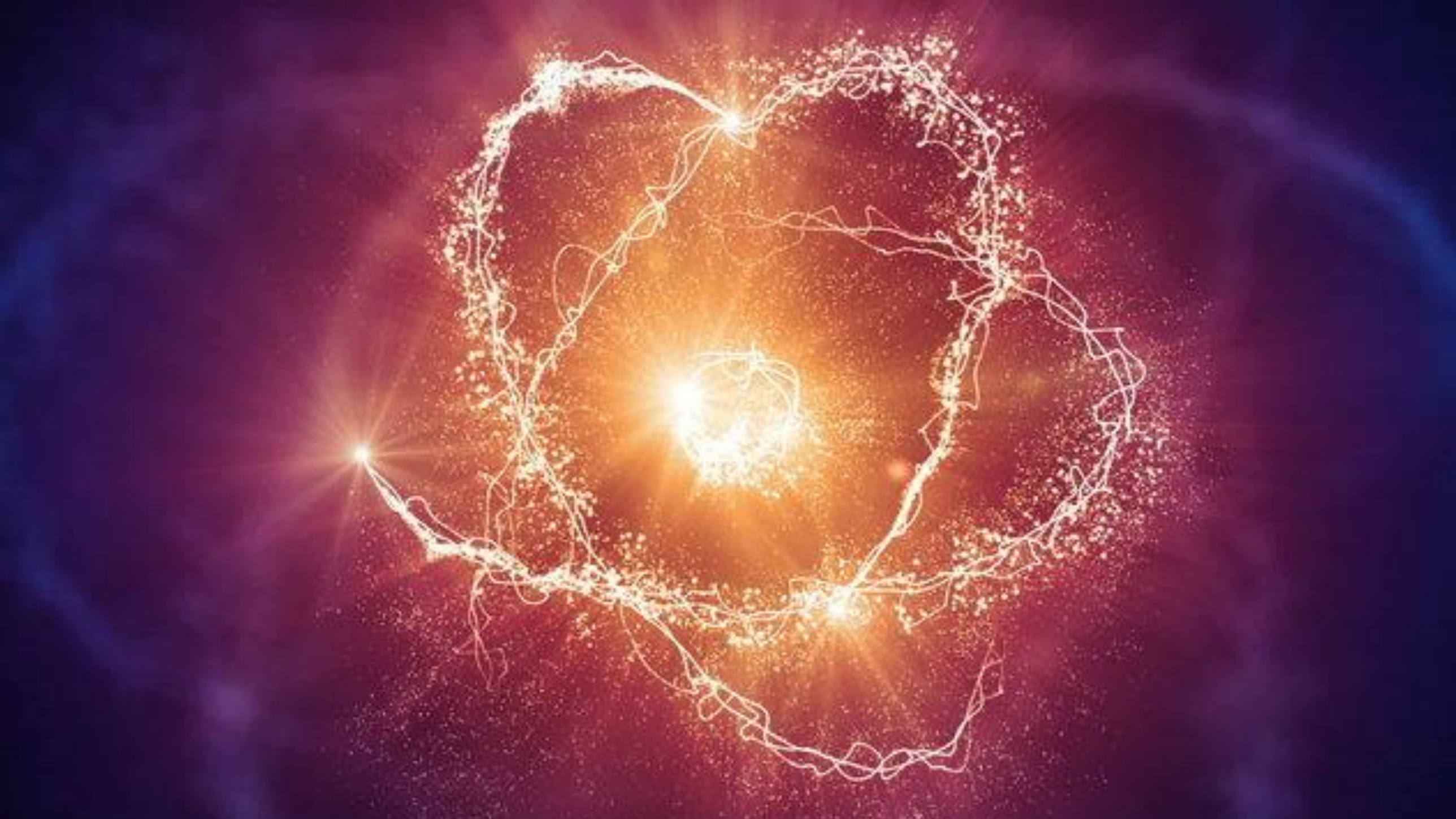


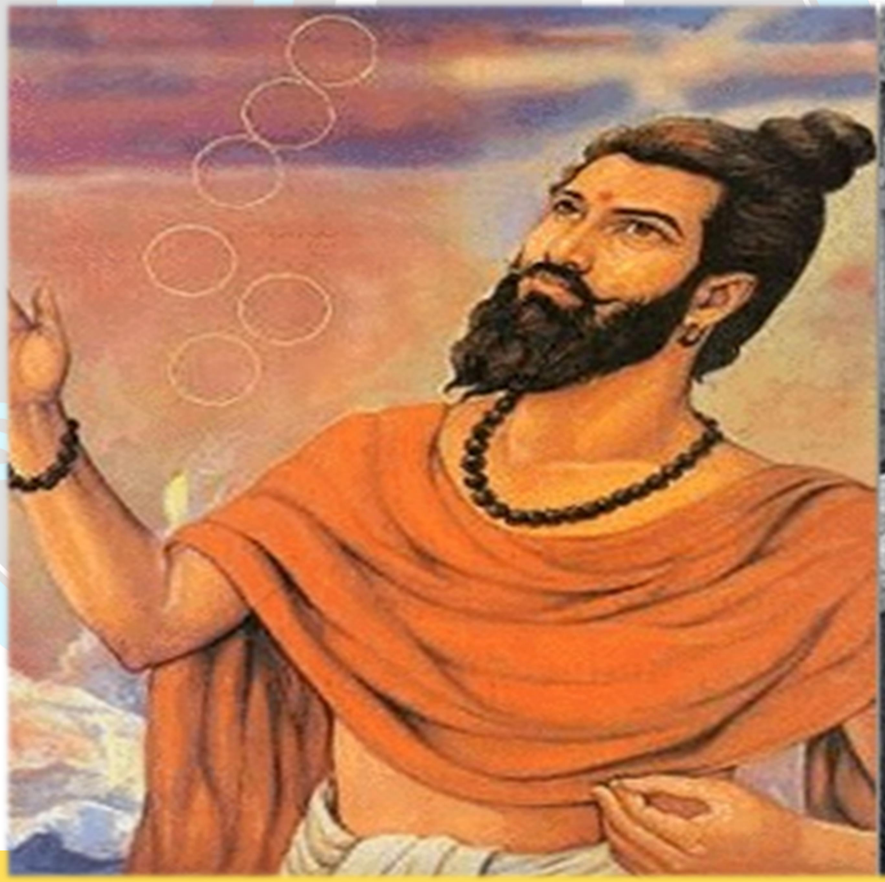
CONTENTS

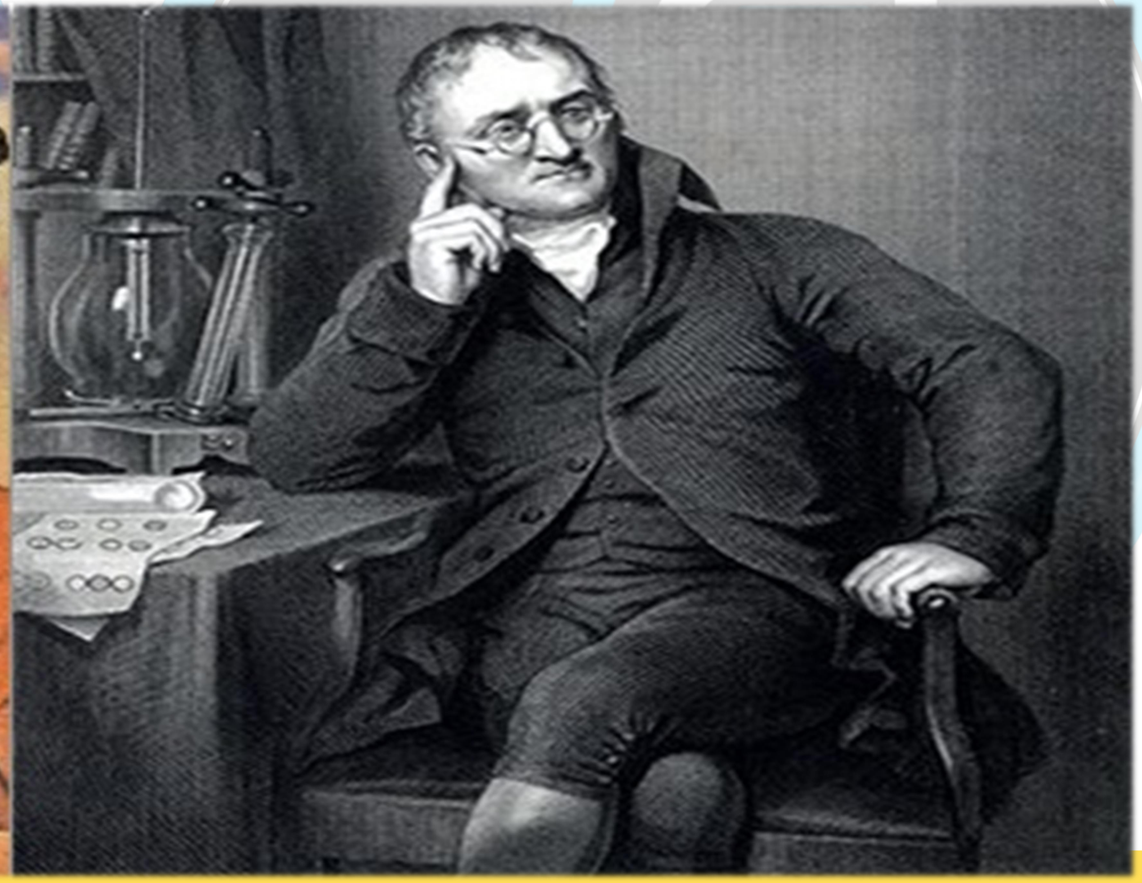
	FOREWORD	*iii*
	RATIONALISATION OF CONTENT IN THE TEXTBOOK	*v*
Chapter 1	MATTER IN OUR SURROUNDINGS	1
Chapter 2	IS MATTER AROUND US PURE?	14
Chapter 3	ATOMS AND MOLECULES	26
Chapter 4	STRUCTURE OF THE ATOM	38
Chapter 5	THE FUNDAMENTAL UNIT OF LIFE	49
Chapter 6	TISSUES	60
Chapter 7	MOTION	72
Chapter 8	FORCE AND LAWS OF MOTION	87
Chapter 9	GRAVITATION	100
Chapter 10	WORK AND ENERGY	113
Chapter 11	SOUND	127
Chapter 12	IMPROVEMENT IN FOOD RESOURCES	140
	ANSWERS	152– 154

भारत के महान् ऋषि कणाद (Kanad) के अनुसार,

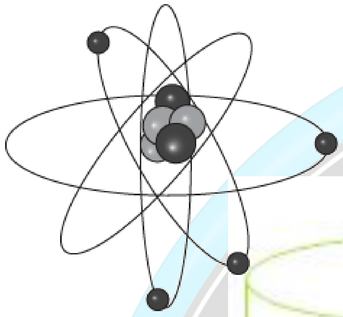
"सभी पदार्थ अत्यन्त सूक्ष्म कणों से बने होते हैं।“ इन्होंने इन कणों को परमाणु (Atom) बताया है।

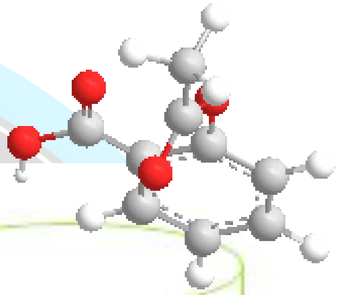
The material from which every object in the world is made is called MATTER.

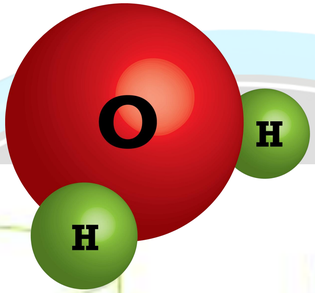


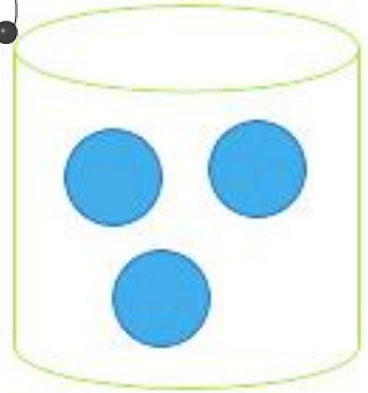


Atoms and Molecules (परमाणु और अणु)

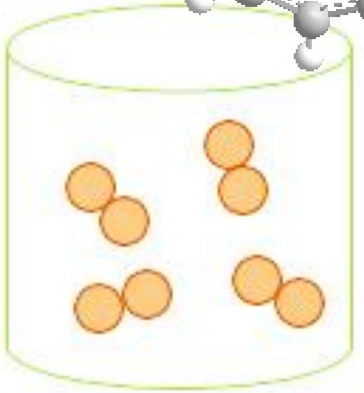




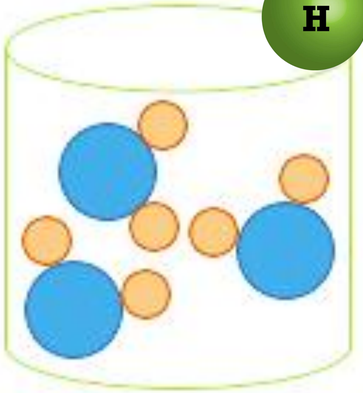




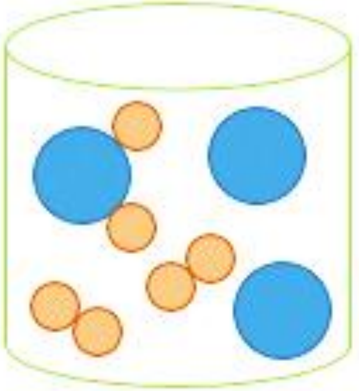
Atoms



Molecules

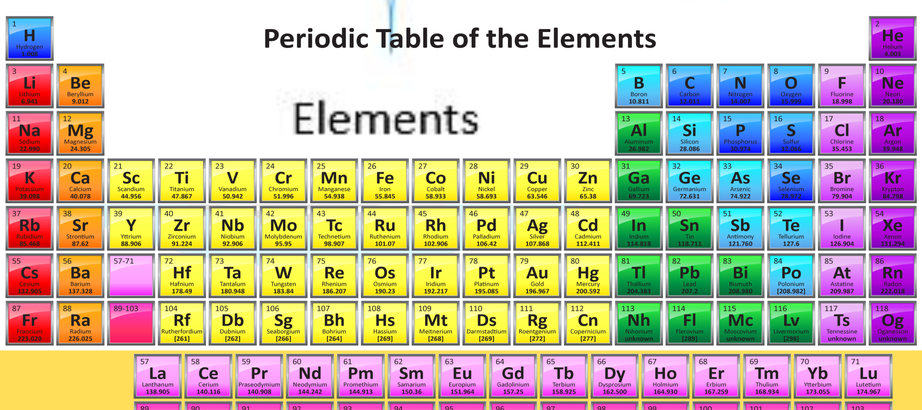


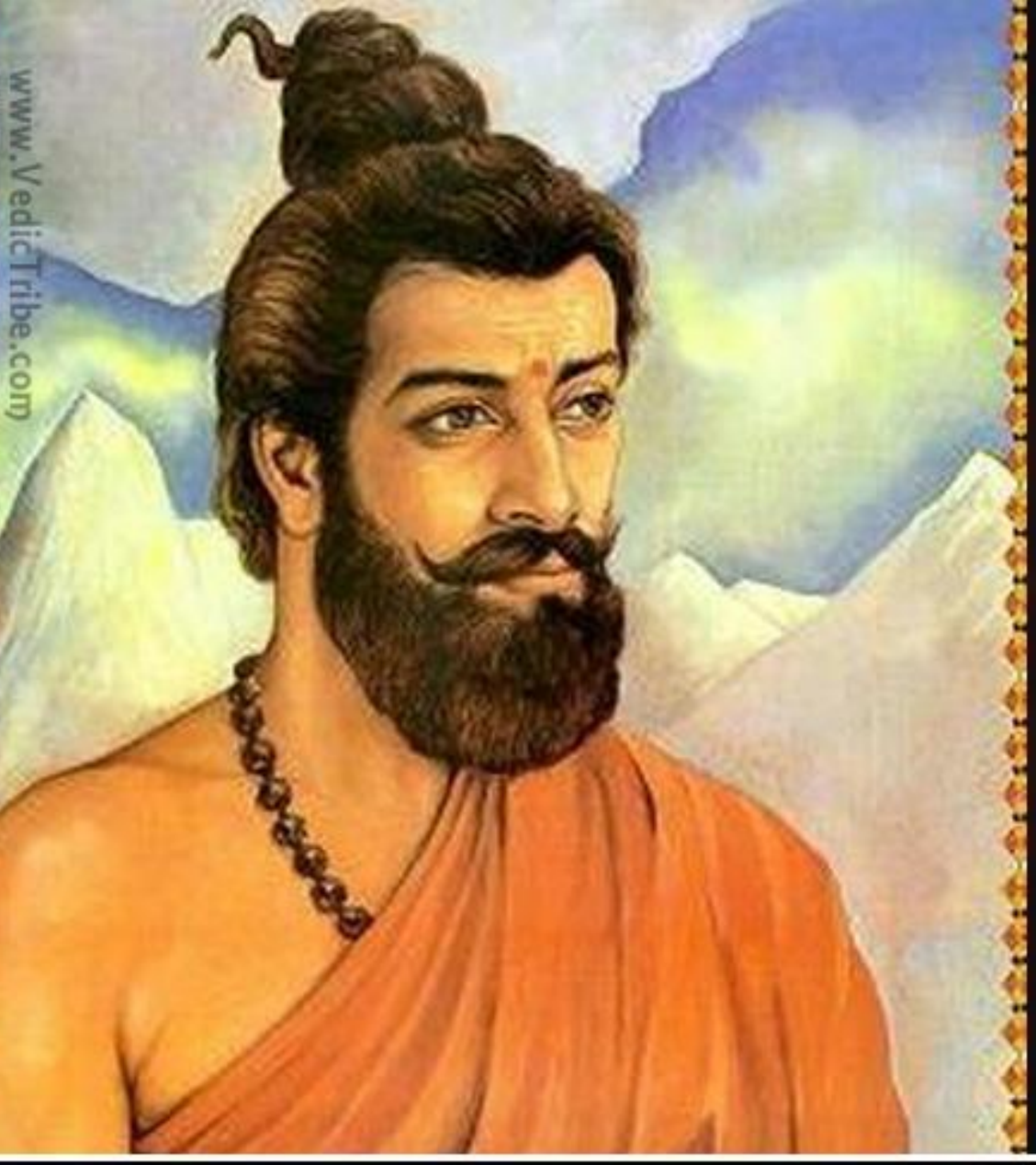
Compound

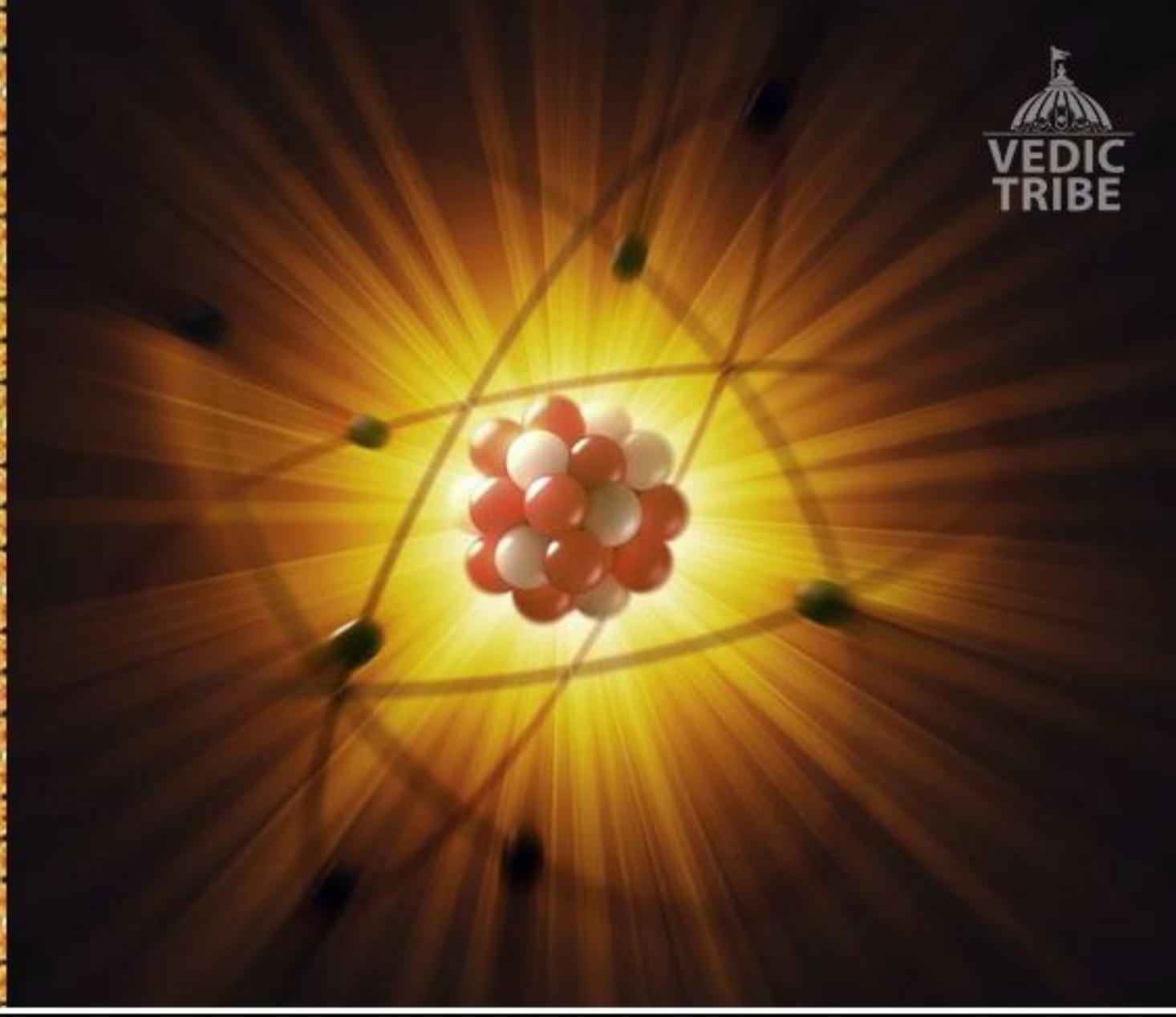


Mixture

Periodic Table of the Elements

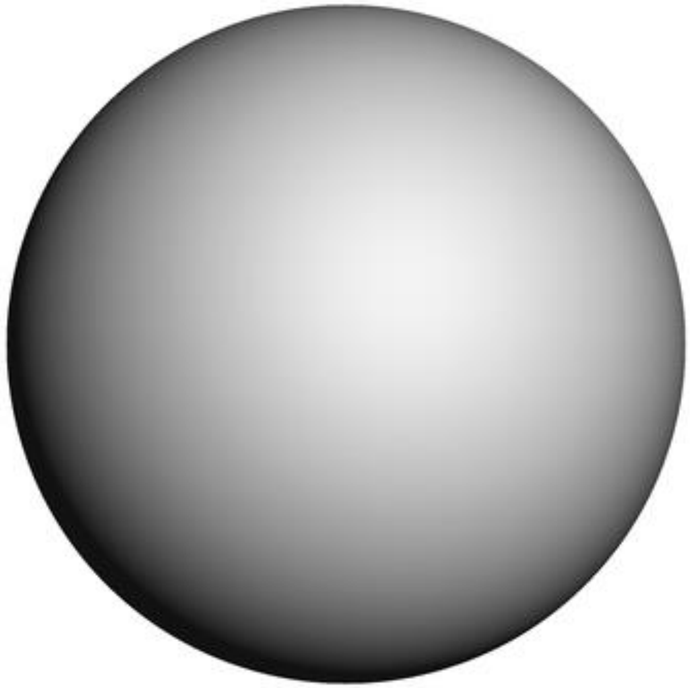




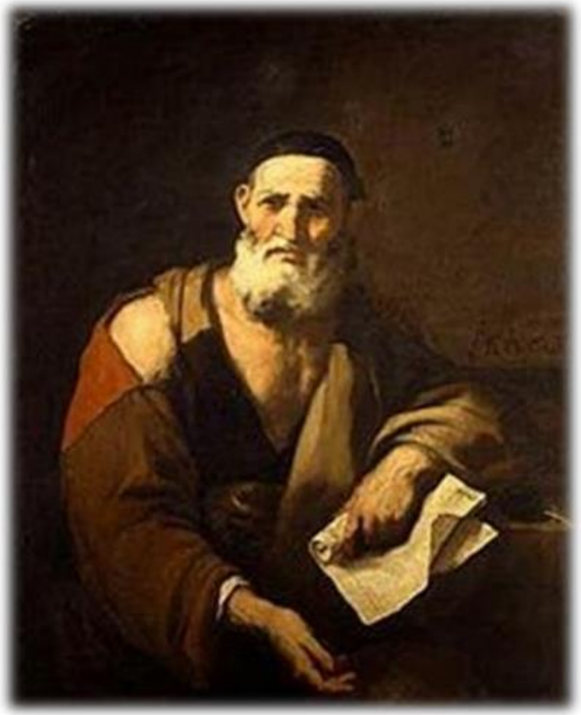


ACHARYA KANADA: THE FATHER OF ATOMIC THEORY

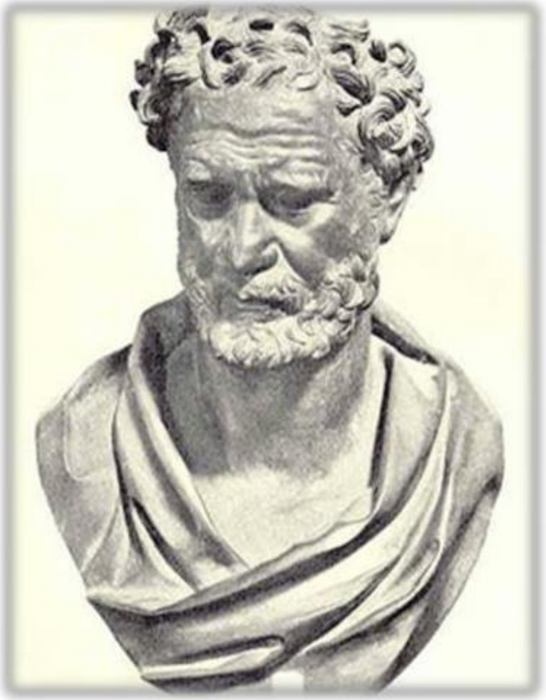
- ग्रीक के दार्शनिक **लूसिपस (475 ई.पू.) तथा डिमोक्राइट्स (460-370 ई.पू.)** ने भी यही कल्पना की थी कि परमाणु (Atoms) **द्रव्य का सूक्ष्मतम अविभाज्य कण है।** Greek philosophers **Leucippus (475 BC)** and **Democrites (460-370 BC)** had also imagined that atoms are the smallest indivisible particles of matter.



Leucippus

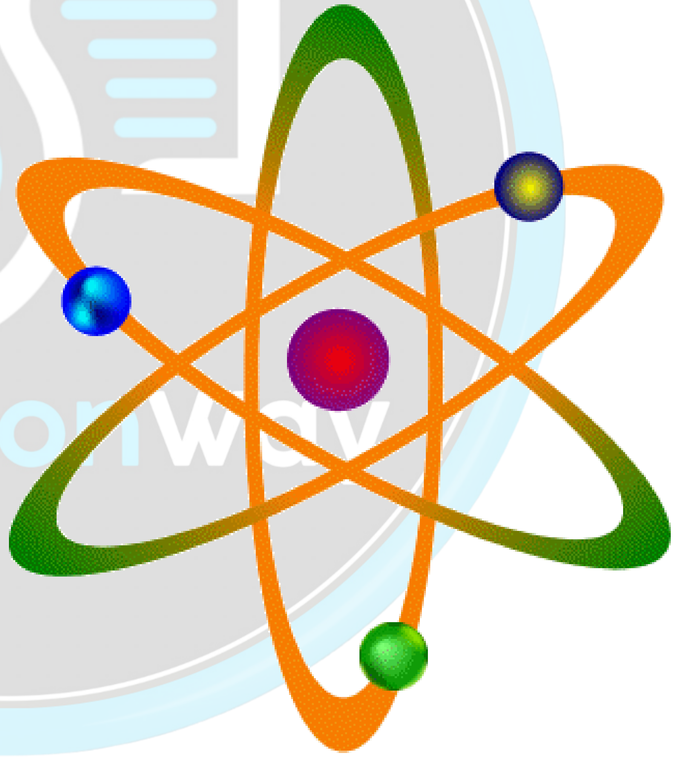


Democritus



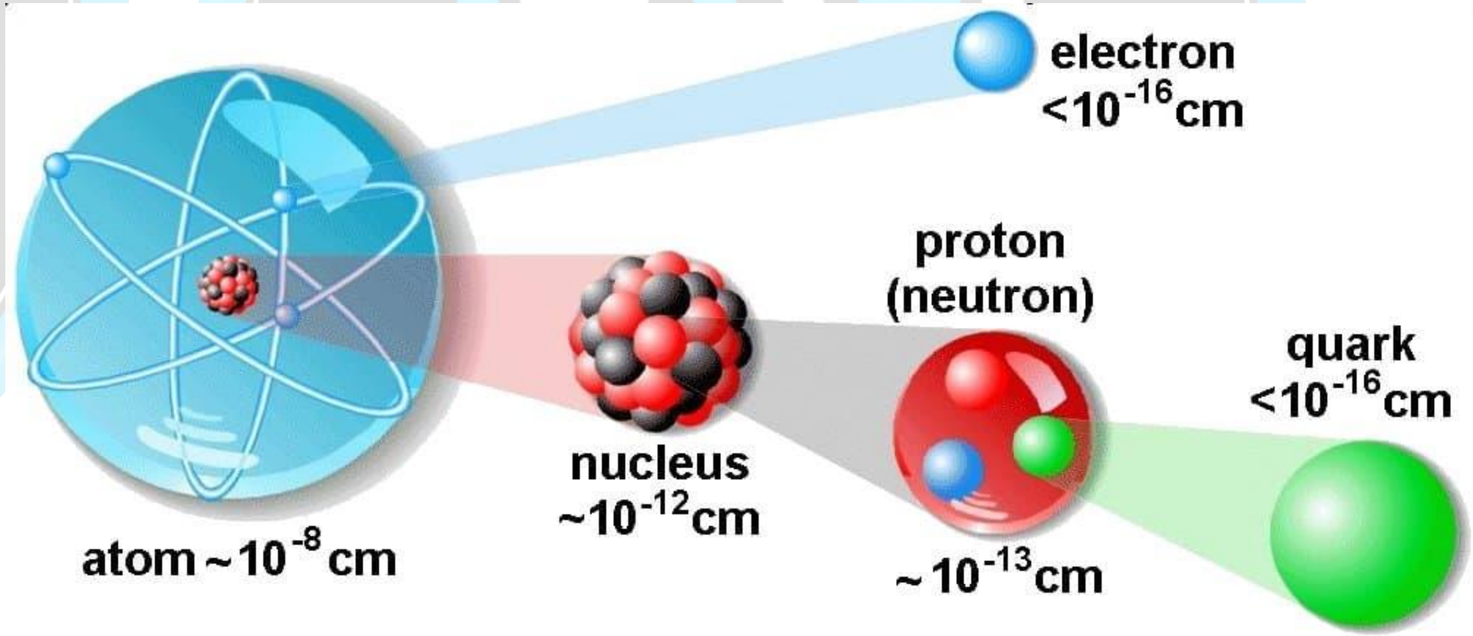
Atoms and Molecules (परमाणु और अणु)

- द्रव्य का सूक्ष्मतम तथा अविभाज्य कण, जो उस द्रव्य का सभी अभिलाक्षणिक गुण रखता है, परमाणु कहलाता है। The smallest and indivisible particle of a substance, which possesses all the characteristic properties of that substance, is called an atom.
- परमाणु को अंग्रेजी में एटम (Atom) कहा जाता है। एटम "Atom = a + tomos“
- इसमें "Tomos" एक ग्रीक शब्द है, जिसका अर्थ "काटना (to cut)" होता है।



परमाणु कितने बड़े होते हैं? (परमाणुओं का आकार)

- परमाणुओं का आकार इतना सूक्ष्म होता है कि उन्हें नंगी आँखों से नहीं देखा जा सकता है।
- The Size Of Atoms Is So Tiny That They Cannot Be Seen With The Naked Eye.
- परमाणु गोलाकार होता है।
- Atoms Are Generally Spherical In Shape.
- परमाणुओं की त्रिज्या नैनोमीटर में मापी जाती है।
- The Radius Of Atoms Is Measured In Nanometers.



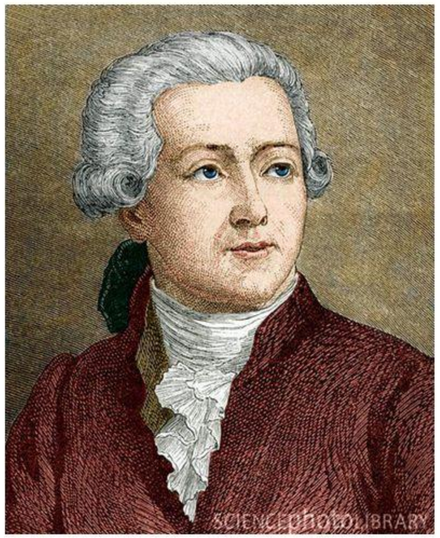
Atoms and Molecules (परमाणु और अणु)

Atoms and Molecules (परमाणु और अणु)

LAWS OF CHEMICAL COMBINATION

- Laws of Chemical Combination
- Laws of Constant proportion

LAW OF CONSERVATION OF MASS



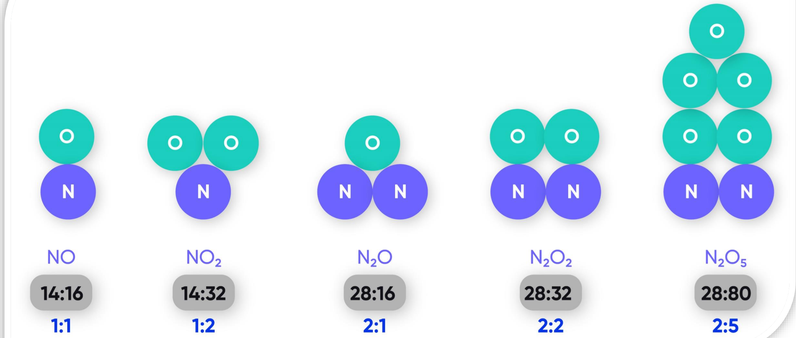
एंटोयन लेवोयजीयर

Antoine Lavoisier

जोसेफ प्रोउस्ट

joseph proust

LAW OF CONSTANT PROPORTION

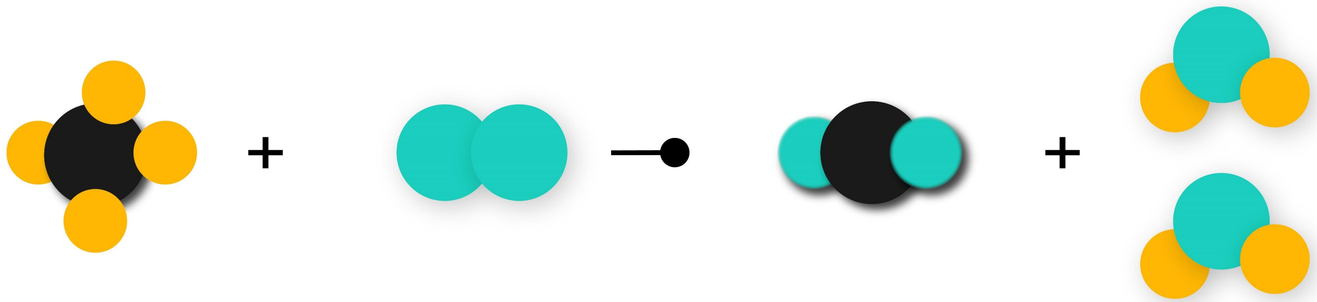


Law of Conservation of Mass द्रव्यमान संरक्षण का नियम

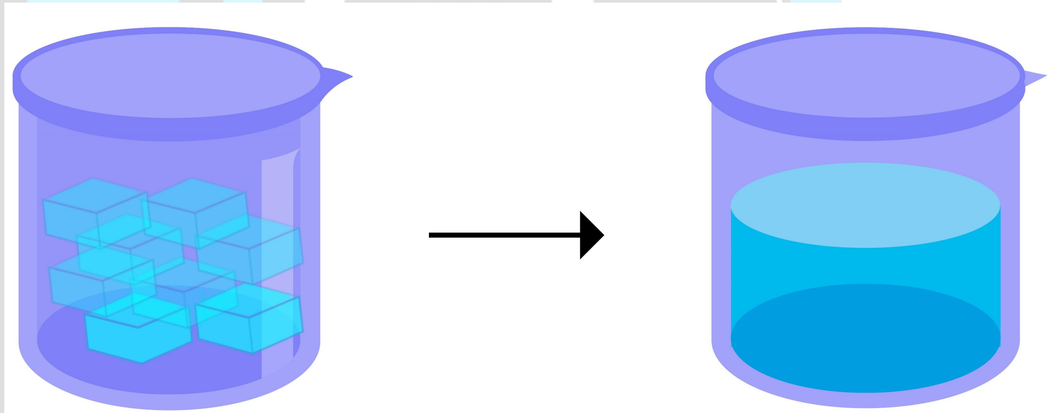
This law was put forth by Antoine Lavoisier in 1789.

Law of conservation of mass states that mass can neither be created nor destroyed in a chemical reaction.

द्रव्यमान संरक्षण का नियम कहता है कि रासायनिक प्रतिक्रिया में द्रव्यमान का न तो सृजन किया जा सकता है और न ही विनाश किया जा सकता है।



CH_4	$2O_2$	CO_2	$2H_2O$
Methane	Oxygen	Carbon dioxide	Water
16g	2*32g	44g	2*18g
	80g		80g



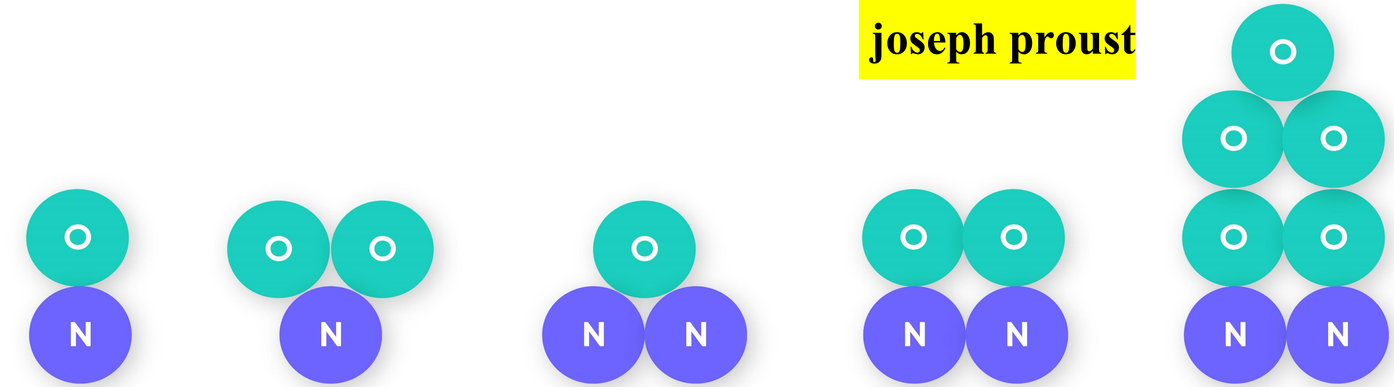
Law of Constant Proportion स्थिर अनुपात का नियम

जोसेफ प्रोउस्ट
joseph proust

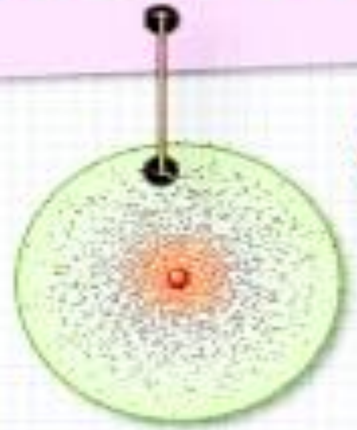
दो या दो से अधिक तत्व हमेशा द्रव्यमान के समान अनुपात में मौजूद होते हैं इससे कोई फर्क नहीं पड़ता कि यौगिक कहां से आया या इसे किसने तैयार किया।

Two or more elements are always present in the same proportions by mass no matter where the compound came from or who prepared it.

This led to the law of constant proportions which is also known as the law of definite proportions. This law was stated by Proust as "*In a chemical substance the elements are always present in definite proportions by mass*".



Timeline of Atomic Models



Chadwick, 1932

Bohr, 1913

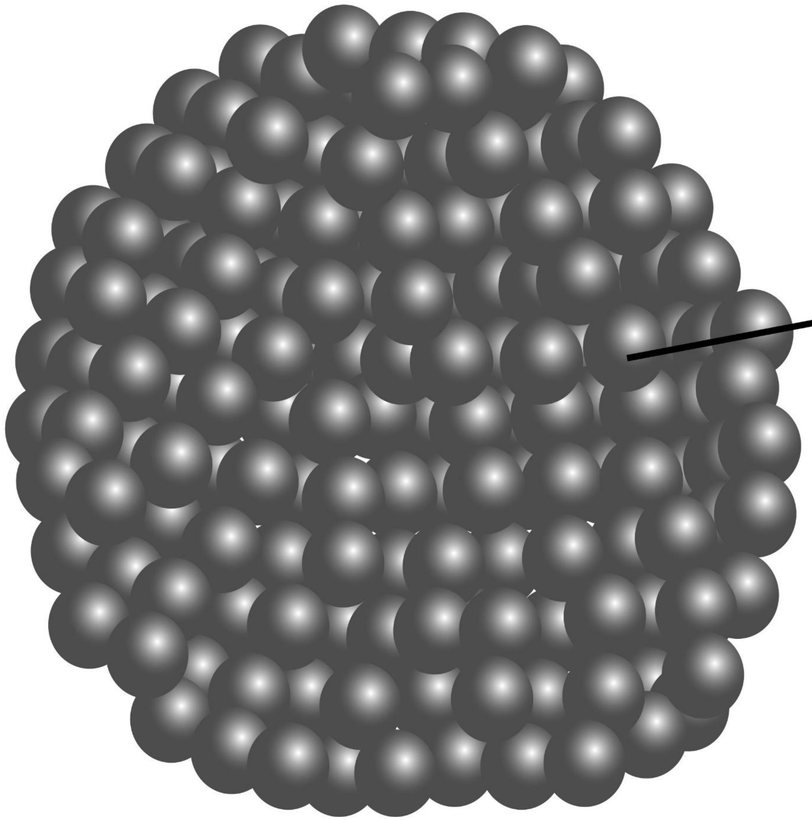
Schrodinger, 1926

Dalton, 1808

Thomson, 1897

Rutherford, 1911

Dalton's Atomic Theory डाल्टन का परमाणु सिद्धांत



John Dalton was born in a poor weaver's family in 1766 in England. He began his career as a teacher at the age of twelve. Seven years later he became a school principal. In 1793, Dalton left for Manchester to teach mathematics, physics and chemistry in a college. He spent most of his life there teaching and researching. In 1808, he presented his atomic theory which was a turning point in the study of matter.

John Dalton

4.6 DALTON'S ATOMIC THEORY

Although the origin of the idea that matter is composed of small indivisible particles called *'a-tomio'* (meaning, *indivisible*), dates back to the time of Democritus, a Greek Philosopher (460–370 BC), it again started emerging as a result of several experimental studies which led to the laws mentioned above.

John Dalton
(1776–1884)

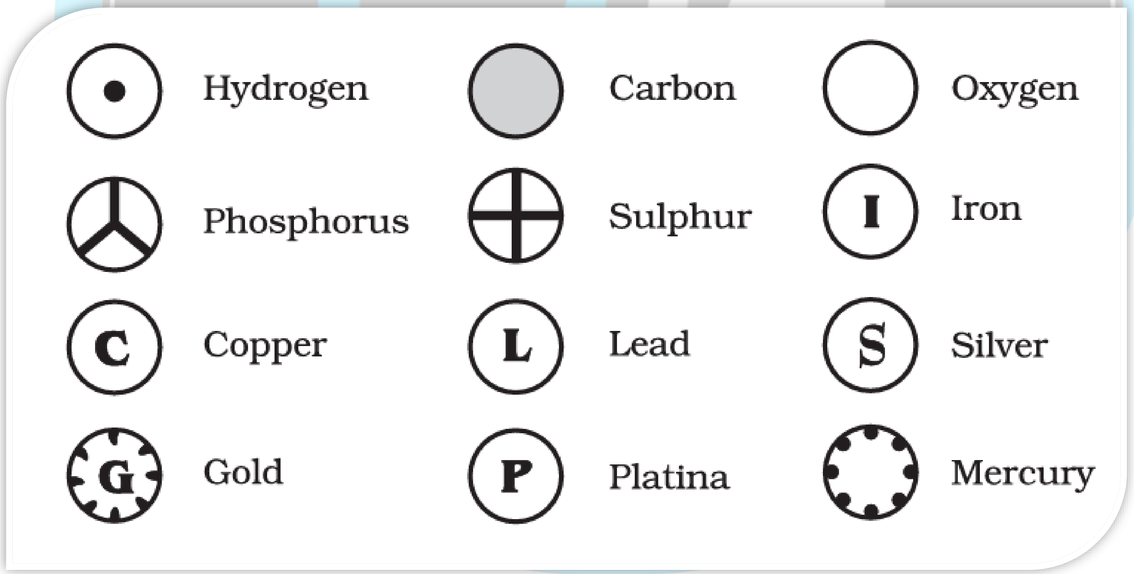
In 1808, Dalton published 'A New System of Chemical Philosophy', in which he proposed the following :

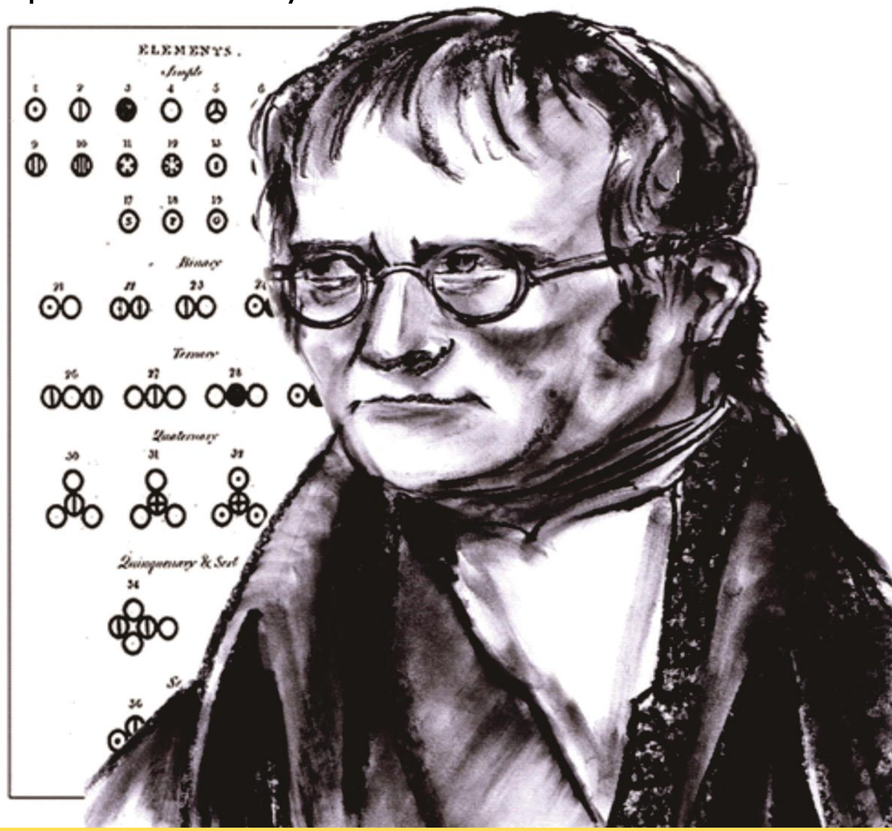
1. Matter consists of indivisible atoms.
2. All atoms of a given element have identical properties, including identical mass. Atoms of different elements differ in mass.
3. Compounds are formed when atoms of different elements combine in a fixed ratio.
4. Chemical reactions involve reorganisation of atoms. These are neither created nor destroyed in a chemical reaction.

1. डाल्टन का परमाणु सिद्धान्त (Dalton's Atomic Theory)

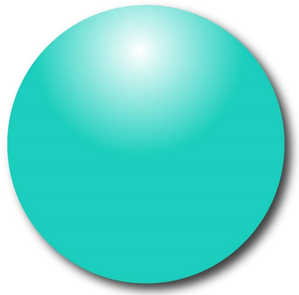
- द्रव्य की संरचना का गहन अध्ययन करने के पश्चात् सर्वप्रथम(इंग्लैण्ड) के वैज्ञानिक **जॉन डाल्टन (John Dalton) ने 1804 ई.** में द्रव्य की संरचना तथा परमाणु सम्बन्धी एक सुव्यवस्थित विचार प्रस्तुत किया जिसे **डॉल्टन का परमाणुवाद (Dalton's atomic theory)** कहते हैं।

- After deeply studying the structure of matter, the first (England) scientist John Dalton presented a systematic idea related to the structure of matter and atoms in 1804 AD, which is called Dalton's atomic theory.

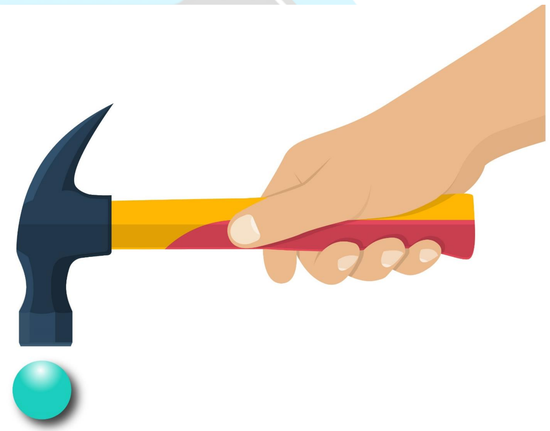




Atoms and Molecules (परमाणु और अणु)



Indivisible Atom
(Hard Sphere)



Atoms cannot be **destroy** or **created**

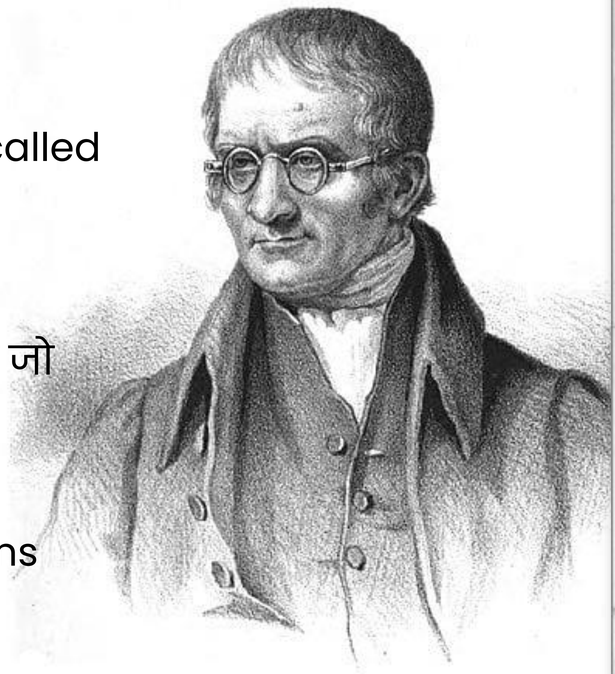
डाल्टन का परमाणु सिद्धान्त (Dalton's Atomic Theory)

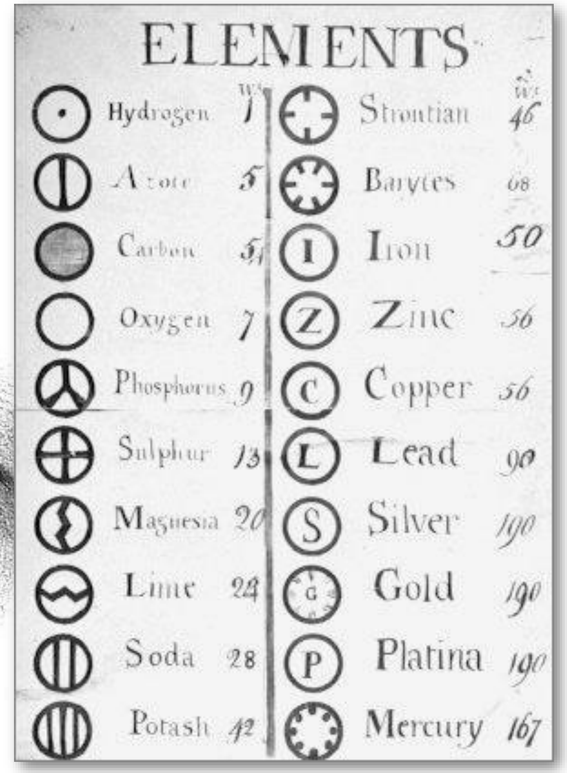
(1) पदार्थ या तत्त्व अनेक सूक्ष्म कणों से बना है जिन्हें **परमाणु (atoms)** कहते हैं।

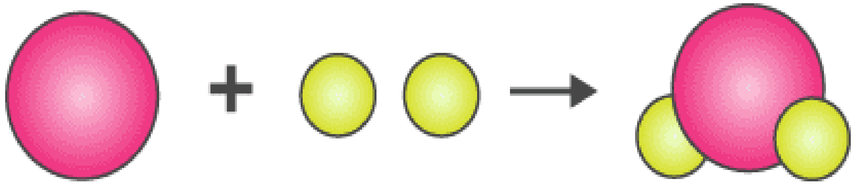
Matter or elements are made up of many microscopic particles called atoms.

(2) परमाणु तत्त्व का **सूक्ष्मतम कण** है जिसे **विभाजित नहीं किया** जा सकता है तथा जो **रासायनिक क्रिया के दौरान अपरिवर्तित रहता है।** An atom is the smallest particle of an element which cannot be divided and which remains unchanged during chemical reactions.

(3) किसी तत्त्व के सभी परमाणु, भार, आकार व अन्य गुणों में समान होते हैं। परन्तु अलग-अलग तत्त्वों के परमाणुओं के भार व गुणों में भिन्नता होती है।All atoms of an element are similar in weight, size and other properties. But there is variation in the weight and properties of atoms of different elements.



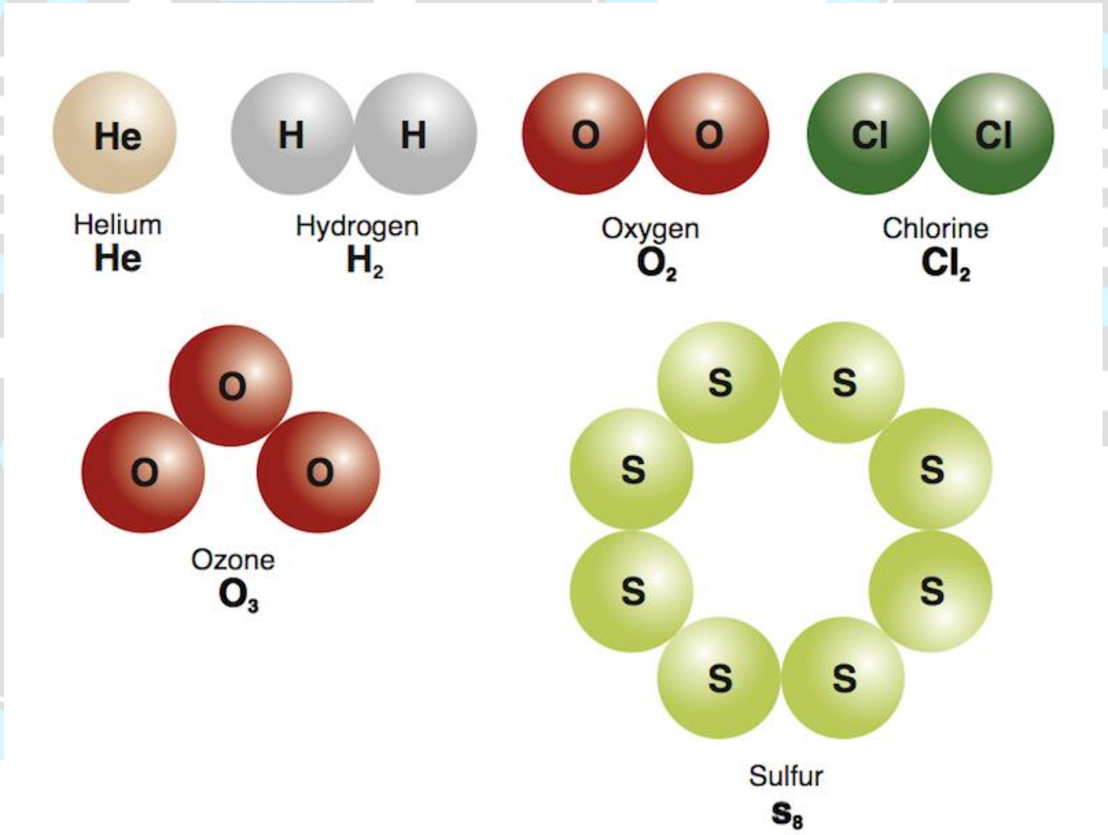


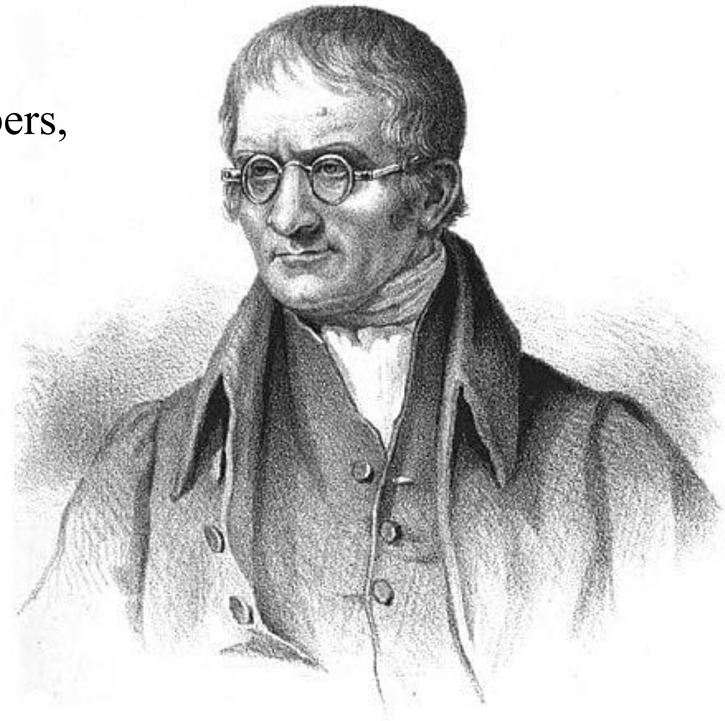


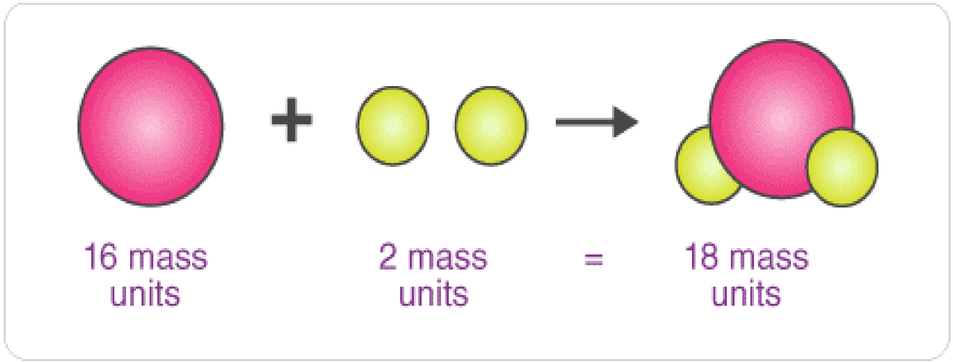
डाल्टन का परमाणु सिद्धान्त (Dalton's Atomic Theory)

(IV) दो या **दो से अधिक तत्त्वों के परमाणु पूर्ण संख्या में**, Atoms of two or more elements in whole numbers,

निश्चित सरल अनुपात (1:1, 1:2, 2:3 आदि) में संयुक्त होते हैं तथा यौगिक-परमाणु (compound atom) बनाते हैं।

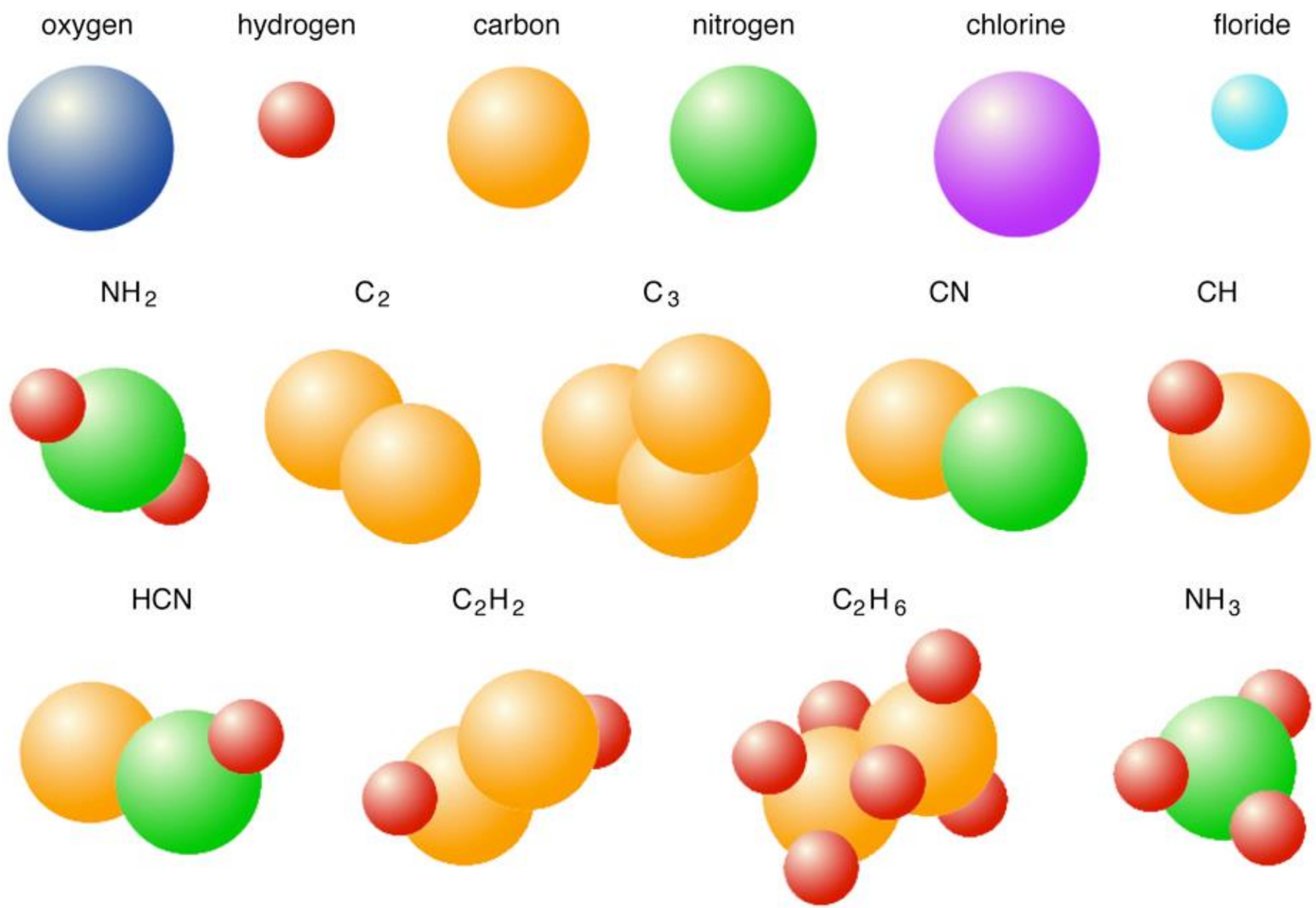






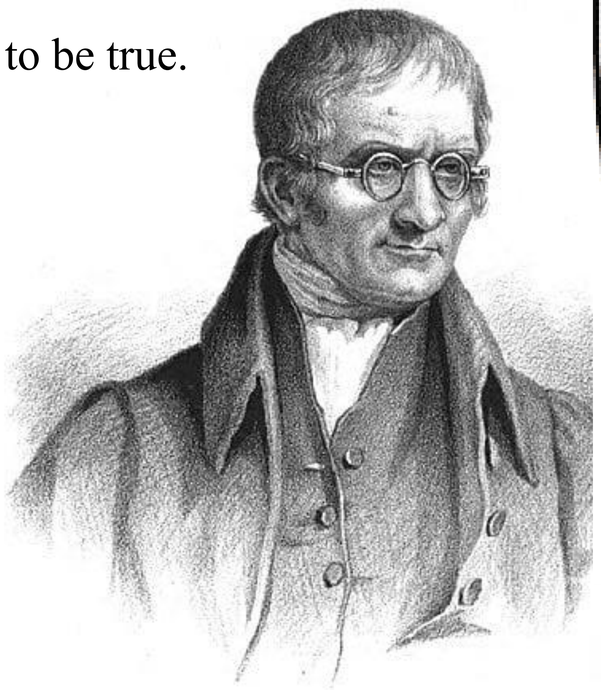
डाल्टन का परमाणु सिद्धान्त (Dalton's Atomic Theory)

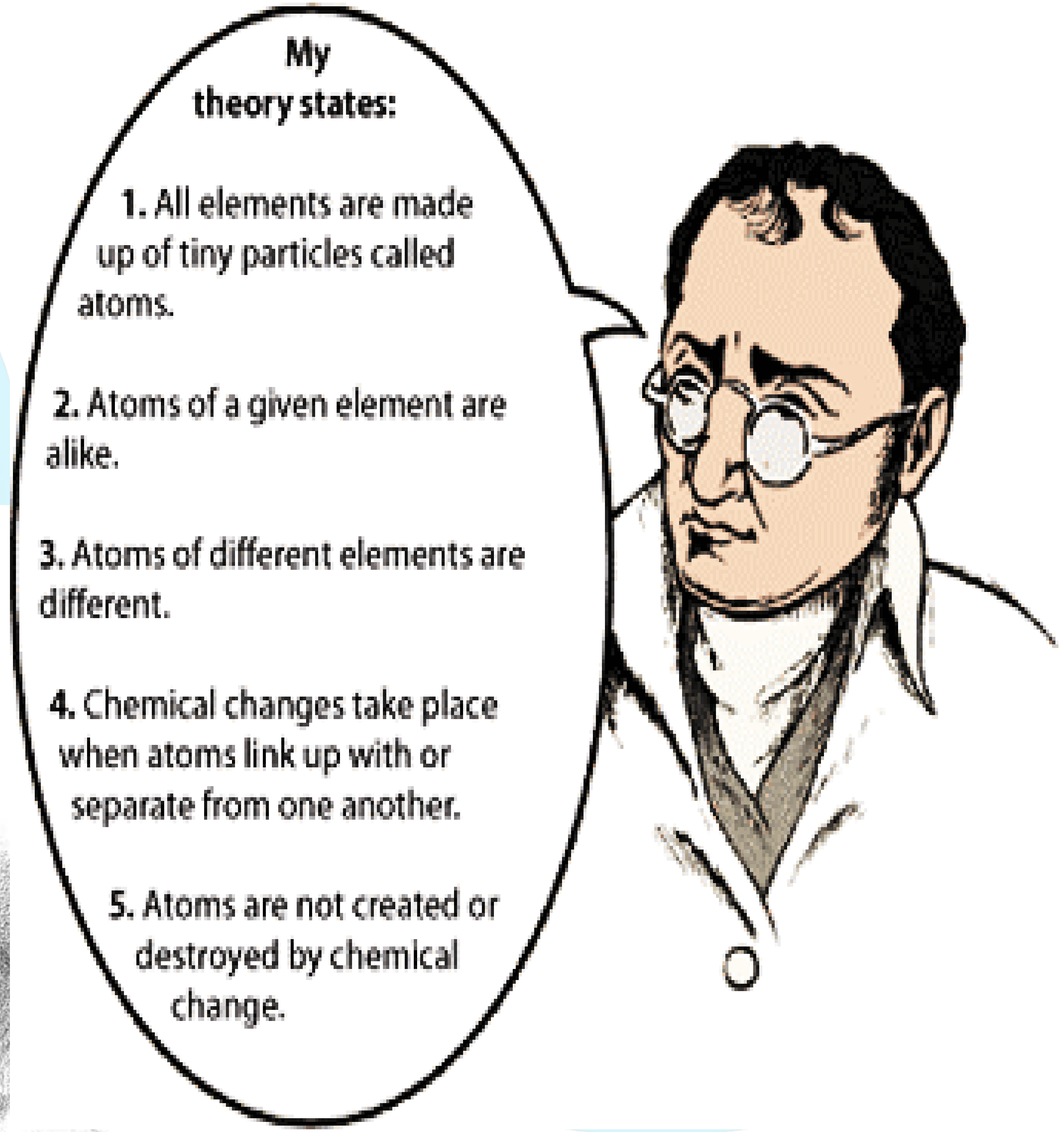
(V) एक ही यौगिक के सभी यौगिक-परमाणु भी समान होते हैं।All the compound atoms of the same compound are also the same. इन्हीं यौगिक परमाणुओं को बाद में आवागाद्रो ने अणु (molecule) कहा। These compound atoms were later called molecules by **Avagadro.**

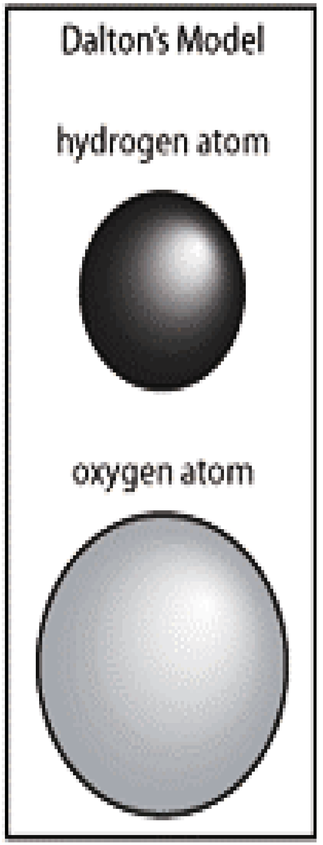


डाल्टन का परमाणु सिद्धान्त (Dalton's Atomic Theory)

(VI) परमाणु अविनाशी है अर्थात् इसे न तो बनाया जा सकता है और न ही नष्ट किया जा सकता है। अर्थात् डाल्टन ने द्रव्य की अविनाशिता का नियम सत्य माना। Atom is indestructible i.e. it can neither be created nor destroyed. That is, Dalton considered the law of indestructibility of matter to be true.

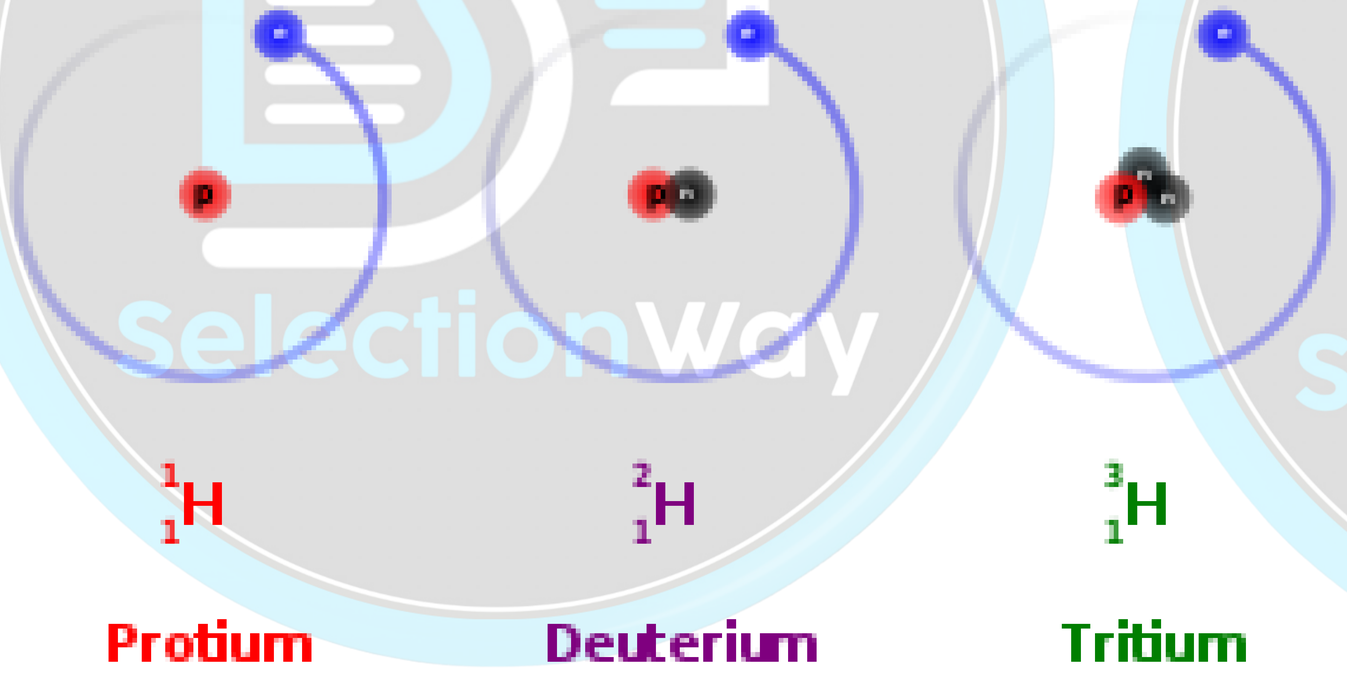






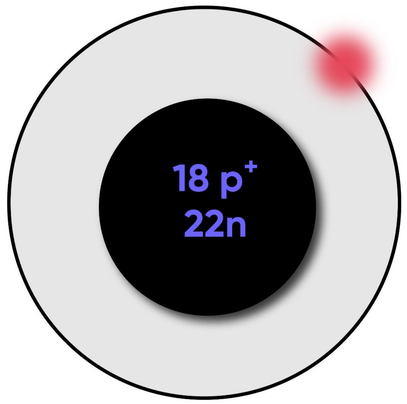
डाल्टन का परमाणुवाद नियम : दोष - Dalton's law of atomism: flaws

- एक ही तत्व के परमाणुओं का द्रव्यमान भिन्न-भिन्न क्यों होता है? Why do atoms of the same element have different masses?
- उदाहरण- समस्थानिक / isotope

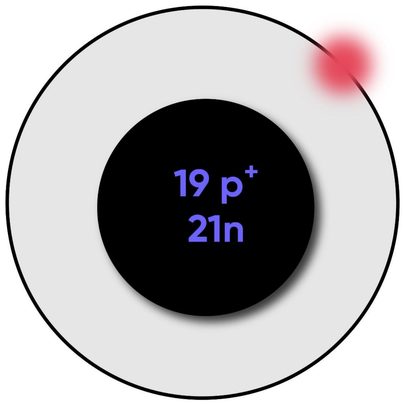


डाल्टन का परमाणुवाद नियम : दोष - Dalton's law of atomism: flaws

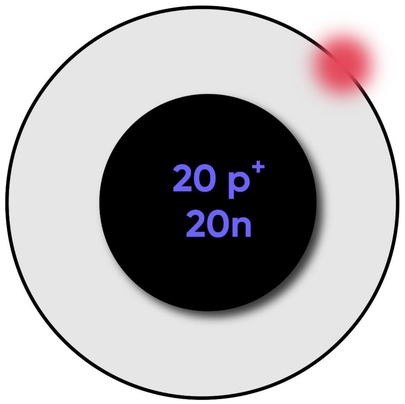
- एक ही तत्वों के परमाणु आपस में संयोग क्यों करते है? Why do atoms of the same elements combine with each other?



$^{40}_{18}Ar$



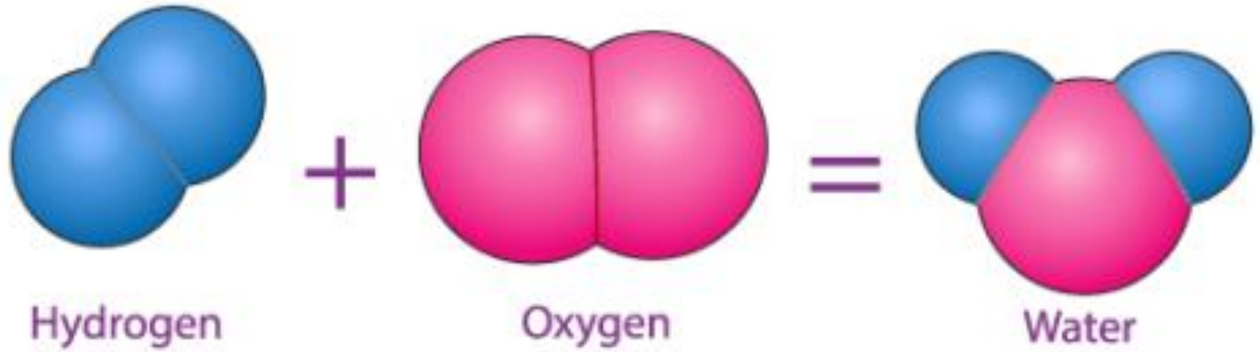
$^{40}_{19}Ar$



$^{40}_{20}Ar$

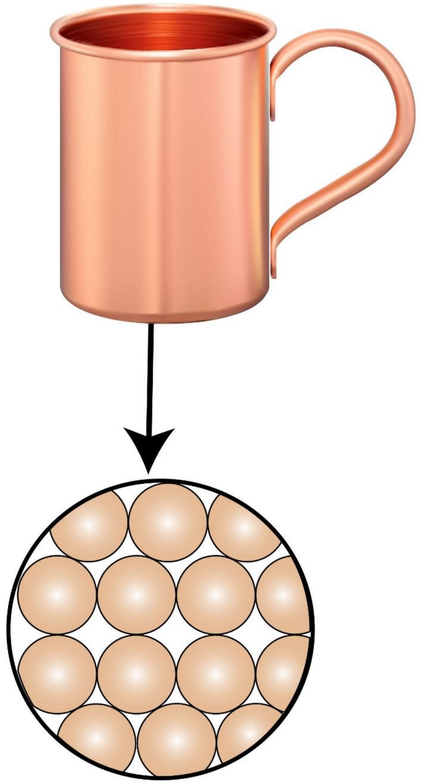
How Do Atoms Exist? परमाणु कैसे अस्तित्व में रहते हैं?

- Atoms Normally Do Not Exist Independently परमाणु सामान्यतः स्वतंत्र रूप से अस्तित्व में नहीं रहते
- They Normally Exist In The Form Of Molecules. वे सामान्यतः अणु के रूप में मौजूद रहते हैं।
- Molecules Are Groups Of Two Or More Atoms Held Together. अणु दो या दो से अधिक परमाणुओं के समूह होते हैं जो एक साथ जुड़े होते हैं।
- Molecules Of Atoms Of The Same Type Are Called Elements.. एक ही प्रकार के परमाणुओं के अणुओं को तत्व कहा जाता है।

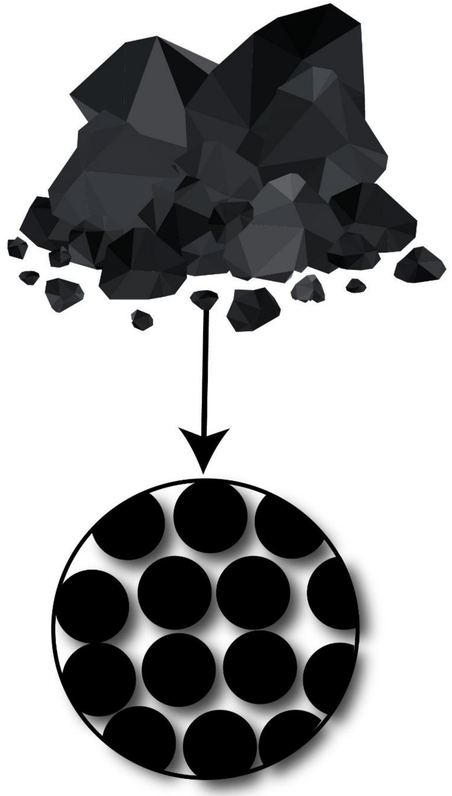


$$2H_2 + O_2 = 2H_2O$$

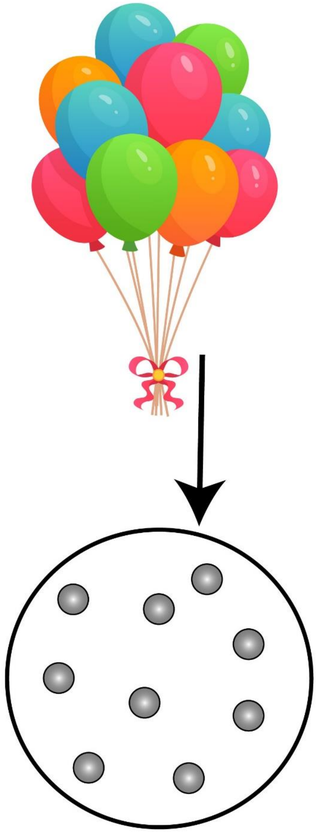
Atoms and Molecules (परमाणु और अणु)



Copper is an element made up of **copper atoms** only



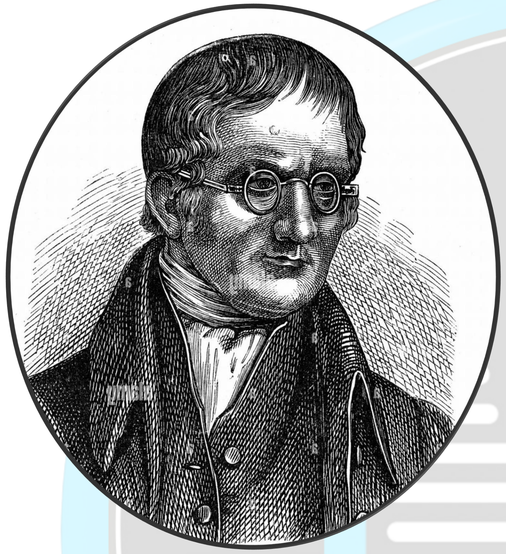
Carbon is an element made up of **carbon atoms** only



Helium is an element made up of **helium atoms** only

Ancient And Modern Day Symbols Of Atoms Of Different Elements?

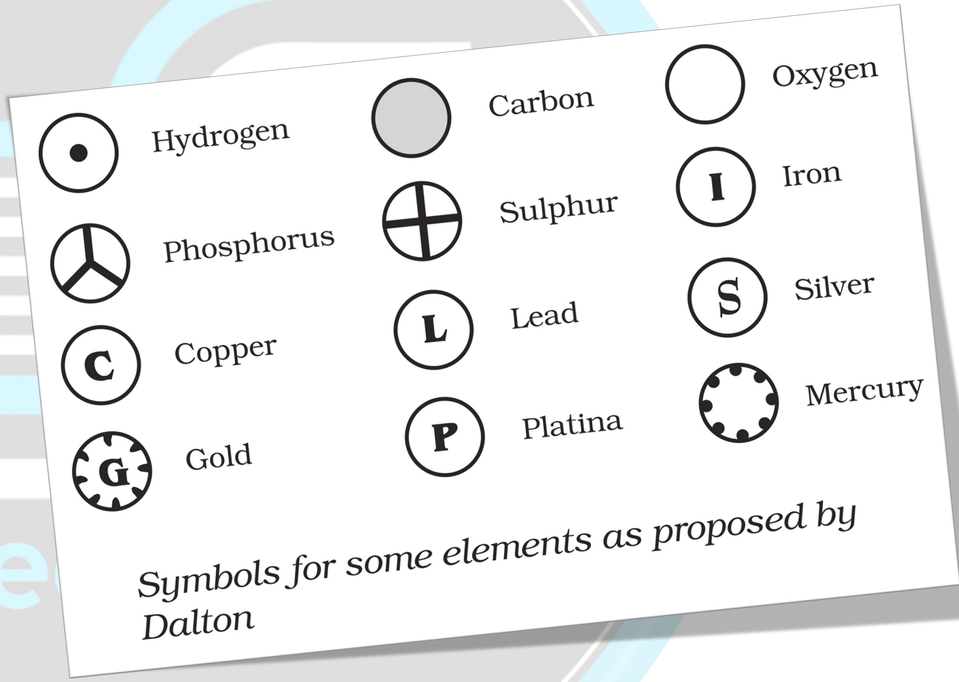
विभिन्न तत्वों के परमाणुओं के प्राचीन और आधुनिक प्रतीक?



John Dalton was the first scientist to use symbols for elements, where each symbol represented a definite quantity, specifically one atom of the element. **जॉन डाल्टन पहले वैज्ञानिक** थे जिन्होंने **तत्वों के लिए प्रतीकों का** प्रयोग किया, जहां प्रत्येक प्रतीक एक निश्चित मात्रा, विशेष रूप से तत्व के एक परमाणु को दर्शाता था।

Berzilius suggested that element symbols be derived from one or two letters of the element's name.

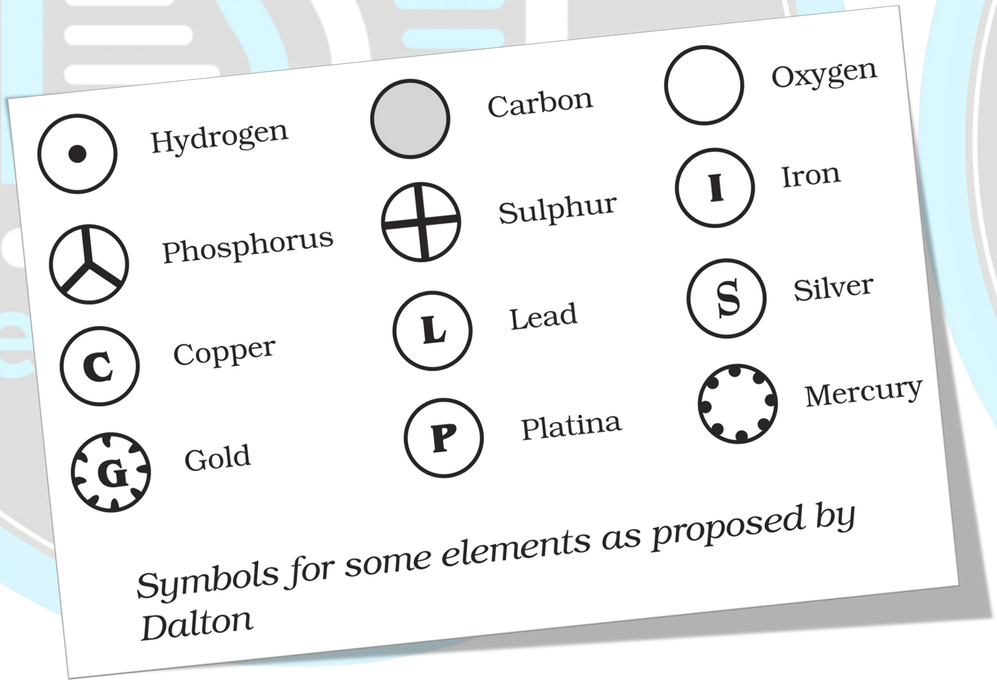
बर्ज़ीलियस ने सुझाव दिया कि तत्व प्रतीकों को तत्व के नाम के एक या दो अक्षरों से व्युत्पन्न किया जाना चाहिए।



Symbols for some elements as proposed by Dalton

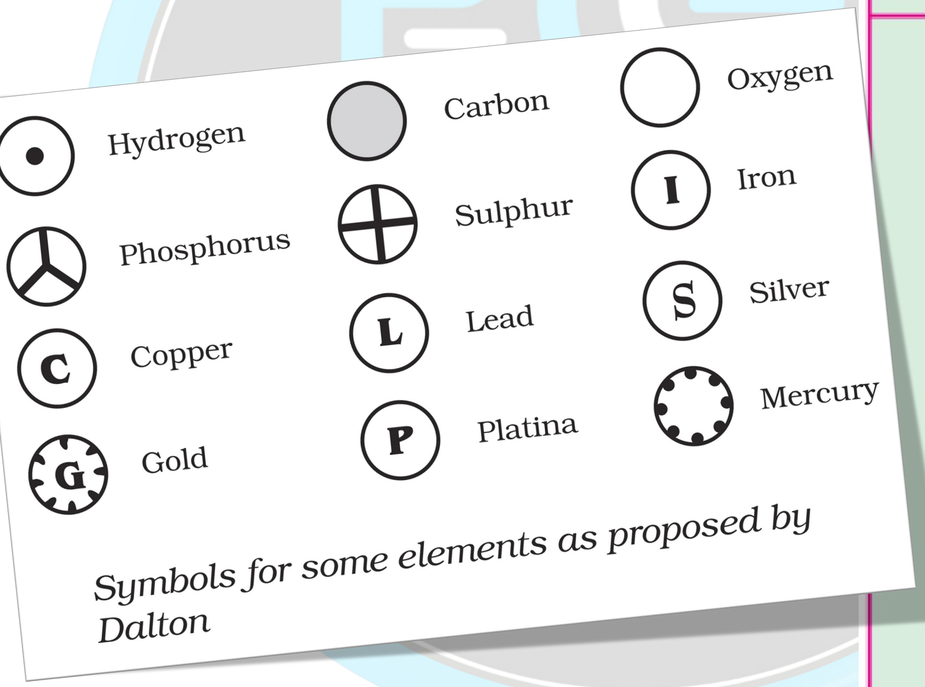
Origin of Element Names: Element Names are often derived from the place of discovery (e.g., copper from Cyprus). Some names reflected specific colors (e.g., gold from the English word for yellow).

तत्वों के नाम अक्सर खोज के स्थान से लिए जाते हैं (जैसे, साइप्रस से तांबा)। कुछ नाम विशिष्ट रंगों को दर्शाते हैं (जैसे, पीले रंग के लिए अंग्रेजी शब्द से सोना)।



Modern Symbols

- **The International Union of Pure and Applied Chemistry (IUPAC)** शुद्ध एवं अनुप्रयुक्त रसायन विज्ञान का अंतर्राष्ट्रीय संघ (आईयूपीएसी)



Symbols for some elements as proposed by Dalton

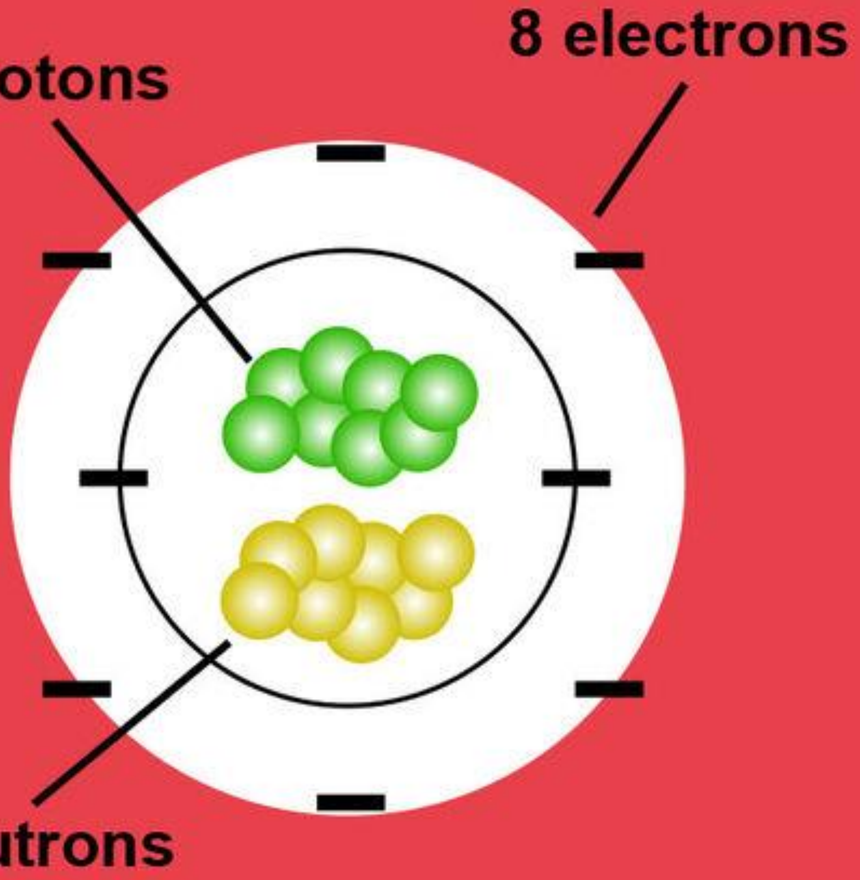
Symbols Derived from English Names of the Elements

English name of the element	*Symbol*	*English name of the element*	*Symbol*
1. Hydrogen	H	14. Sulphur	S
2. Helium	He	15. Chlorine	Cl
3. Lithium	Li	16. Argon	Ar
4. Boron	B	17. Calcium	Ca
5. Carbon	C	18. Manganese	Mn
6. Nitrogen	N	19. Nickel	Ni
7. Oxygen	O	20. Zinc	Zn
8. Fluorine	F	21. Bromine	Br
9. Neon	Ne	22. Krypton	Kr
10. Magnesium	Mg	23. Iodine	I
11. Aluminium	Al	24. Barium	Ba
12. Silicon	Si	25. Cobalt	Co
13. Phosphorus	P	26. Uranium	U

Symbols Derived from Latin Names of the Elements

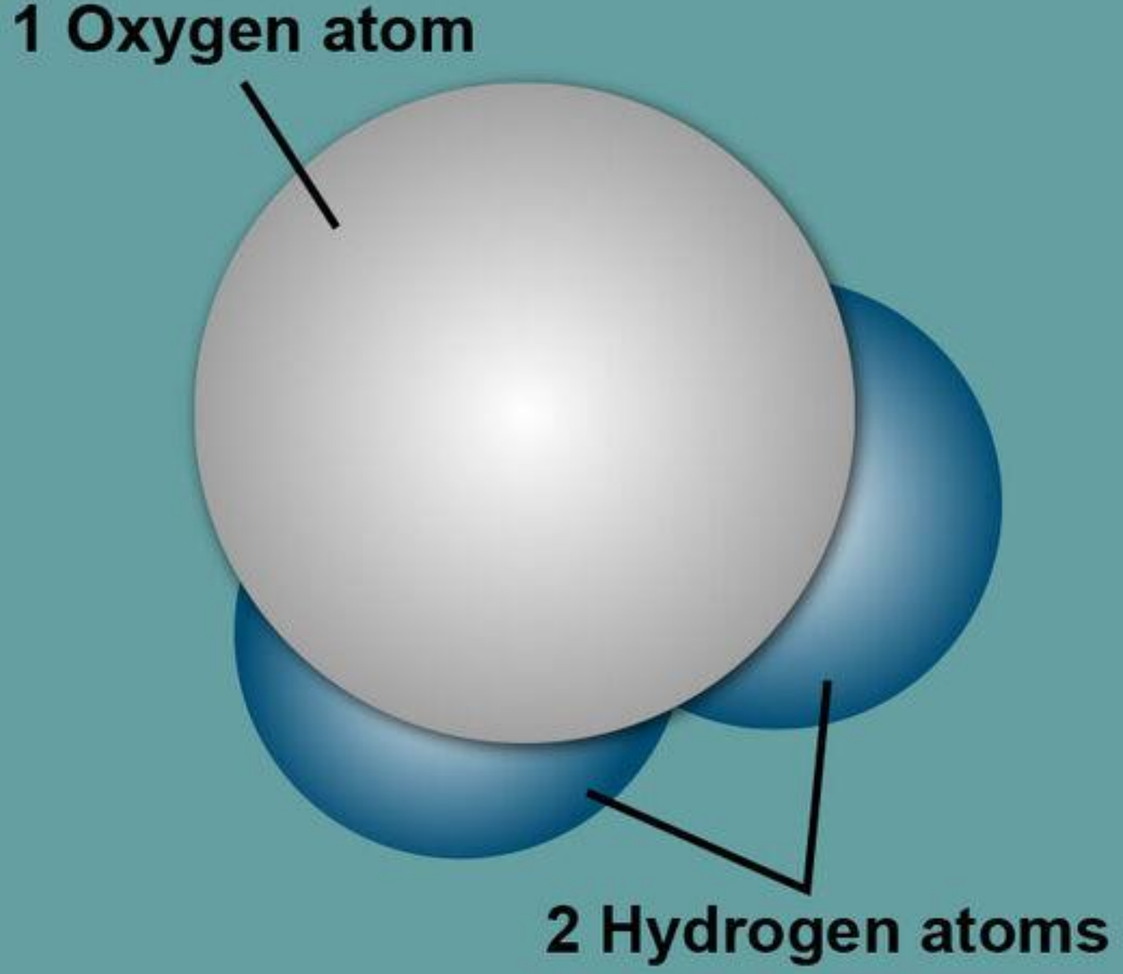
English name of the element	*Symbol*	*Latin name of the element*
1. Sodium	Na	Natrium
2. Potassium	K	Kalium
3. Iron	Fe	Ferrum
4. Copper	Cu	Cuprum
5. Silver	Ag	Argentum
6. Gold	Au	Aurum
7. Mercury	Hg	Hydragyrum
8. Lead	Pb	Plumbum
9. Tin	Sn	Stannum

ATOM



OXYGEN

MOLECULE



WATER - H_2O

Atoms and Molecules (परमाणु और अणु)

Classification of Matter (पदार्थ का वर्गीकरण)

Physical Matter (भौतिक पदार्थ)

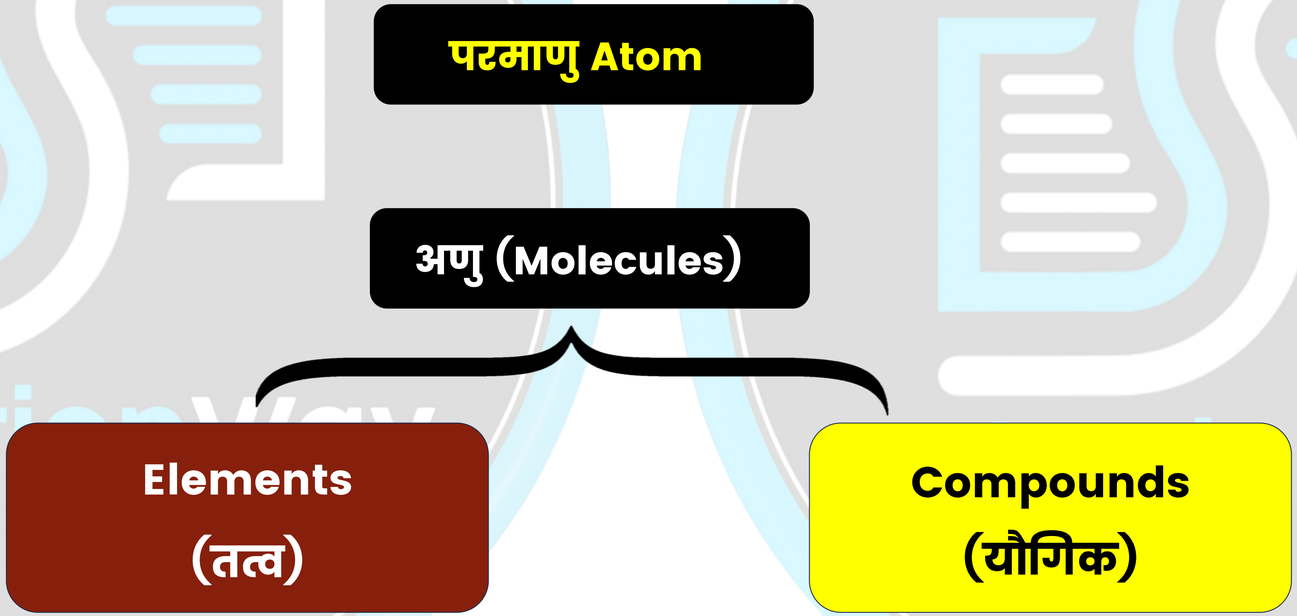
1. Solid (ठोस)
2. Liquid (द्रव)
3. Gas (गैस / वायु)
4. Plasma (प्लाज़्मा)
5. Bose–Einstein Condensate (बोस–आइंस्टीन संघनन)

Chemical Matter (रासायनिक वर्गीकरण)

- **Pure Substance (शुद्ध पदार्थ)**
  - **Elements (तत्व)**
    - Metallic (धात्विक)
    - Non-Metallic (अधात्विक)
  - **Compounds (यौगिक)**
    - Organic (कार्बनिक)
    - Inorganic (अकार्बनिक)
- **Mixtures (मिश्रण)**
  - Homogeneous Mixture (सांगर्मी मिश्रण)
  - Heterogeneous Mixture (असांगर्मी मिश्रण)

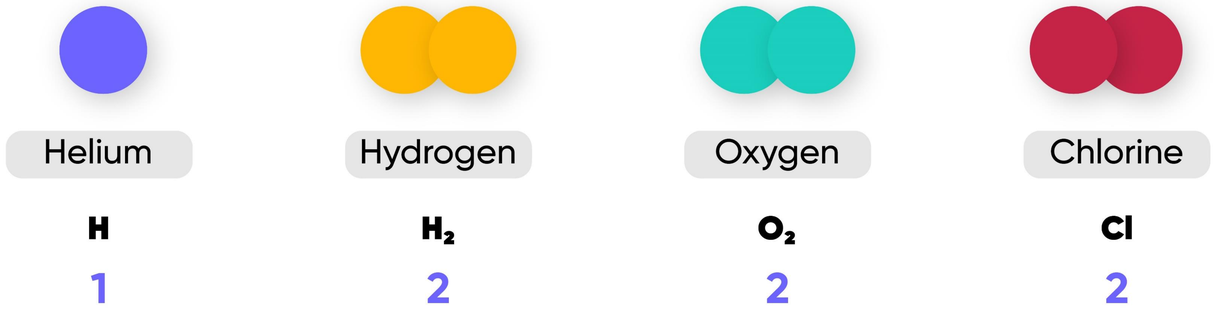
Atoms and Molecules (परमाणु और अणु)

किसी पदार्थ (तत्त्व अथवा यौगिक) का वह सूक्ष्मतम कण जो स्वतन्त्र अवस्था में रह सकता है, अणु कहलाता है। यह दो अथवा अधिक परमाणुओं के रासायनिक संयोग से बनता है। The smallest particle of a substance (element or compound) that can exist in a free state is called a molecule. It is formed by the chemical combination of two or more atoms.



Atoms and Molecules (परमाणु और अणु)

	Atoms परमाणुओं	Molecules अणुओं
1	**Atoms are the smallest particles** of an element that can participate in a chemical reaction. परमाणु किसी तत्व के सबसे छोटे कण होते हैं जो रासायनिक प्रतिक्रिया में भाग ले सकते हैं।	**Molecules are the smallest** parts of an element or compound, which exist independently. अणु किसी तत्व या यौगिक के सबसे छोटे भाग होते हैं, जो स्वतंत्र रूप से मौजूद होते हैं
2	**They do not break** up during chemical reactions. वे रासायनिक प्रतिक्रियाओं के दौरान विघटित नहीं होते।	**They break up during** chemical reactions. वे रासायनिक प्रतिक्रियाओं के दौरान टूट जाते हैं
3	They may not exist in a free state. वे स्वतंत्र अवस्था में नहीं सकते हैं	They exist in free forms. वे स्वतंत्र रूप में मौजूद हैं।



3.3.1 Molecules of Elements

The molecules of an element are constituted by the same type of atoms. Molecules of many elements, such as argon (Ar), helium (He) etc. are made up of only one atom of that element. But this is not the case with most of the non-metals. For example, a molecule of oxygen consists of two atoms of oxygen and hence it is known as a diatomic molecule, O_2. If 3 atoms of oxygen unite into a molecule, instead of the usual 2, we get ozone, O_3. The number of atoms constituting a molecule is known as its atomicity.

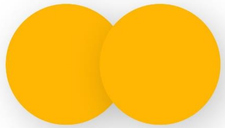
Metals and some other elements, such as carbon, do not have a simple structure but consist of a very large and indefinite number of atoms bonded together.

MOLECULES OF SINGLE ELEMENT AND THEIR ATOMICITY

Helium

H

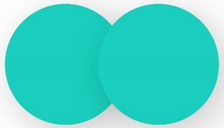
1



Hydrogen

H_2

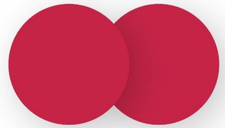
2



Oxygen

O_2

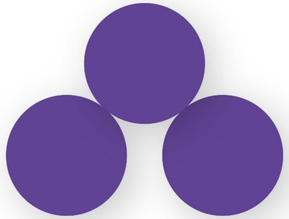
2



Chlorine

Cl

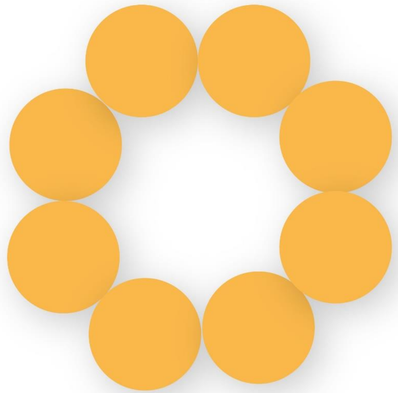
2



Sulfur

S_8

8



Ozone

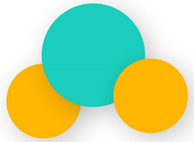
O_3

3

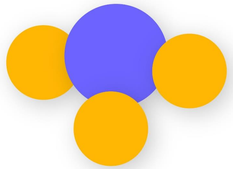
3.3.2 Molecules of Compounds

Atoms of different elements join together in definite proportions to form molecules of compounds. Few examples are given in Tab

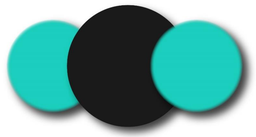
Water



Ammonia



Carbon dioxide



Methane

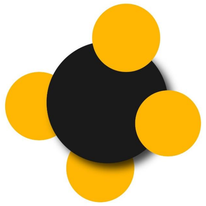
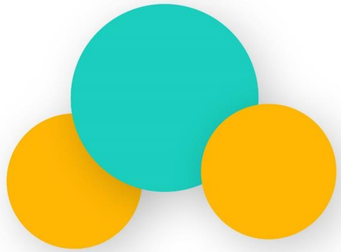


Table 3.4 : Molecules of some compounds

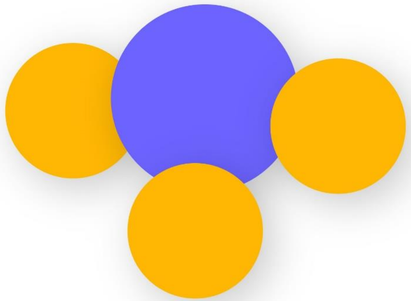
Compound	Combining Elements	Ratio by Mass
Water (H_2O)	Hydrogen, Oxygen	1:8
Ammonia (NH_3)	Nitrogen, Hydrogen	14:3
Carbon dioxide (CO_2)	Carbon, Oxygen	3:8

MOLECULES OF COMPOUNDS

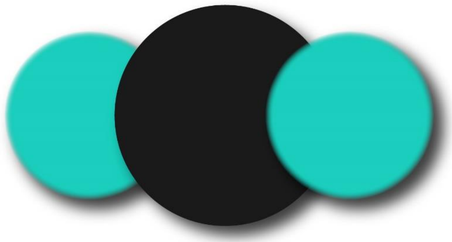
Water



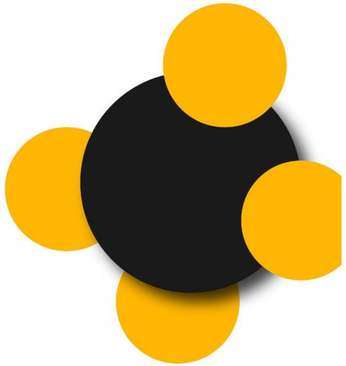
Ammonia



Carbon dioxide

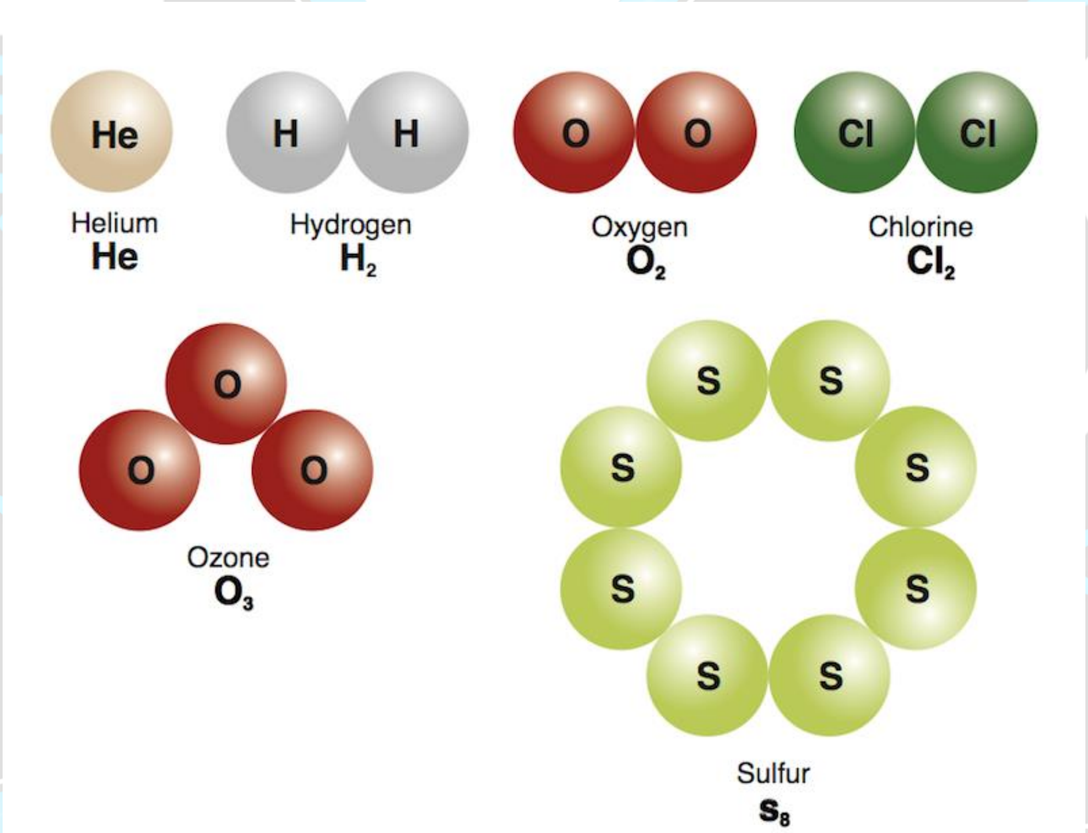


Methane



कुछ तत्त्व अणु के रूप में पाए जाते हैं जबकि कुछ तत्त्व परमाणु के रूप में ही पाए जाते हैं, क्यों?

Some elements are found in the form of molecules while some elements are found only in the form of atoms, why?



परमाणुकता (Atomicity)

अणु में उपस्थित परमाणुओं की संख्या को उस अणु की परमाणुकता (Atomicity) कहते हैं। The number of atoms present in a molecule is called atomicity of that molecule.

(1) एक परमाणुक (Mono Atomic) - Ar, He, Na, Cu, Ag

(2) द्विपरमाणुक (Di-Atomic) -O2, Cl2, Br2, N2, HCl

(3) त्रिपरमाणुक (Tri Atomic) -O, CO_2, SO_2

(4) चतुर्परमाणुक (Tetra-Atomic) - P_1, H_2O_2, NH,

(5) बहुपरमाणुक (Poly Atomic) - S, H_2SO_4 HPO

Table 3.3 : Atomicity of some elements

Type of Element	Name	Atomicity
Non-Metal	Argon	Monoatomic
	Helium	Monoatomic
	Oxygen	Diatomic
	Hydrogen	Diatomic
	Nitrogen	Diatomic
	Chlorine	Diatomic
	Phosphorus	Tetra-atomic
	Sulphur	Poly-atomic

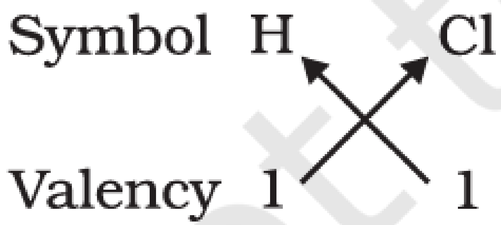
आयन मूलक (Ion)

परमाणु अपने बाह्यतम कक्ष में इलेक्ट्रॉन त्यागकर या ग्रहण कर आवेशित हो जाता है, इन आवेशित कणों को आयन कहते हैं। ये दो प्रकार के होते हैं-

Table 3.6: Names and symbols of some ions

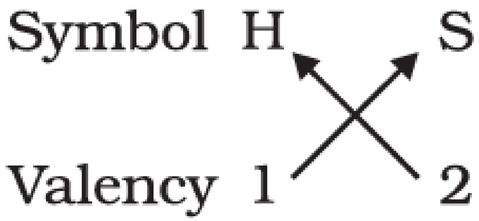
Vale-ncy	Name of ion	Symbol	Non-metallic element	Symbol	Polyatomic ions	Symbol
1.	Sodium	Na^+	Hydrogen	H^+	Ammonium	NH_4^+
	Potassium	K^+	Hydride	H^-	Hydroxide	OH^-
	Silver	Ag^+	Chloride	Cl^-	Nitrate	NO_3^-
	Copper (I)*	Cu^+	Bromide	Br^-	Hydrogen	
			Iodide	I^-	carbonate	HCO_3^-
2.	Magnesium	Mg^{2+}	Oxide	O^{2-}	Carbonate	CO_3^{2-}
	Calcium	Ca^{2+}	Sulphide	S^{2-}	Sulphite	SO_3^{2-}
	Zinc	Zn^{2+}			Sulphate	SO_4^{2-}
	Iron (II)*	Fe^{2+}				
	Copper (II)*	Cu^{2+}				
3.	Aluminium	Al^{3+}	Nitride	N^{3-}	Phosphate	PO_4^{3-}
	Iron (III)*	Fe^{3+}				

1. Formula of hydrogen chloride



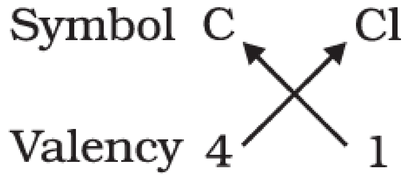
Formula of the compound would be HCl.

2. Formula of hydrogen sulphide



Formula : H_2S

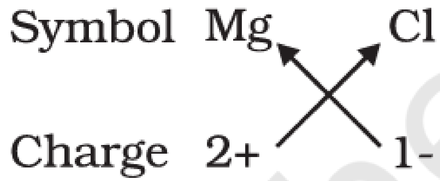
3. Formula of carbon tetrachloride



Formula : CCl_4

For magnesium chloride, we write the symbol of cation (Mg^{2+}) first followed by the symbol of anion (Cl^-). Then their charges are criss-crossed to get the formula.

4. Formula of magnesium chloride



Formula : $MgCl_2$

Table 3.6: Names and symbols of some ions

Vale-ncy	Name of ion	Symbol	Non-metallic element	Symbol	Polyatomic ions	Symbol
1.	Sodium	Na^+	Hydrogen	H^+	Ammonium	NH_4^+
	Potassium	K^+	Hydride	H^-	Hydroxide	OH^-
	Silver	Ag^+	Chloride	Cl^-	Nitrate	NO_3^-
	Copper (I)*	Cu^+	Bromide	Br^-	Hydrogen	
			Iodide	I^-	carbonate	HCO_3^-
2.	Magnesium	Mg^{2+}	Oxide	O^{2-}	Carbonate	CO_3^{2-}
	Calcium	Ca^{2+}	Sulphide	S^{2-}	Sulphite	SO_3^{2-}
	Zinc	Zn^{2+}			Sulphate	SO_4^{2-}
	Iron (II)*	Fe^{2+}				
	Copper (II)*	Cu^{2+}				
3.	Aluminium	Al^{3+}	Nitride	N^{3-}	Phosphate	PO_4^{3-}
	Iron (III)*	Fe^{3+}				

(a) Formula for aluminium oxide:

Symbol	Al	O
Charge	3+	2-

Formula : Al_2O_3

(b) Formula for calcium oxide:

Symbol	Ca	O
Charge	2+	2-

Here, the valencies of the two elements are the same. You may arrive at the formula Ca_2O_2. But we simplify the formula as CaO.

(c) Formula of sodium nitrate:

Symbol/ Formula	Na	NO_3
Charge	1+	1-

Formula : $NaNO_3$

(d) Formula of calcium hydroxide:

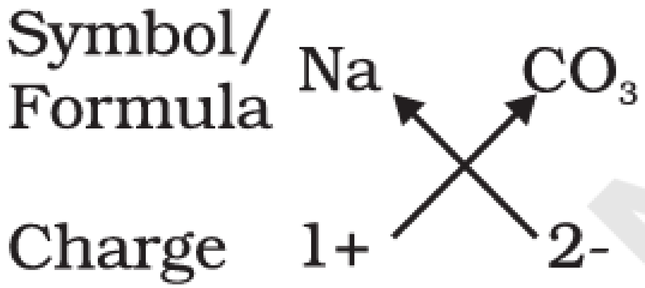
Symbol/ Formula	Ca	OH
Charge	2+	1-

Formula : $Ca(OH)_2$

Table 3.6: Names and symbols of some ions

Vale-ncy	Name of ion	Symbol	Non-metallic element	Symbol	Polyatomic ions	Symbol
1.	Sodium	Na^+	Hydrogen	H^+	Ammonium	NH_4^+
	Potassium	K^+	Hydride	H^-	Hydroxide	OH^-
	Silver	Ag^+	Chloride	Cl^-	Nitrate	NO_3^-
	Copper (I)*	Cu^+	Bromide	Br^-	Hydrogen	
			Iodide	I^-	carbonate	HCO_3^-
2.	Magnesium	Mg^{2+}	Oxide	O^{2-}	Carbonate	CO_3^{2-}
	Calcium	Ca^{2+}	Sulphide	S^{2-}	Sulphite	SO_3^{2-}
	Zinc	Zn^{2+}			Sulphate	SO_4^{2-}
	Iron (II)*	Fe^{2+}				
	Copper (II)*	Cu^{2+}				
3.	Aluminium	Al^{3+}	Nitride	N^{3-}	Phosphate	PO_4^{3-}
	Iron (III)*	Fe^{3+}				

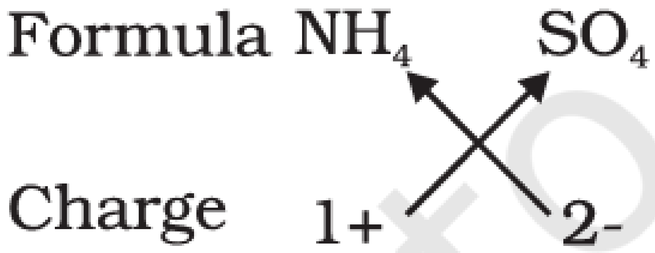
(e) Formula of sodium carbonate:



Formula : Na_2CO_3

In the above example, brackets are not needed if there is only one ion present.

(f) Formula of ammonium sulphate:



Formula : $(NH_4)_2SO_4$

we use the word formula unit for those substances whose constituent particles are ions. For example, sodium chloride as discussed above, has a formula unit NaCl. Its formula unit mass can be calculated as–

$$1 \times 23 + 1 \times 35.5 = 58.5 \text{ u}$$

Example 3.2 Calculate the formula unit mass of $CaCl_2$.

Solution:

Atomic mass of Ca
+ (2 × atomic mass of Cl)
= 40 + 2 × 35.5 = 40 + 71 = 111 u

Questions

1. *Calculate the molecular masses of H_2, O_2, Cl_2, CO_2, CH_4, C_2H_6, C_2H_4, NH_3, CH_3OH.*
2. *Calculate the formula unit masses of ZnO, Na_2O, K_2CO_3, given atomic masses of Zn = 65 u, Na = 23 u, K = 39 u, C = 12 u, and O = 16 u.*

3.5.3 Mole Concept

Take an example of the reaction of hydrogen and oxygen to form water:

$$2H_2 + O_2 \rightarrow 2H_2O.$$

The above reaction indicates that

(i) two molecules of hydrogen combine with one molecule of oxygen to form two molecules of water, or

(ii) 4 u of hydrogen molecules combine with 32 u of oxygen molecules to form 36 u of water molecules.

We can infer from the above equation that the quantity of a substance can be characterised by its mass or the number of molecules. But, a chemical reaction equation indicates directly the number of atoms or molecules taking part in the reaction. Therefore, it is more convenient to refer to the quantity of a substance in terms of the number of its molecules or atoms, rather than their masses. So, a new unit "mole" was introduced. One mole of any species (atoms,

03 Calculate the molar mass of the following substances.

(a) Ethyne, C_2H_2

(b) Sulphur molecule, S_8

(c) Phosphorus molecule, P_4 (Atomic mass of phosphorus = 31)

(d) Hydrochloric acid, HCl

(e) Nitric acid, HNO_3

Molar mass of C = 12g

Molar mass of H = 1g

Molar mass of S = 32g

Molar mass of P = 31g

Molar mass of Cl = 35.5g

Molar mass of N = 14g

Molar mass of O = 16g

(d) Hydrochloric acid, HCl

Molar mass of HCl = 1 x Molar mass of H + 1 x Molar mass of Cl

= 1x 1g + 1 x 35.5g

= 1g + 35.5g

= **36.5g**

(e) Nitric acid, HNO_3

Molar mass of HNO_3 = 1 x Molar mass of H + 1 x Molar mass of N + 3 x Molar mass of O

=1x 1g + 1 x 14g + 3 x 16g

= 1g + 14g + 48g

= **63g**

(a) **Ethyne, C_2H_2**

Molar mass of C_2H_2 = 2 x Molar mass of C + 2 x Molar mass of H
= 2x 12g + 2 x 1g
= 24g + 2g
= **26g**

(b) **Sulphur molecule, S_8**

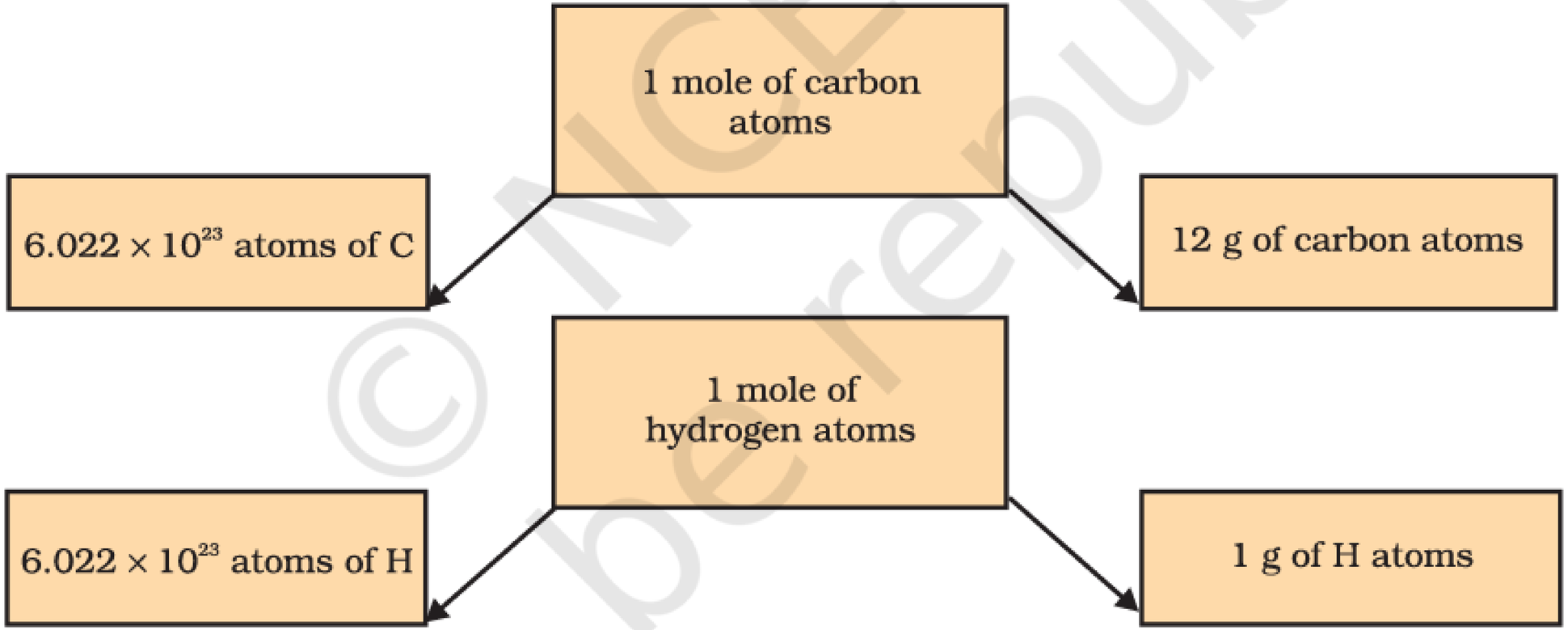
Molar mass of S_8 = 8 x Molar mass of S
= 8x 32g
= **256g**

(c) **Phosphorus molecule, P_4**

Molar mass of P_4 = 4 x Molar mass of P
= 4 x 31g
= **124g**

Mole Concept

One mole is the **amount of substance that contains the same number of particles** (atoms/ ions/ molecules/ formula units etc.) **as there are atoms in exactly 12 g of Carbon-12** . एक मोल पदार्थ की वह मात्रा है जिसमें कणों (परमाणु/आयन/अणु/सूत्र इकाइयाँ आदि) की संख्या उतनी ही होती है जितनी कार्बन-12 के ठीक 12 ग्राम में परमाणु होते हैं

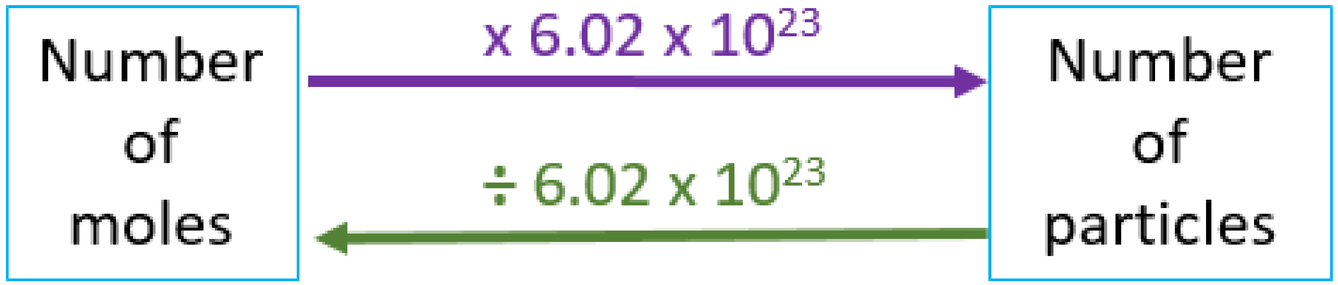


Lorenzo Romano Amedeo Carlo Avogadro (1776-1856)

He is known for the Avogadro's hypothesis. In honour of his contributions, the number of fundamental particles in a mole of substance was named as Avogadro number. Though Avogadro didn't predict the number of particles in equal volumes of gas, his hypothesis did lead to the eventual determination of the number as 6.022×10^{23} Rudolf Clausius, with his kinetic theory of gases, provided evidence for Avogadro's law.

One mole (1 mol) of a substance contains 6.02×10^{23} particles of the substance.

The number 6.02×10^{23} is called the Avogadro Constant.



- 1 mole of Carbon atoms = 6.022×10^{23} Carbon atoms
- 1 mole of Sodium atoms = 6.022×10^{23} Sodium atoms
- 1 mole of Hydrogen ions = 6.022×10^{23} Hydrogen ions
- 1 mole of molecules of Water = 6.022×10^{23} molecules of Water
- 0.5 mole of Carbon atoms = 3.011×10^{23} atoms of Carbon