

PERIODIC TABLE

**gold, silver, tin, copper, lead, mercury
sulfur, carbon**

Elements known since antiquity

PERIODIC TABLE

phosphorous

PERIODIC TABLE



Isolated from
60 buckets of urine
Greek: *phôs* (light)
and *phoros* (bearer)

PERIODIC TABLE

White, non-metallic; used by alchemists attempting to make gold.

**Was also used as a spell component
Extremely poisonous: 50 mg fatal**

**Must be stored in water
exposure to air causes ignition**

**Over the next 200 years, much
learned about the properties of
elements and their compounds**

LAW OF TRIADS

**Johann Dobereiner (1817):
groups of 3 similar elements**

Ca, Sr, Ba

Cl, Br, I

Li, Na, K

**Proposed nature contained triads of elements.
The middle element had properties that were
an average of the other two members when
ordered by the atomic weight.**

Law of Octaves

1863 - John Newlands, an English chemist, classified the known elements into groups based on similar physical properties

Law of Octaves

"any given element will exhibit similar behavior to the eighth element following it in the table"

H	F	Cl	Co/Ni	Br	Pd	I	Pt/Ir
Li	Na	K	Cu	Rb	Ag	Cs	Tl
G	Mg	Ca	Zn	Sr	Cd	Ba/V	Pb
Bo	Al	Cr	Y	Ce/La	U	Ta	Th
C	Si	Ti	In	Zn	Sn	W	Hg
N	P	Mn	As	Di/Mo	Sb	Nb	Bi
O	S	Fe	Se	Ro/Ru	Te	Au	Os

"Father" of the periodic table



Lothar Meyer

"Father" of the periodic table



Dmitri Mendeleev

"Father" of the periodic table

Both chemists produced remarkably similar results at the same time working independently of one another.

**Mendeleev's table published 1869,
Meyer's appeared 1870**

What Did Mendeleev Do?

Made a card for each of the 63 known elements

Each contained element's symbol, atomic weight and characteristic chemical and physical properties

Arranged the cards in order of ascending atomic weight. Elements fell into vertical groups of elements of similar properties

What Did Mendeleev Do?

Mendeleev's table showed similarities in vertical, horizontal, and diagonal groupings (not just triads)

Gaps in table - predicted existence and properties of unknown elements which he called eka-aluminum, eka-boron, and eka-silicon.

What Did Mendeleev Do?

Group	I	II	III	IV	V	VI	VII	VIII
Period 1	H=1							
2	Li=7	Be=9.4	B=11	C=12	N=14	O=16	F=19	
3	Na=23	Mg=24	Al=27.3	Si=28	P=31	S=32	Cl=35.5	
4	K=39	Ca=40	?=44	Ti=48	V=51	Cr=52	Mn=55	Fe=56,Co=59 Ni=59
5	Cu=63	Zn=65	?=68	?=72	As=75	Se=78	Br=80	
6	Rb=85	Sr=87	?Yt=88	Zr=90	Nb=94	Mo=96	?=100	Ru=104,Rh=104 Pd=106
7	Ag=108	Cd=112	In=113	Sn=118	Sb=122	Te=125	J=127	
8	Cs=133	Ba=137	?Di=138	?Ce=140				
9								
10			?Er=178	?La=180	Ta=182	W=184		Os=195,Ir=197 Pt=198
11	Au=199	Hg=200	Tl=204	Pb=207	Bi=208			
12				Th=231		U=240		

What Did Mendeleev Do?

Later named gallium, scandium and germanium which fit his predictions

Predicted 10 elements would be discovered

Rayleigh and Ramsey

Lord Rayleigh (1842-1919) and William Ramsey (1852-1916) greatly enhanced the periodic table by discovering the "inert gases"

Rayleigh and Ramsey

In 1895 Rayleigh reported the discovery of a new gaseous element named argon

This element was chemically inert and did not fit any of the known periodic groups

Ramsey followed by discovering the remainder of the inert gases and positioning them in the periodic table.

The Inert Gases

- Helium (He), neon (Ne), argon (Ar), krypton (Kr), xenon(Xe), radon (Rn)
- Very inert and combine with very few elements
- All are colorless, odorless gases

The Inert Gases

Neon gas normally glows **red**

Colors other than red produced using argon, mercury and phosphor

Eric Ehlenberger

Modern Periodic Table

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

	IA																VIIIA	
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	71 *Lu	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	103 †Lr	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt									

* Lanthanides

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
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† Actinides

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
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Modern Periodic Table

The periodic table is organized into groups (IA-VIIA) and periods (1-7). Elements are color-coded by their groups: IA (orange), IIA (green), IIIA-VIIA (yellow), VIII (blue), and VIIIA (red).

1	IA	H	IIA																		VIIA	He		
2		Li	Be											IIIA	IVA	VA	VIA	VIIA					Ne	
3		Na	Mg	IIIB	IVB	VB	VIIB	VIIIB	VIIIB	VIIIB	VIIIB	VIIIB	VIIIB	IB	IB									Ar
4		K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br						Kr
5		Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I						Xe
6		Cs	Ba	*Lu	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At						Rn
7		Fr	Ra	*Lr	Rf	Db	Sg	Bh	Hs	Mt														

* Lanthanides

57	58	59	60	61	62	63	64	65	66	67	68	69	70
La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb

† Actinides

88	89	90	91	92	93	94	95	96	97	98	99	100	101	102
Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	

Of these 109 elements:

9 naturally radioactive 16 artificial radioactive

Modern Periodic Table

Legend:

- Nonmetals (Yellow)
- Semimetals (Green)
- Metals (Pink)

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	Db	Sg	Bh	Hs	Mt																							
																		Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
																		Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr

Of these 109 elements:

87 metals

8 semimetals

17 nonmetals

Modern Periodic Table

	IA																			VIIA	
1	H																				He
2	Li	Be																			Ne
3	Na	Mg	III B	IV B	V B	VI B	VII B	VIII B	IX B	X B											Ar
4	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br				Kr
5	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I				Xe
6	Cs	Ba	*Lu	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At				Rn
7	Fr	Ra	†Lr	Rf	Db	Sg	Bh	Hs	Mt												

* Lanthanides	57	58	59	60	61	62	63	64	65	66	67	68	69	70
	La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Th	Dy	Ho	Er	Tm	Yb
† Actinides	88	89	90	91	92	93	94	95	96	97	98	99	100	101
	Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No

Of these 109 elements:

11 gases

2 liquids

Properties of Metals

Lustrous, malleable, ductile

Conductors of heat and electricity

Solids at room temperature, except mercury

Lose electrons when reacting with nonmetals

Properties of Non-metals

Physical state varies

Poor conductors of heat and electricity

**Gain electrons when reacting with metals;
share electrons when reacting with other
nonmetals**

Many exist as diatomic molecules

**Can divide elements
into other categories:**

**Representative elements
transition metals
inner transition**

Group Similarities

Certain properties of elements exhibit a gradual change in properties as we go down a group or across a period.

Knowing these trends helps to understand chemical properties

1. Atomic Size (Radius)

Atomic Radii (pm)

1A	2A	3A	4A	5A	6A	7A	8A
Li 152	Be 112	B 85	C 77	N 75	O 73	F 72	Ne 71
Na 186	Mg 160	Al 143	Si 118	P 110	S 103	Cl 100	Ar 98
K 227	Ca 197	Ga 135	Ge 122	As 120	Se 119	Br 114	Kr 112
Rb 248	Sr 215	In 167	Sn 140	Sb 140	Te 142	I 133	Xe 131
Cs 265	Ba 222	Tl 170	Pb 146	Bi 150	Po 168	At (140)	Rn (141)

Within a group

Trend - Atoms get larger

Why? - Electrons go into new shells

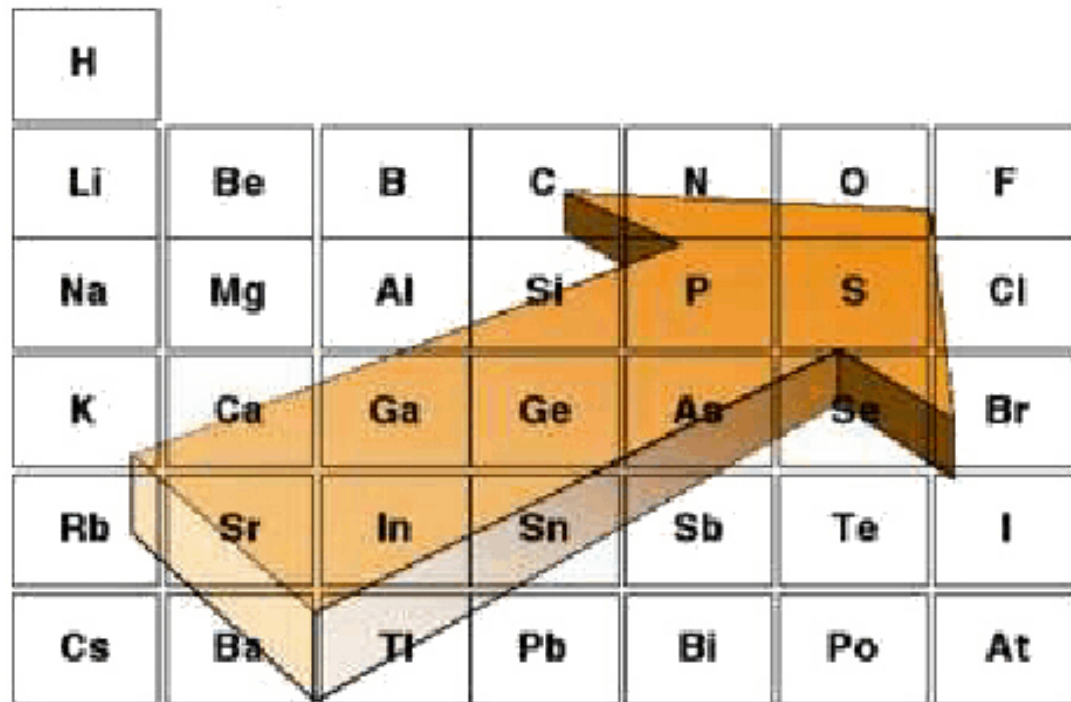
Across a period

Trend - Atoms get smaller

Why? - There are more protons which attract the electrons, making the atom smaller

2. Ionization Energy

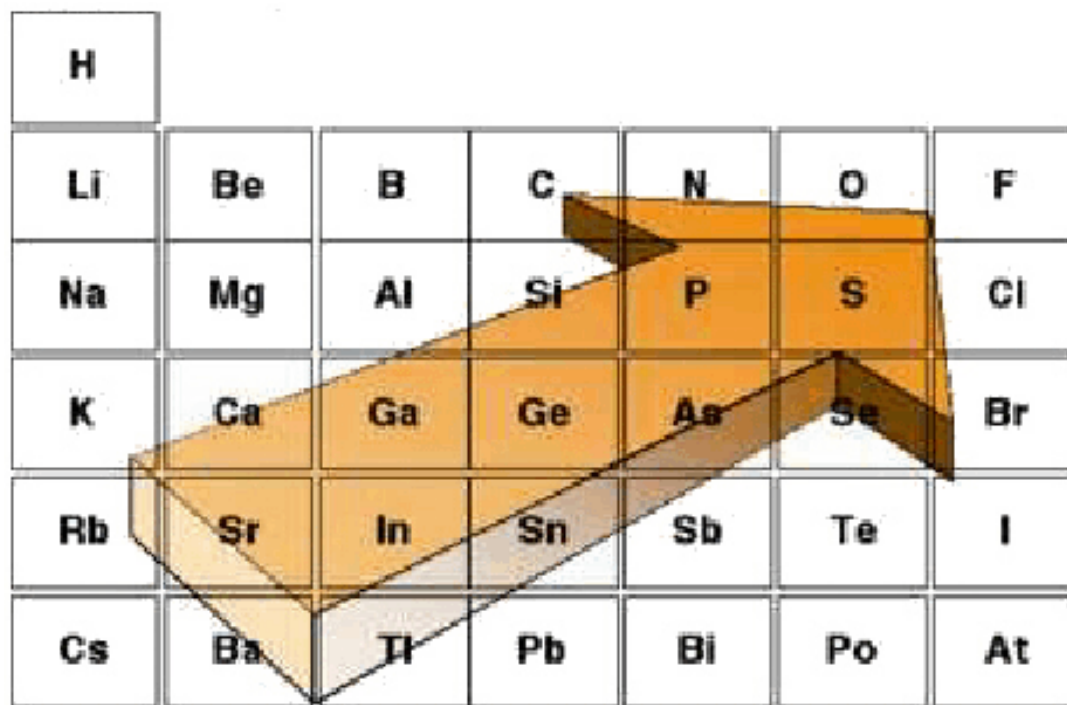
Energy required to remove an electron from valance (outer) shell



H						
Li	Be	B	C	N	O	F
Na	Mg	Al	Si	P	S	Cl
K	Ca	Ga	Ge	As	Se	Br
Rb	Sr	In	Sn	Sb	Te	I
Cs	Ba	Tl	Pb	Bi	Po	At

3. Electronegativity

Ability of an atom to attract electrons



H						
Li	Be	B	C	N	O	F
Na	Mg	Al	Si	P	S	Cl
K	Ca	Ga	Ge	As	Se	Br
Rb	Sr	In	Sn	Sb	Te	I
Cs	Ba	Tl	Pb	Bi	Po	At

Common Group Names

		Alkaline metals														Alkaline metal earths						Halogens	Noble gases
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	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu							
			Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr							

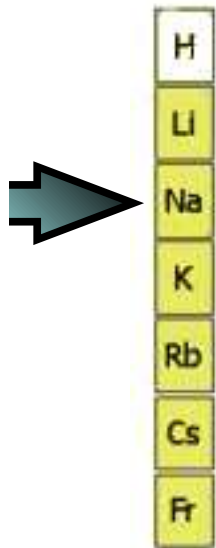
Group Similarities

Alkaline metals																																				Noble gases																	
Alkaline metal earths																																				Noble gases																	
Halogens																																				Noble gases																	
Alkaline metals																																				Noble gases																	
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																																				
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Fr	Ra	Ac																Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu																						
																		Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr																						

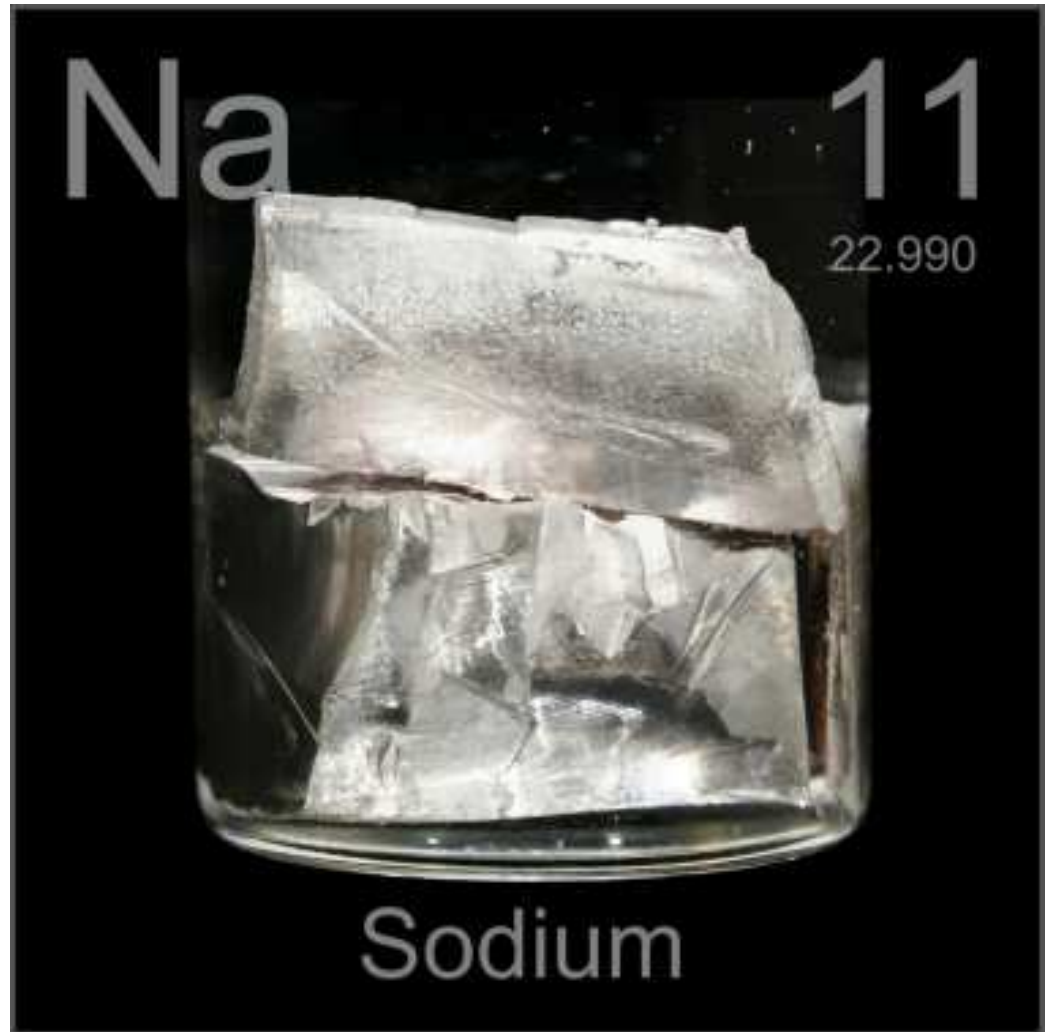
**Elements in a group have similar chemical & physical properties.
Reason: Outer shell has same number of electrons**

Group Similarities

Alkali metals



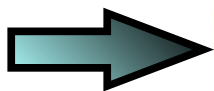
H
Li
Na
K
Rb
Cs
Fr



Group Similarities

Alkali metals

H
Li
Na
K
Rb
Cs
Fr



Why are there rows on the bottom of the periodic table ?

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	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
Cs	Ba	La	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Mn	No	Lr	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
Fr	Ra	Ac																													

This arrangement takes too much space and is hard to read.