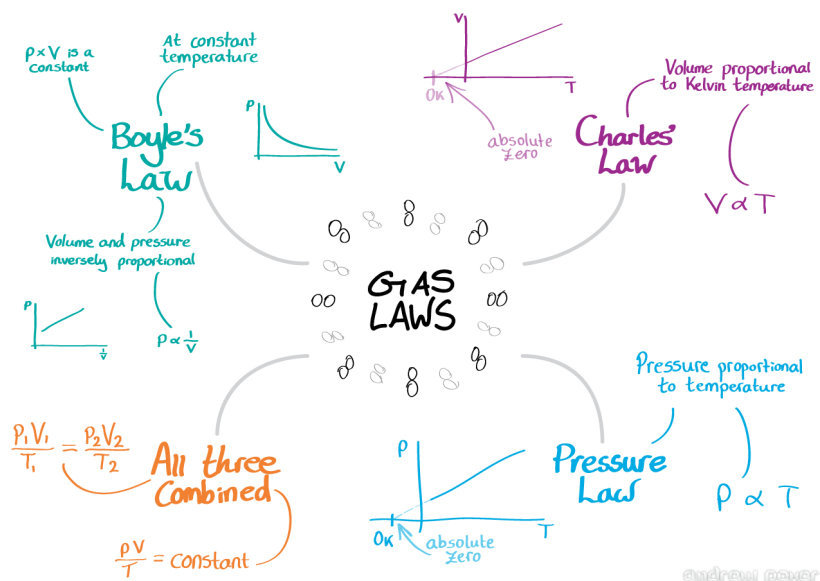


CHEMISTRY 11 GAS LAWS



Pressure is measured in:

$$1 \text{ atm} = 760. \text{ mmHg} = \mathbf{101.3 \text{ kPa}}$$

STP : $0^\circ\text{C} = 273 \text{ K}$ and 101.3 kPa
Standard Temperature and Pressure

THE IDEAL GAS CONSTANT "R"

$$\mathbf{R} = 8.31 \frac{\text{kPa} \cdot \text{L}}{\text{moles} \cdot \text{K}}$$

RTP : $25^\circ\text{C} = 298 \text{ K}$ and 101.3 kPa
Room Temperature and Pressure

START BY WATCHING THIS 9 minute video: <https://youtu.be/BxUS1K7xu3o>

From this video, we understand that we can make several (mathematical) and observational relationships between the pressure and volume of gases.

The rest of this document highlights these various mathematical relationships:

Dalton's Law of Partial Pressures:

-the total pressure exerted by the mixture of non-reactive gases is equal to the sum of the partial pressures of individual gases

$$P_T = P_a + P_b + P_c + \dots + P_z$$

Example: Determine the total pressure of a gas mixture that contains oxygen, nitrogen, and helium if the partial pressures of the gases are $P_{O_2} = 20.0$ kPa, $P_{N_2} = 46.7$ kPa, and $P_{He} = 26.7$ kPa.

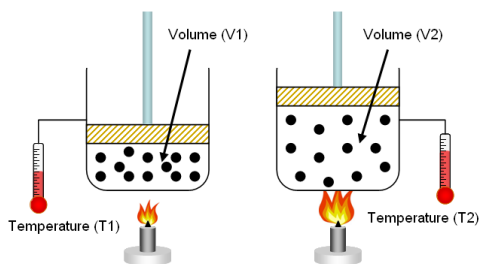
A hot air balloon will float on air... Why? Why does air become less dense as it is heated?

⇒ Watch this 3 minute video: <https://youtu.be/BY9VGS2eXas>

Charles' Law:

-when the pressure and the number of moles of a gas are held constant, the volume of a gas is directly proportional to the **Kelvin temperature**.

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

**Charles Law EXAMPLES:**

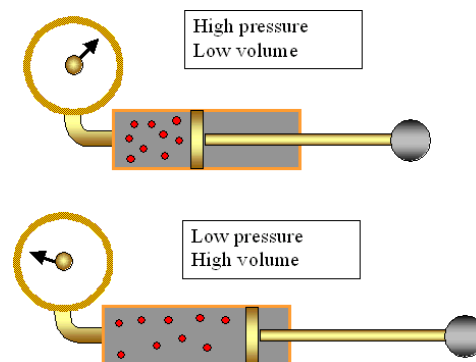
1. A 250 mL sample of gas exists at 25 °C. What volume will the gas occupy at 50. °C if pressure remains constant?

2. Nitrogen gas occupies 400. mL at 100 °C. At what temperature would the gas occupy 200. mL?

Boyle's Law:

-when the temperature and the number of moles of a gas are held constant, the volume of a gas is inversely proportional to the pressure applied on the gas.

$$V_1P_1 = V_2P_2$$

**Boyles Law EXAMPLES:**

1. A sample of gas occupies 10.L at 105 kPa. At what pressure will it occupy 13.4 L?
(Assume constant temperature, when no reference to energy change is mentioned).

2. A sample of gas occupies 9.8 L under a pressure of 101.3 kPa. What will its volume be at 108 kPa?

Base on Charles' and Boyle's Laws, we can logically see this relationship:

Gay-Lussac's Law:

-the pressure of a gas, at constant volume, is directly proportional to the absolute temperature.

$$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$

Kelvin temperature!

EXAMPLE:

1. At constant volume, a gas exerts 500. kPa of pressure on a container's walls at 250. K.
What will the pressure be at 350. K?

⇒ **WATCH THIS 5.5 minute video:** <https://youtu.be/ir64EcRkf5Q>

While watching this video, pay attention to his use of the graph to find mathematical relationships

Interested in the simulations he was using in this video?

CHECK THEM OUT HERE! <https://phet.colorado.edu/en/simulation/gas-properties>

Ideal gas law: $PV = nRT$

- Where P = pressure in kPa
- V = Volume (of a gas) in L
- n = the **number** of moles
- R is the ideal gas constant
- T is the temperature in **Kelvin**

IDEAL GAS:

An Ideal gas is a state of matter above its boiling point but below its plasma point AND meets the following criteria:

IDEAL GAS

vs.

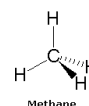
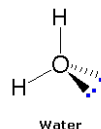
REAL GAS

no attractive forces between neighbouring molecules

liquids and solids result from attractions between molecules

all molecules are perfect spheres

H₂O “V shaped” CH₄ “tetrahedral”



molecules occupy zero volume (don't occupy any space)

mass and volume are essential properties of matter

molecule collisions are perfectly elastic

energy loss during collisions causes chemical reactions

HOWEVER, despite the inadequate nature of each assumption, the combination of these allows a good model, providing the gas is not near its condensing point.

This means that in Chemistry (and sometimes in Physics) we treat gases as if they are real, so that we can determine the volume, pressure, etc.

Ideal Gas Law EXAMPLES:

1. What volume will 480 g of ammonia gas occupy at 125 °C and 180 kPa?

2. What pressure is exerted by 54.0 g of Xenon in a 1.00 L flask at 20 °C?

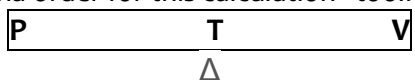
3. A sample of oxygen gas occupies 3.25 L 24 °C and 100.4 kPa. What is the mass of the gas?

Combined gas law:

If... $\frac{V_1 P_1}{T_1} = R$ and $\frac{V_2 P_2}{T_2} = R$ Then... $\frac{V_1 P_1}{T_1} = \frac{V_2 P_2}{T_2}$

Kelvin temperature!

memory hint: write the letters in alpha order for this calculation "tool." Think of a teeter totter.



If Pressure increases, then Volume decreases
 If Volume decreases, then Pressure increases
 etc.

Combined Gas Laws EXAMPLES:

1. A sample of neon occupies 100.L at 27.0°C at 133 kPa.

What volume would it occupy at standard conditions?

V1 =

V2 =

T1 =

T2 =

P1 =

P2 =

2. A meteorological balloon occupies 140 litres at 39°C and 95 kPa.

What volume will it occupy at 85°C and 121 kPa?

V1 =

V2 =

T1 =

T2 =

P1 =

P2 =