



**LAWS OF
MATTER**

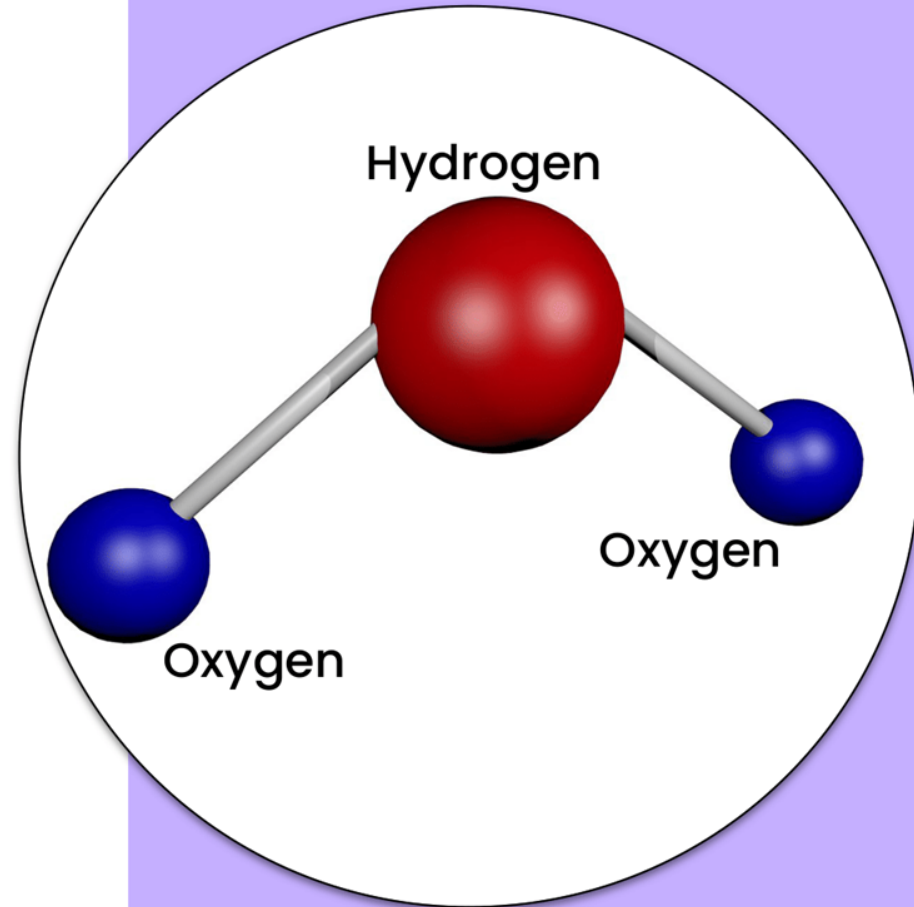
LAWS OF MATTER

- The Law of Conservation of Mass states that in a chemical reaction, the total mass of the reactants is always equal to the total mass of the products.



LAWS OF MATTER

- The **Law of Definite Composition** states:
 - Chemical compounds contain two or more pure substances
 - Compounds always have the same proportion of elements by mass
- **Example:** Water has 11% hydrogen and 89% oxygen.

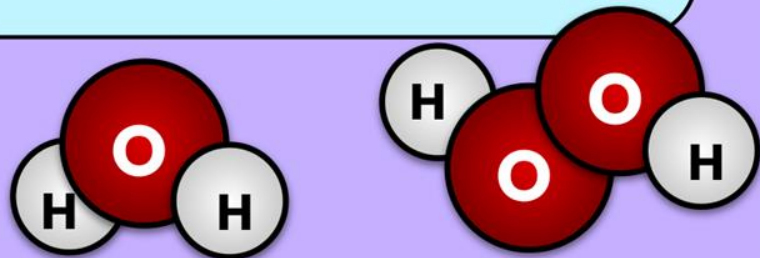


LAWS OF MATTER

- The Law of Multiple Proportions states:
 - When one element combines with another to form **more than one compound**...
 - ... The ratio of the elements' masses in the compounds are simple whole numbers of each other.

Example

$$\frac{\text{Ratio of H to O in water}}{\text{Ratio of H to O in hydrogen peroxide}} = \frac{15.999 \text{ g}}{31.998 \text{ g}} = 1 : 2$$

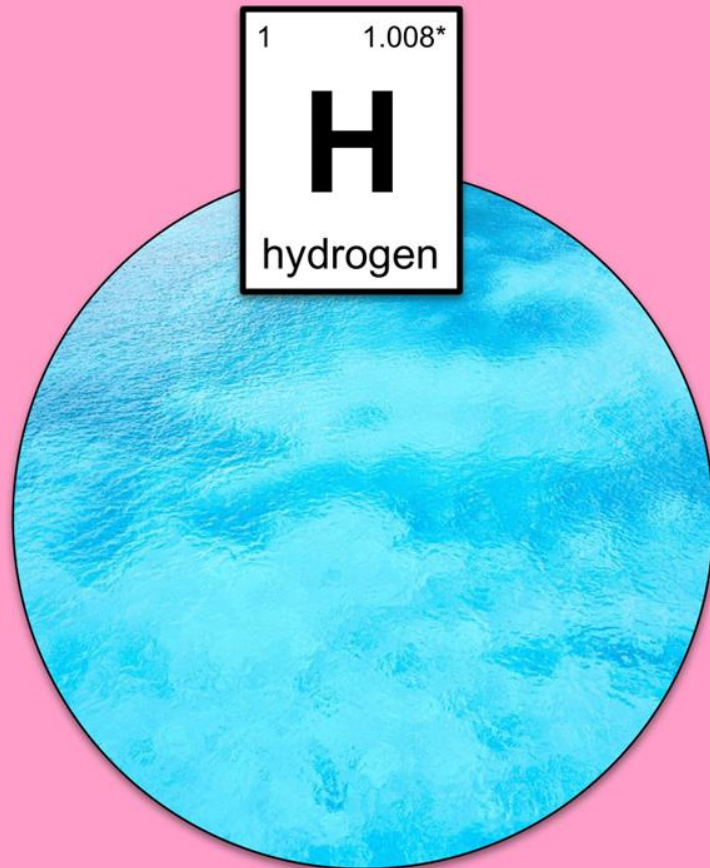


THE PERIODIC TABLE OF ELEMENTS

1 H																	2 He																														
3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne																														
11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar																														
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr																														
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe																														
55 Cs	56 Ba		72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn																														
87 Fr	88 Ra		104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Uut	114 Fl	115 Uup	116 Lv	117 Uus	118 Uuo																														
<table border="1"> <tbody> <tr> <td>57 La</td> <td>58 Ce</td> <td>59 Pr</td> <td>60 Nd</td> <td>61 Pm</td> <td>62 Sm</td> <td>63 Eu</td> <td>64 Gd</td> <td>65 Tb</td> <td>66 Dy</td> <td>67 Ho</td> <td>68 Er</td> <td>69 Tm</td> <td>70 Yb</td> <td>71 Lu</td> </tr> <tr> <td>89 Ac</td> <td>90 Th</td> <td>91 Pa</td> <td>92 U</td> <td>93 Np</td> <td>94 Pu</td> <td>95 Am</td> <td>96 Cm</td> <td>97 Bk</td> <td>98 Cf</td> <td>99 Es</td> <td>100 Fm</td> <td>101 Md</td> <td>102 No</td> <td>103 Lr</td> </tr> </tbody> </table>																		57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu	89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr
57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu																																	
89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr																																	

PERIODIC TABLE OF ELEMENTS

- The periodic table shows all the **elements**.
- The elements are ordered by increasing atomic number and are arranged based on their properties.
- Elements are used to form other substances.

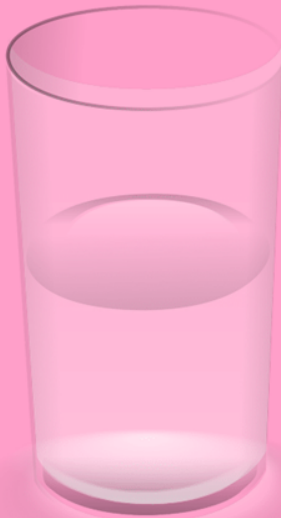


PERIODIC TABLE OF ELEMENTS

Hydrogen
(H)

1	1.008*
H	
hydrogen	

Water
(H₂O)



- **Elements** are represented on the periodic table according to their element symbol.
 - Hydrogen is represented by H.
- **Compounds** are pure substances made of two or more different elements.
 - Only certain elements can combine, and they can only combine in certain proportions.

PERIODIC TABLE OF ELEMENTS

Beryllium
is a metal

4	9.012
Be	
beryllium	

9	19.00
F	
fluorine	

Fluorine is a
nonmetal

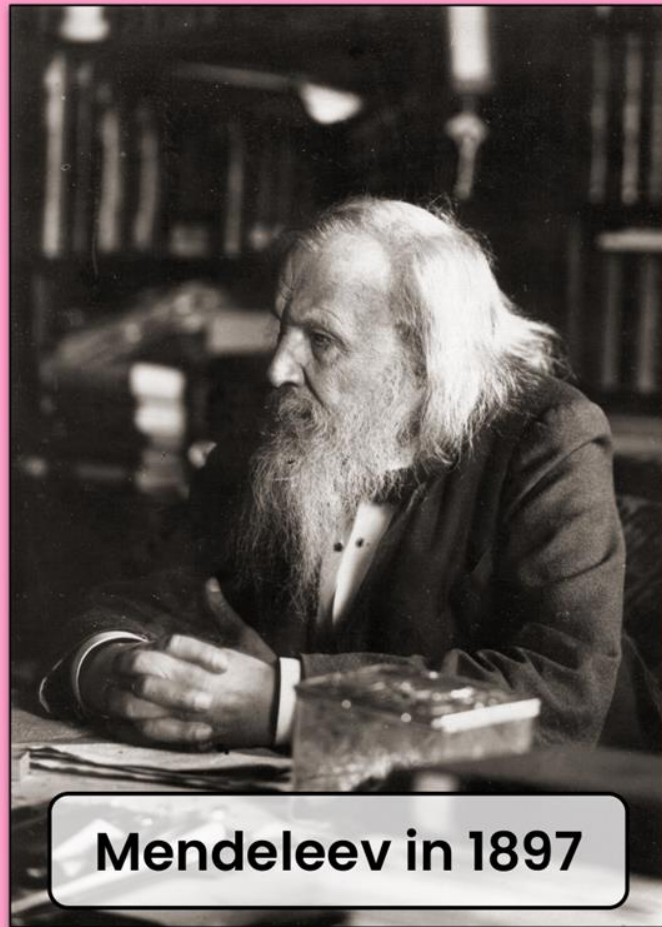
Boron is a
metalloid

5	10.81
B	
boron	

- **Metals** are typically found on the left and centre of the periodic table.
 - They are dense, lustrous, malleable, have high melting points, and are great conductors of heat and electricity.
- **Nonmetals** are dull, brittle, and conduct heat and electricity poorly.
- **Metalloids** have properties of both metals and nonmetals.

PERIODIC TABLE OF ELEMENTS

- Dmitri Mendeleev constructed the first version of the periodic table based on Dalton's Theory.
- At the time, there were only 63 known elements, and he arranged them according to their atomic mass.
 - It has been revised and reorganized with a focus on the atomic structure of each element.



Mendeleev in 1897

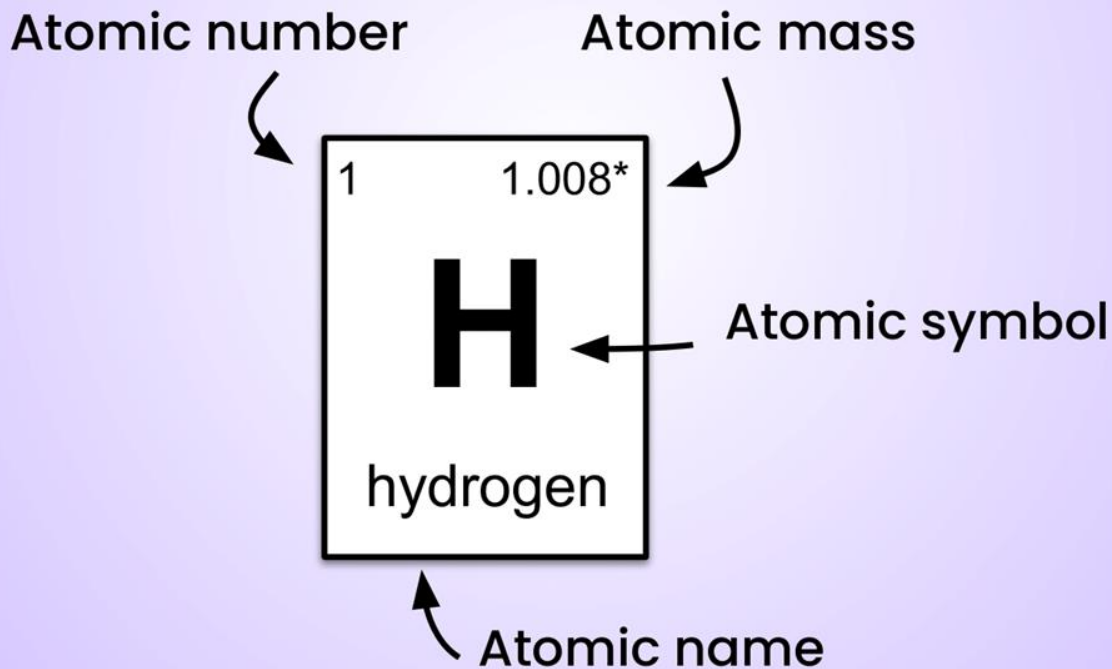
PERIODIC TABLE OF ELEMENTS

The periodic table contains key information about each element:

Atomic name	Name of the element on the periodic table
Atomic symbol	One or two letters to represent an element in the periodic table
Atomic number	<ul style="list-style-type: none">• Number of protons an atom has• Can be used to identify elements
Atomic mass	<ul style="list-style-type: none">• Mass of an atom of a chemical element expressed in atomic mass units• You can find the average number of neutrons of an element by subtracting the atomic number from the atomic mass

PERIODIC TABLE OF ELEMENTS

Reading elements on the periodic table:





Think about it!

Navigate the periodic table to determine the atomic symbol, atomic number, and atomic mass of each element.

Platinum	
Symbol	#
Number	#
Atomic mass	#

Krypton	
Symbol	#
Number	#
Atomic mass	#

Oxygen	
Symbol	#
Number	#
Atomic mass	#

Magnesium	
Symbol	#
Number	#
Atomic mass	#

PERIODIC TABLE OF ELEMENTS

- The periodic table is organized into groups (columns) and periods (rows).
 - Groups on the periodic table have similar physical and chemical properties.
- The periodic table also has **chemical families** (see the coloured elements below).

Group → 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

Period ↓

1	1 H																2 He	
2	3 Li	4 Be										5 B	6 C	7 N	8 O	9 F	10 Ne	
3	11 Na	12 Mg										13 Al	14 Si	15 P	16 S	17 Cl	18 Ar	
4	19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
5	37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
6	55 Cs	56 Ba		72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
7	87 Fr	88 Ra		104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Uut	114 Fl	115 Uup	116 Lv	117 Uus	118 Uuo

PERIODIC TABLE OF ELEMENTS

Examples of chemical families are described below:

Alkali Metals

- These are located in Group 1 in the periodic table.
- Alkali metals are extremely reactive and easily combine with other elements or compounds.

Group

	1	2
1	1 H	
2	3 Li	4 Be
3	11 Na	12 Mg
4	19 K	20 Ca
5	37 Rb	38 Sr
6	55 Cs	56 Ba
7	87 Fr	88 Ra

Alkaline Earth Metals

- These are located in Group 2 in the periodic table.
- Very reactive, but not as reactive as alkali metals.
- Greyish-white colour
- Very metallic and good conductors

PERIODIC TABLE OF ELEMENTS

Examples of chemical families are described below:

Noble Gases

- Located in group 18
- 6 noble gases in total
- Unique because their outer shell contains the maximum number of electrons
 - Causes them to be stable

Group

↪ 17 18

	2 He
9 F	10 Ne
17 Cl	18 Ar
35 Br	36 Kr
53 I	54 Xe
85 At	86 Rn

Halogens

- Located in group 17
- Contains six non-metallic elements
- They are in three states of matter (solid, liquid and gas) when stored at room temperature

PERIODIC TABLE OF ELEMENTS

1											18						
1 1.008* H hydrogen	2										2 4.003 He helium						
3 6.94* Li lithium	4 9.012 Be beryllium											5 10.81* B boron	6 12.01* C carbon	7 14.01* N nitrogen	8 16.00* O oxygen	9 19.00 F fluorine	10 20.18 Ne neon
11 22.99 Na sodium	12 24.31* Mg magnesium											13 26.98 Al aluminium	14 28.09* Si silicon	15 30.97 P phosphorus	16 32.06* S sulfur	17 35.45* Cl chlorine	18 39.95 Ar argon
19 39.10 K potassium	20 40.08 Ca calcium	21 44.96 Sc scandium	22 47.87 Ti titanium	23 50.94 V vanadium	24 52.00 Cr chromium	25 54.94 Mn manganese	26 55.85 Fe iron	27 58.93 Co cobalt	28 58.69 Ni nickel	29 63.55 Cu copper	30 65.38* Zn zinc	31 69.72 Ga gallium	32 72.63 Ge germanium	33 74.92 As arsenic	34 78.97* Se selenium	35 79.90* Br bromine	36 83.80 Kr krypton
37 85.47 Rb rubidium	38 87.62 Sr strontium	39 88.91 Y yttrium	40 91.22 Zr zirconium	41 92.91 Nb niobium	42 95.95* Mo molybdenum	43 [98] Tc technetium	44 101.1 Ru ruthenium	45 102.9 Rh rhodium	46 106.4 Pd palladium	47 107.9 Ag silver	48 112.4 Cd cadmium	49 114.8 In indium	50 118.7 Sn tin	51 121.8 Sb antimony	52 127.6 Te tellurium	53 126.9 I iodine	54 131.3 Xe xenon
55 132.9 Cs caesium	56 137.3 Ba barium	57-71 lanthanum series	72 178.5 Hf hafnium	73 180.9 Ta tantalum	74 183.8 W tungsten	75 186.2 Re rhenium	76 190.2 Os osmium	77 192.2 Ir iridium	78 195.1 Pt platinum	79 197.0 Au gold	80 200.6 Hg mercury	81 204.4* Tl thallium	82 207.2 Pb lead	83 209.0 Bi bismuth	84 [209] Po polonium	85 [210] At astatine	86 [222] Rn radon
87 [223] Fr francium	88 [226] Ra radium	89-103 actinide series	104 [267] Rf rutherfordium	105 [268] Db dubnium	106 [269] Sg seaborgium	107 [270] Bh bohrium	108 [277] Hs hassium	109 [278] Mt meitnerium	110 [281] Ds darmstadtium	111 [282] Rg roentgenium	112 [285] Cn copernicium	113 [286] Nh nihonium	114 [289] Fl flerovium	115 [290] Mc moscovium	116 [293] Lv livermorium	117 [294] Ts tennessine	118 [294] Og oganeson

*H: [1.00784, 1.00811]
 Li: [6.938, 6.997]
 B: [10.806, 10.821]
 C: [12.0096, 12.0116]
 N: [14.00643, 14.00728]
 O: [15.99903, 15.99977]
 Mg: [24.304, 24.307]
 Si: [26.084, 26.086]
 S: [32.059, 32.076]
 Cl: [35.446, 35.457]
 Br: [79.901, 79.907]
 Tl: [204.382, 204.385]
 Zn: 65.38(2)
 Se: 78.96(3)
 Mo: 95.96(2)

57 138.9 La lanthanum	58 140.1 Ce cerium	59 140.9 Pr praseodymium	60 144.2 Nd neodymium	61 [145] Pm promethium	62 150.4 Sm samarium	63 152.0 Eu europium	64 157.3 Gd gadolinium	65 158.9 Tb terbium	66 162.5 Dy dysprosium	67 164.9 Ho holmium	68 167.3 Er erbium	69 168.9 Tm thulium	70 173.0 Yb ytterbium	71 175.0 Lu lutetium
89 [227] Ac actinium	90 232.0 Th thorium	91 231.0 Pa protactinium	92 238.0 U uranium	93 [237] Np neptunium	94 [244] Pu plutonium	95 [243] Am americium	96 [247] Cm curium	97 [247] Bk berkelium	98 [251] Cf californium	99 [252] Es einsteinium	100 [257] Fm fermium	101 [258] Md mendelevium	102 [259] No nobelium	103 [266] Lr lawrencium