CHEMICAL GAS LAWS

The chemical behaviour of gases was studied by Gay-Lussac. Gay-Lussc was a French chemist and physicist. He described the combining volumes of gases that react together. In his experiments, all temperatures and pressures were kept constant.

On steam (H_2O), Gay Lussac observed that two volumes of hydrogen reacted with one volume of oxygen to yield two volumes of steam.

	hydrogen	+	oxygen	⟶	steam
volume	2	:	1	:	2
Ratio	2	:	1	:	2

On Hydrogen chloride (HCl) gas. Gay Lussac observed that one volume of hydrogen combined with one of chlorine to yield two volumes of hydrogen chloride gas.

	hydrogen	+	chlorine	⟶	steam
volume	1	:	1	:	2
ratio	1	:	1	:	2

Gay Lussac noticed that the combining volumes as well as the volumes of the products, if gaseous, were related by simple ratios of whole numbers. He proposed the Law of Combining Volumes or Gaseous Volumes.

> *The Gay-Lussac's Law of combining volumes states that when gases react, they do so in volumes which are in simple ratios to one anoher and to the volumes of the products, if gaseous, provided that the temperature and the pressure remain constant.*

Avogadro's Hypothesis

Avogadro (1776-1856), an Italian professor, put forward a hypothesis that explained Gay-Lussac Law satisfactorily.

Avogadro's Hypothesis states that equal volumes of all gases at the same temperature and pressure contain the same number of molecules.

In recent years, Avogadro's hypothesis was confirmed and is now known as *Avogadro's Law*.

Avogadro's Number: matter is made up of different kinds of particles—atoms, molecules, and ions. The particles of most elements is the atom. Counting the atoms, molecules and ions in matter is not easy, however, we can count particles if we introduce a term that represents a certain number of particles just as a dozen eggs represents 12eggs, a mole of a substance represent 6.02×10^{23} particles of any substance. This experimentally determined number 6.02×10^{23} is called Avogadro's number.

Molar Volume of Gases: From Avogadro's law, one mole of any gas at stp has a voluem of $22.4dm^3$. Thus one mole of chlorine gas has a volume of $22.4dm^3$ just as carbon(IV)oxide at stp.

Avogadro's Law and Gay-Lussac's Law

By applying Avogadro's Law, the volume of gases can be converted into the relative number of molecules they contain. This helps to explain Gay-Lussac's Law. The experimentally observed Gay-Lussac law can be re-stated as follows: "When gases react, they do so in small whole number of molecules of products." This is also what Dalton had suggested.

Nature of the Molecule

In the reaction between hydrogen and chlorine, one molecule of hydrogen reacts with one molecule of chlorine to yield two molecules of hydrogen chloride. This is in accordance with Avogadro's law. Since only whole atoms can take part in a chemical combination (atomic theory), the molecule of hydrogen and the molecule of chlorine that combine to yield two molecules of hydrogen chloride must contain to yield two

molecules of hydrogen chloride must contain more than one atom each. Otherwise, there would be a halving of each atom which is contrary to the Atomic theory. If the hydrogen and the chlorine molecules are assumed to contain two atoms each, the formation of the two molecules of hydrogen chloride is possible without having to halve the atoms.