

CHEMISTRY II

1. ELEMENTS
2. PERIODIC TABLE
3. PROPERTIES OF ELEMENTS

ELEMENTS

Elements are...

- The basic building blocks of matter
- Made up of one type of atom (cannot be broken down further)
- About 90 elements occur naturally (carbon, silver, oxygen)
- Some elements are synthesized in labs
- Have varying properties

ELEMENTS

Each element has a

- **Chemical name**
 - Based on Latin words, countries, names of famous scientists
- **Chemical symbol**
 - One or two letters (first letter is capitalized)
 - Synthetic or unnamed elements have placeholder names or three-letter symbols

MENDELEEV'S PERIODIC TABLE

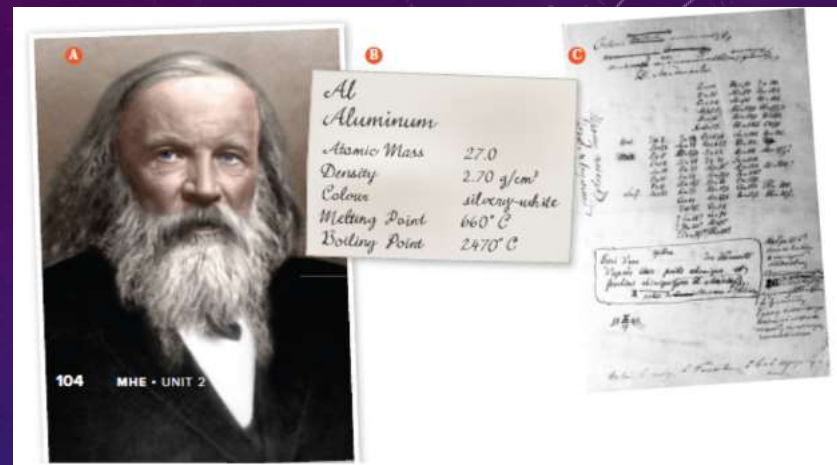
Video:

https://www.youtube.com/watch?v=fPnwBITSmgU&ab_channel=TED-Ed

MENDELEEV'S PERIODIC TABLE

1860s: Dmitri Mendeleev

- Looked at different ways to organize the elements
- Wrote properties of elements on cards so that he could rearrange them and compare properties (“chemical solitaire”)
- Properties included atomic mass (average mass of an atom of an element), density, and melting point.

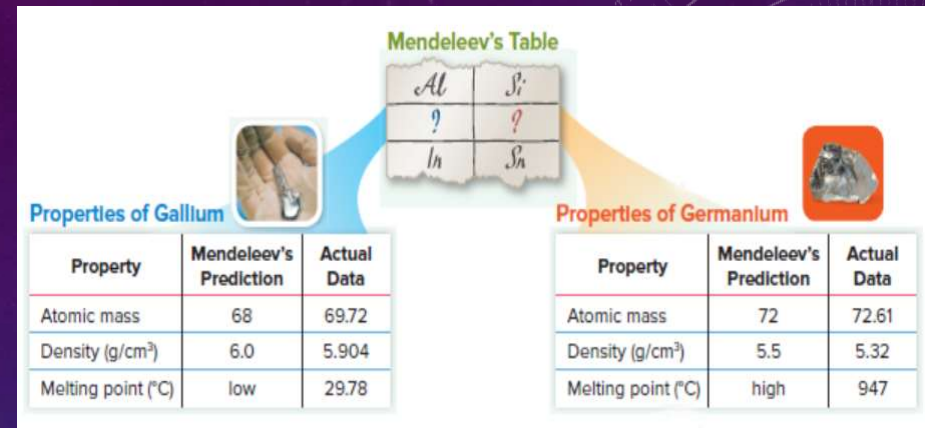


MENDELEEV'S PERIODIC TABLE

Mendeleev's periodic table:

- Ordered the elements by increasing atomic mass.
- Grouped elements into "families" based on similar properties (density, melting point)
- Left gaps in his periodic table to predict the existence of elements not yet found yet
 - These missing elements would have properties similar to other elements in the same families.

Mendeleev's Table



Properties of Gallium

Property	Mendeleev's Prediction	Actual Data
Atomic mass	68	69.72
Density (g/cm ³)	6.0	5.904
Melting point (°C)	low	29.78

Properties of Germanium

Property	Mendeleev's Prediction	Actual Data
Atomic mass	72	72.61
Density (g/cm ³)	5.5	5.32
Melting point (°C)	high	947

MENDELEEV'S PERIODIC TABLE

Mendeleev's periodic table was ordered by increasing atomic mass:

- Did not work perfectly – some elements were out of order so they would fit in a family that had similar properties

Mendeleev's Periodic Table

Series	Group I	Group II	Group III	Group IV	Group V	Group VI	Group VII	Group VIII
1	H=1							
2	Li=7	Be=9.1	B=11	C=12	N=14	O=16	F=19	
3	Na=23	Mg=24.4	Al=27	Si=28	P=31	S=32	Cl=35.5	Fe=56, Ni=58.5, Co=59.1, Cu=63.3.
4	K=39.1	Ca=40	— =44	Ti=48.1	V=51.2	Cr=52.3	Mn=55	
5	(Cu)=63.3	Zn=65.4	— =68	— =72	As=75	Se=79	Br=80	Rh=103, Ru=101.3, Pd=106, Ag=107.9.
6	Rb=85.4	Sr=87.5	Y=89	Zr=90.7	Nb=94.2	Mo=95.9	— =100	
7	(Ag)=107.9	Cd=112	In=113.7	Sn=119	Sb=120.3	Te=128.2	I=126.9	— — —
8	Cs=132.9	Ba=137	Lan=138.5	Cer=141.5	Di=145	—	—	— — —
9	(—)	—	—	—	—	—	—	In=133.1, Pt=194.8, Os=200, Au=196.7.
10	—	—	Yb=173.2	—	Ta=182.8	W=184	—	
11	(Au)=196.7	Hg=200.4	Tl=204.1	Pb=208.9	Bi=208	—	—	— — —
12	—	—	—	Tl=203.4	—	U=239	—	— — —

MODERN PERIODIC TABLE

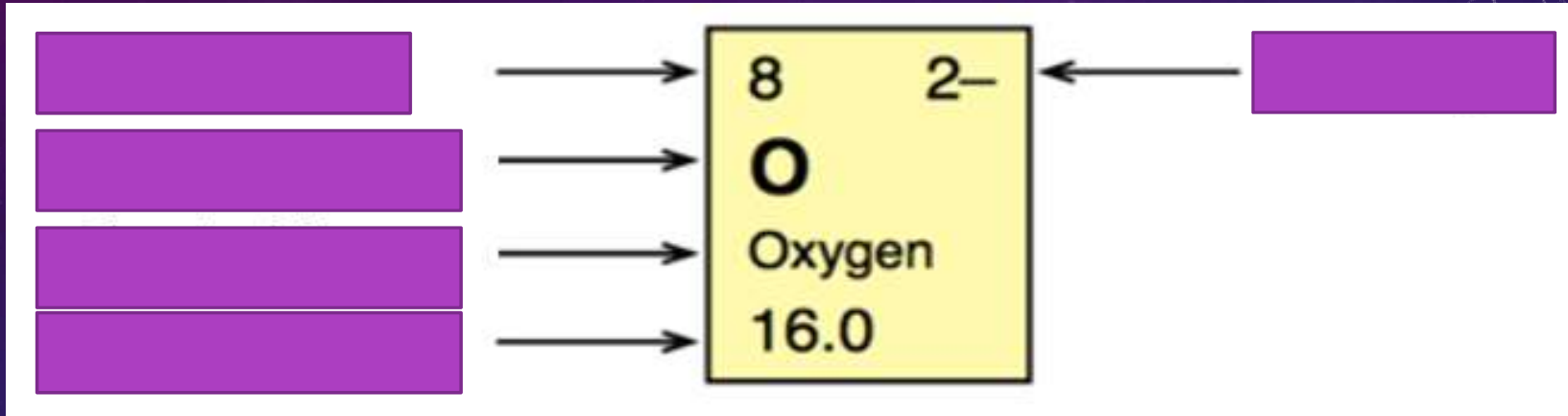
Modern periodic table is ordered by increasing atomic number.

- Henry Moseley: scientist that determined an element's atomic number (the number of protons in an atom)
- When elements are arranged according to increasing atomic number, the elements fit perfectly and do not require re-ordering

MODERN PERIODIC TABLE

Video:

https://www.youtube.com/watch?v=rz4Dd1I_fX0&ab_channel=AsapSCIENCE



MODERN PERIODIC TABLE

We can use the information from the periodic table in order to find information about subatomic particles.

Name	Charge	Location	To find the number of particles for each elements, look at the...
Proton	<u>Positive</u>	<u>Nucleus</u>	<u>Atomic number</u>
Neutron	<u>Neutral</u>	<u>Nucleus</u>	<u>Atomic mass – atomic number</u>
Electron	<u>Negative</u>	<u>Electron shells/rings</u>	<u>Atomic number</u>

METALS

On the periodic table, there are three categories shown on the periodic table:

Metal:

- Shiny and hard (typically)
- Malleable and ductile
- Conducts electricity and heat
- Found to the left of the zigzag line on the periodic table

Periodic Table of the Elements

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 H Hydrogen 1.0																	2 He Helium 4.0
3 Li Lithium 6.9	4 Be Beryllium 9.0																10 Ne Neon 20.2
11 Na Sodium 23.0	12 Mg Magnesium 24.3																18 Ar Argon 39.9
19 K Potassium 39.1	20 Ca Calcium 40.1	21 Sc Scandium 45.0	22 Ti Titanium 47.9	23 V Vanadium 50.9	24 Cr Chromium 52.0	25 Mn Manganese 54.9	26 Fe Iron 55.8	27 Co Cobalt 58.9	28 Ni Nickel 58.7	29 Cu Copper 63.5	30 Zn Zinc 65.4	31 Ga Gallium 69.7	32 Ge Germanium 72.6	33 As Arsenic 74.9	34 Se Selenium 79.0	35 Br Bromine 79.9	36 Kr Krypton 83.8
37 Rb Rubidium 85.5	38 Sr Strontium 87.6	39 Y Yttrium 88.9	40 Zr Zirconium 91.2	41 Nb Niobium 92.9	42 Mo Molybdenum 95.9	43 Tc Technetium (98)	44 Ru Ruthenium 101.1	45 Rh Rhodium 102.9	46 Pd Palladium 106.4	47 Ag Silver 107.9	48 Cd Cadmium 112.4	49 In Indium 114.8	50 Sn Tin 118.7	51 Sb Antimony 121.8	52 Te Tellurium 127.6	53 I Iodine 126.9	54 Xe Xenon 131.3
55 Cs Cesium 132.9	56 Ba Barium 137.3	57 La Lanthanum 138.9	58 Ce Cerium 140.1	59 Pr Praseodymium 140.9	60 Nd Neodymium 144.2	61 Pm Promethium (145)	62 Sm Samarium 150.4	63 Eu Europium 152.0	64 Gd Gadolinium 157.3	65 Tb Terbium 158.9	66 Dy Dysprosium 162.5	67 Ho Holmium 164.9	68 Er Erbium 167.3	69 Tm Thulium 168.9	70 Yb Ytterbium 173.0	71 Lu Lutetium 175.0	
87 Fr Francium (223)	88 Ra Radium (226)	89 Ac Actinium (227)	90 Th Thorium (232)	91 Pa Protactinium (231)	92 U Uranium (238)	93 Np Neptunium (237)	94 Pu Plutonium (244)	95 Am Americium (243)	96 Cm Curium (247)	97 Bk Berkelium (247)	98 Cf Californium (251)	99 Es Einsteinium (252)	100 Fm Fermium (257)	101 Md Mendelevium (288)	102 No Nobelium (289)	103 Lr Lawrencium (260)	

NON-METALS

Periodic Table of the Elements

Legend:

- metal (blue)
- semi-metal (green)
- non-metal (yellow)
- natural (white)
- synthetic (blue)

Callout: Based on mass of C-12 at 12.00. Any value in parentheses is the mass of the most stable or best known isotope for elements that do not occur naturally.

Non-metal:

- Not shiny, malleable, or ductile
- Poor conductor of electricity and heat
- Found to the right of the zigzag line on the periodic table
- Generally gases or brittle, dull solids.

SEMI-METALS (METALLOIDS)

Periodic Table of the Elements

Legend:

- metal (blue)
- semi-metal (green)
- non-metal (yellow)
- natural (O)
- synthetic (Db)

Callout box example:

22	3+	47.88	Ti	3+
Titanium				

Based on mass of C-12 at 12.001.

Any values in parentheses is the mass of the most stable or best known isotope for elements that do not occur naturally.

Semi-metals (Metalloids):

- Have physical and chemical properties of both metals and non-metals
 - Shiny (like metals)
 - Brittle and *not* ductile (like non-metals)
 - Poor conductors of heat and electricity (like non-metals)

MODERN PERIODIC TABLE

The modern periodic table can also be organized into:

- **Groups (Family) (1-18)**: A vertical column of elements
- **Periods (1-7)**: A horizontal row of elements

ALKALI METALS (GROUP 1)

- Shiny and soft
- Highly reactive with water and oxygen (often stored in a non-reactive liquid such as oil)

Video:

https://www.youtube.com/watch?v=m55kgyApYrY&ab_channel=scientist303

H	
Li	Lithium
Na	Sodium
K	Potassium
Rb	Rubidium
Cs	Cesium
Fr	Francium

ALKALINE EARTH METALS (GROUP 2)

- Shiny and soft (but not as soft as alkali metals)
- Highly reactive (but not as reactive as alkali metals)

Video:

https://www.youtube.com/watch?v=O6DaCYKh77E&ab_channel=DavidRead

Alkaline earth metals

Hydrogen 1 1.01	Helium 2 4.00	Lithium 3 6.94	Beryllium 4 9.01	Boron 5 10.81	Carbon 6 12.01	Nitrogen 7 14.01	Oxygen 8 16.00	Fluorine 9 18.99	Neon 10 20.18
Sodium 11 22.99	Magnesium 12 24.31	Aluminum 13 26.98	Silicon 14 28.09	Phosphorus 15 30.97	Sulfur 16 32.06	Chlorine 17 35.45	Argon 18 39.95	Potassium 19 39.10	Calcium 20 40.08
Scandium 21 44.96	Titanium 22 47.87	Vanadium 23 50.94	Chromium 24 51.99	Manganese 25 54.94	Iron 26 55.85	Cobalt 27 58.93	Nickel 28 58.71	Copper 29 63.55	Zinc 30 65.38
Gallium 31 69.72	Germanium 32 72.64	Arsenic 33 74.92	Selenium 34 78.96	Bromine 35 79.90	Krypton 36 83.80	Rubidium 37 85.47	Strontium 38 87.62	Zirconium 39 91.22	Niobium 40 92.91
Yttrium 39 88.91	Zirconium 40 91.22	Niobium 41 92.91	Molybdenum 42 95.94	Technetium 43 [98]	Ruthenium 44 101.07	Rhodium 45 102.91	Rubidium 37 85.47	Strontium 38 87.62	Yttrium 39 88.91
Cesium 55 132.91	Barium 56 137.33	Lanthanum 57 138.91	Hafnium 72 178.49	Tantalum 73 180.95	Tungsten 74 183.84	Rhenium 75 186.21	Osmium 76 190.23	Iridium 77 192.22	Platinum 78 195.08
Francium 87 [223]	Radium 88 [226]	Actinium 89 [227]	Rutherfordium 104 [261]	Dubnium 105 [262]	Seaborgium 106 [263]	Bhassium 107 [264]	Hassium 108 [265]	Mt 109 [266]	Darmstadtium 110 [267]
Cerium 58 140.12	Praseodymium 59 140.91	Nd 60 144.24	Promethium 61 [145]	Samarium 62 150.36	Europium 63 151.96	Thorium 90 232.04	Protactinium 91 231.04	Uranium 92 238.03	Neptunium 93 [237]
Plutonium 94 [244]	Americium 95 [243]								

HALOGENS (GROUP 17)

Halogen family

1	2	13	14	15	16	17	18												
H	He	B	C	N	O	F	Ne												
Li	Be	Al	Si	P	S	Cl	Ar												
Na	Mg	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe		
Cs	Ba	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn			
Fr	Ra	Rf	Db	Sg	Bh	Hs	Mt												
		La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu			
		Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr			

- Highly reactive (therefore usually found in nature as part of compounds)

Video:

https://www.youtube.com/watch?v=u2ogMUDBaf4&ab_channel=OpenLearnfromTheOpenUniversity

NOBLE GAS (GROUP 18)

Periodic table showing the noble gas group (Group 18) highlighted in red. The noble gases are Helium (He), Neon (Ne), Argon (Ar), Krypton (Kr), Xenon (Xe), and Radon (Rn). The text "noble gases" is written in red above the group.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
H	He																
Li	Be											B	C	N	O	F	Ne
Na	Mg											Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
Fr	Ra	Ac	Rf	Ha	Sg	Ns	Hs	Mt	110	111	112	113					

- Odourless, colourless gases
- Least reactive of all of the elements
 - Helium and neon never form compounds
 - Other noble gases form compounds with great difficulty