جامـــــعـة المــــســتـقـبـل
AL MUSTAQBAL UNIVERSITY

كلية العلـــــوم
قــســـــــــم الادلة الجنائية

المحاضرة الثانية

An Introduction in Chemistry

المادة : كيمياء عامة
المرحلة : الاولى
اسم الاستاذ: م.د. كرار مجيد عبيد

Gases

- A gas is a phase of matter where atoms of a substance are in motion and immediately fill their container))
- A solid is a form of matter that adopts and maintains a shape that is independent of the container it occupies.
- A liquid is a form of matter that adopts the shape of the part of the container it occupies (in a gravitational field, the lower part) and is separated from the unoccupied part of the container by a definite surface.
- A liquid and a solid are examples of a condensed state of matter.
- A liquid and a gas are examples of a fluid form of matter: they flow in response to forces (such as gravity) that are applied.

Properties of gases

1. A gas consists of a large number of tiny particles called molecules.
2. The motion of molecules increases with an increase in temperature.
3. Molecules are in a state of continuous random motion.
4. The intermolecular distances are large.
5. The forces of attraction between the molecules are weak.

Unites of measuring the pressure

- ✓ 1 atm = 760 torr = 760 mmHg = 76 cmHg
- ✓ 1 atm = 1.01325 bar ≈ 1 bar
- ✓ 1 atm = 101325 Pa (1 Pa = 1 $N.m^{-2}$)

Pressure unit table

Unit	Symbol	Equivalent (approx.)
Pascal	Pa	1 Pa = 1 $N{\cdot}m^{-2}$
Kilopascal	kPa	1 kPa = 10^3 Pa
Bar	bar	1 bar = 10^5 Pa
Atmosphere	atm	1 atm = 101325 Pa
Millimeter of mercury	mmHg	1 mmHg ≈ 133.3 Pa
Torr	Torr	1 Torr ≈ 133.3 Pa
Pound per square inch	psi	1 psi ≈ 6894.8 Pa

The volume, V, a measure of the quantity of space the sample occupies (unit: 1 cubic meter, 1 m^3). 1L = dm^3 = $10^{-3}m^3$ = 10^3Cm^3 = 1000 mL

The amount of substance (number of moles), n, a measure of the number of specified entities (atoms, molecules, or formula units) present (unit: 1 mole, 1 mol). Temperature, T, is formally a property that determines in which direction energy will flow as heat when two samples are placed in contact through thermally conducting walls.

Classification of gases

1. Real gas or non-ideal gas.

2. Perfect gas or ideal gas (High in p and low in T).

a. The perfect gas is the one that obeys certain law as boyle's law, Charle's law GayLussac's law and Dalton's law. the total volume at all pressure and temperature.

b. The volume occupied by the molecules themselves is negligible as compared with

c. The intermolecular attraction is almost absent under all conditions.

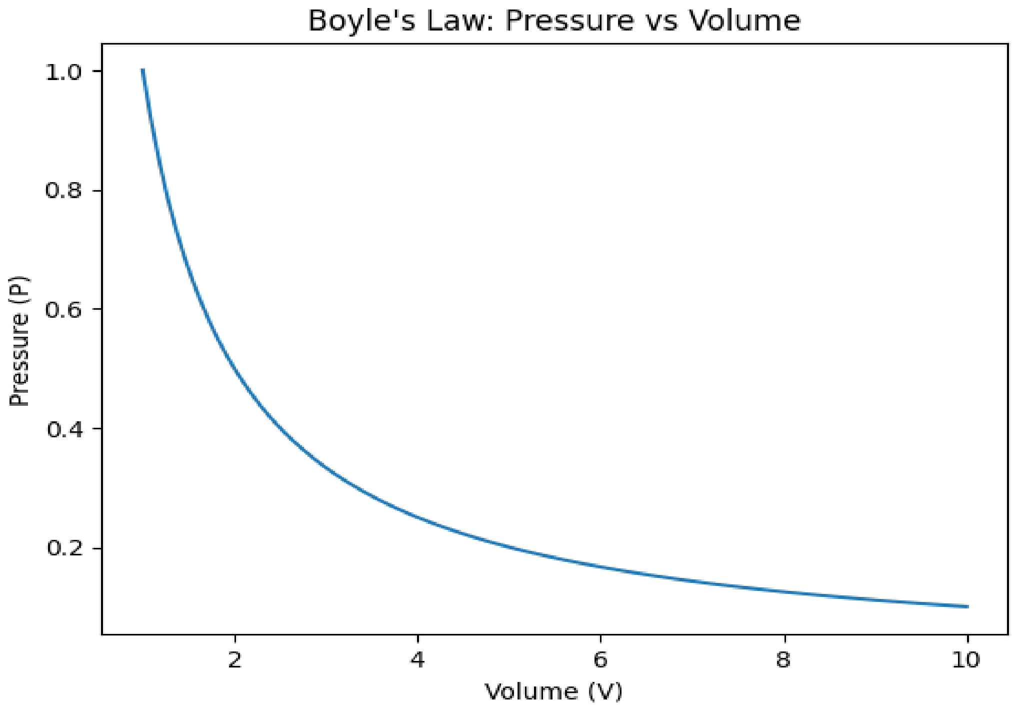
The gas laws

1. Boyle's law: At constant temperature, the pressure of a fixed mass of gas is inversely proportional to its volume.

$$P \propto \frac{1}{V}$$

$$PV = \text{constant}$$

$$P_1V_1 = P_2V_2$$



Example: A 2.5 L container has a gas pressure of 4.6 atm. If the volume is decreased to 1.6 L, what will be the new pressure inside the container?

Solution: V_1 = 2.5 L, V_2 = 1.6 L, p_1 = 4.6 atm and p_2 =? atm

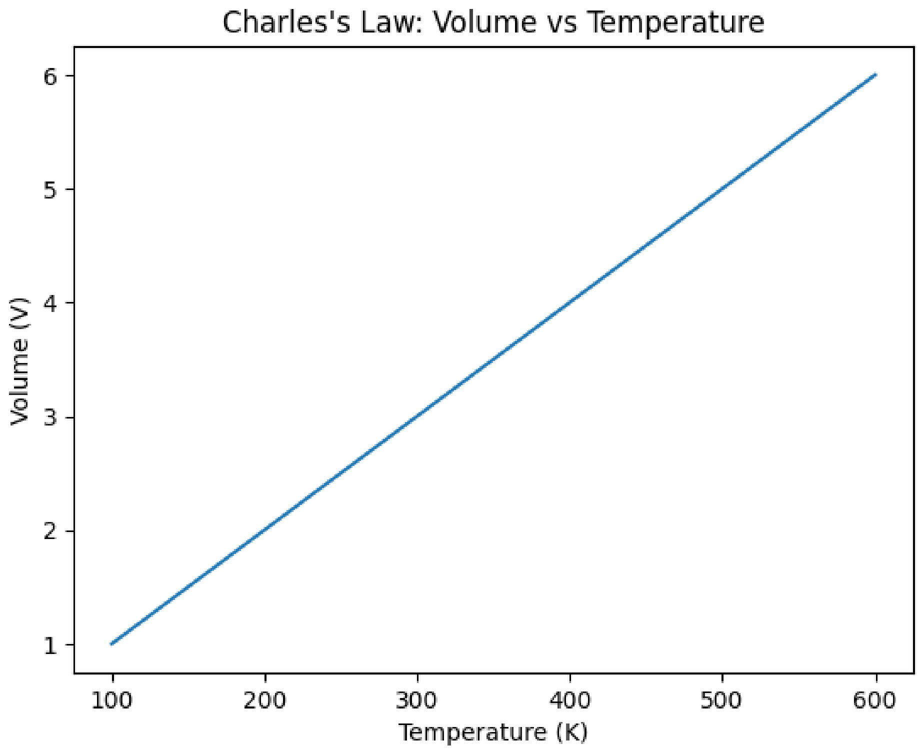
$\mathbf{4.6\ atm)(2.5\ L) = p_2(1.6\ L), p_2 = 7.19\ atm}$

2. Charles's law: At constant pressure, the volume of a fixed mass of gas is directly proportional to its absolute temperature.

$$V \propto T$$

$$\frac{V}{T} = \text{constant}$$

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



Example: A 3.5 L flexible container holds a gas at 250 K. What will the new volume be if the temperature is increased to 400 K?

Solution: $V_1 = 3.5$ L, $V_2 = ?$ L, $T_1 = 250$ K and $T_2 = 400$ K

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

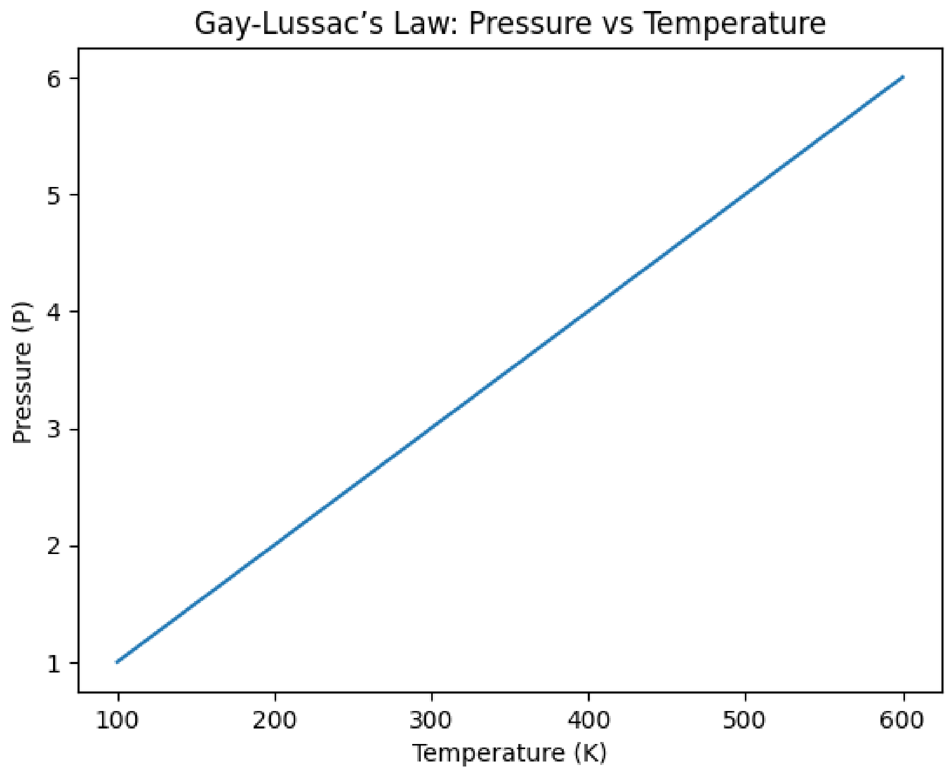
$$\frac{3.5\,L}{250\,\cancel{K}} = \frac{V_2}{400\,\cancel{K}} = 5.6\,L$$

3. Gay-Lussac's law: At constant volume, the pressure of a fixed mass of gas is directly proportional to its absolute temperature.

$$P \propto T$$

$$\frac{P}{T} = \text{constant}$$

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



Example: The pressure of a gas in a rigid container is 125 kPa at 300 K. What is the new pressure if the temperature increases to 900 K?

Solution: T_1 = 300 K, T_2 = 900 K, p_1 = 125 kPa and p_2 =?

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

$$\frac{125\ kPa}{300\ K} = \frac{p_2}{900\ K} = 375\ kPa$$

4. Avogadro's laws: If the temperature and pressure are constant, the volume of a gas is directly proportional to the number of moles (or molecules) of the gas.

$$V \propto n$$

Where:

- V = volume of gas
- n = number of moles of gas

$$\frac{V_1}{n_1} = \frac{V_2}{n_2}$$

Homework: In a sample of gas, 50.0 g of oxygen (O_2) take up 48 L of volume. Keeping the pressure constant, the amount of gas is changed until the volume is 79 L. How many grams of gas are now in the container?

Homework: A 250 mL balloon contains 0.35 moles of N_2 gas. If o.45 moles of N_2 was added to it, what will be the new volume?

Standard Temperature and Pressure (STP)

The standard conditions for a gas are defined as having a pressure of 1 atm (p = 1 atm), a volume of 22.4 L (V = 22.4 L), an amount of 1 mole of gas (n = 1 mol), and a temperature of 0°C [T = 0°C + 273 = 273 K] (i.e., 273 K).

The ideal or perfect gas equation

1) V α 1/p, according to Boyle's law.

2) V α T, according to Charles's law.

3) p α T, according to Gay-Lussac's law

4) V α n, according to Avogadro's law

The relation between these four equations can be as one equation and as follows: $\boldsymbol{pV} = \boldsymbol{constant} \times \boldsymbol{nT}$

$\boldsymbol{pV} = \boldsymbol{nRT}$,($\boldsymbol{Ideal\ or\ perfect\ gas\ law}$)

So, if the pressure is in atmosphere (atm), volume in liter (L), number of moles (n) and temperature is in kelvin (K),

Then

R = 0.082 L.atm/mol.K.

By applying the above equation of the perfect gas pV = nRT,

then R = (1 atm × 22.414 L)/(1 mol × 273 K)

1- R = 0.082 L atm/mol K,

R = (101325 N m^{-2} × 0.0224 m^3)/mol × 273 K

2- R = 8.314 J/(mol K), where J = N.m. so pascal = N.m^{-2} and 22.4 L (0.0224 m3)

3- R = 1.98 cal/mol K, where [1 calorie= 4.184 Joule, so (1.98 = 8.314/4.184)]

Example: Calculate the volume of one mole of a perfect gas under atmospheric pressure 1 atm and temperature 0 ^{O}C (273 K)?

Solution : p = atm , T =273 K ,V = L?

$$V = \frac{nRT}{P}$$

$$V = \frac{\cancel{mol} \times 0.082\ \cancel{atm}\ L\ \cancel{mol^{-1}}\ \cancel{K^{-1}}\ 273\ \cancel{K}}{p} = 22.4\ L$$

Problem:

A container holds 4 moles of gas at a temperature of 300 K and a volume of 20 L. If the gas pressure increases to 4 atm and the temperature is raised to 450 K, what is the new volume of the gas?

Solution:

Use the combined gas law:

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

Solve for V_2:

$$V_2 = \frac{P_1 V_1 T_2}{P_2 T_1} = \frac{1 \times 20 \times 450}{4 \times 300}$$

$$V_2 = \frac{9000}{1200} = 7.5\, L$$