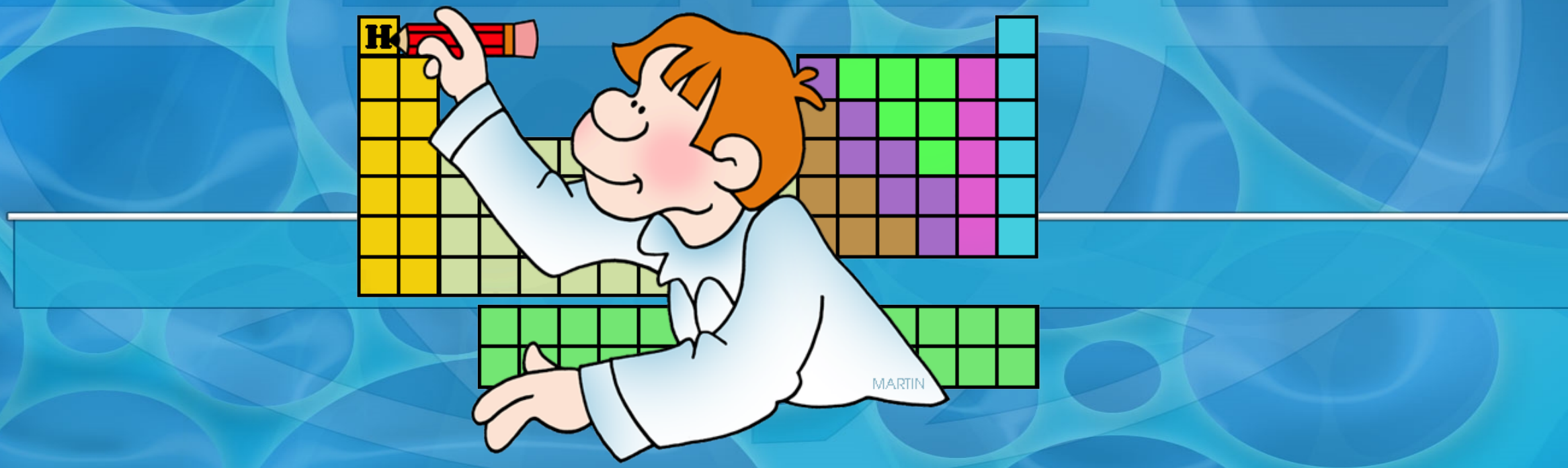
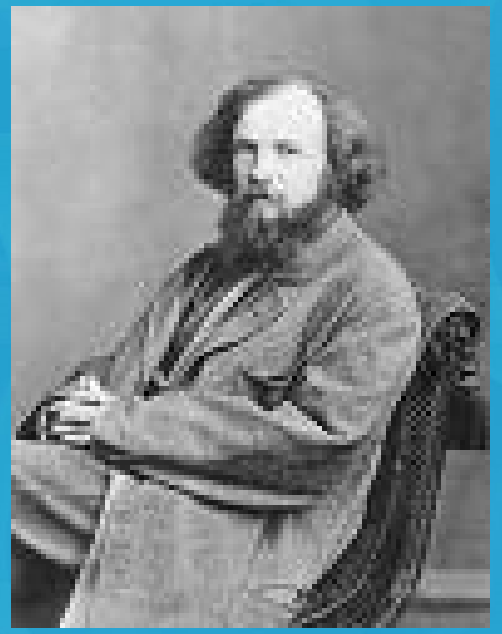
Chapter 5 and Chapter 6

The Periodic Table



Discovering the Elements

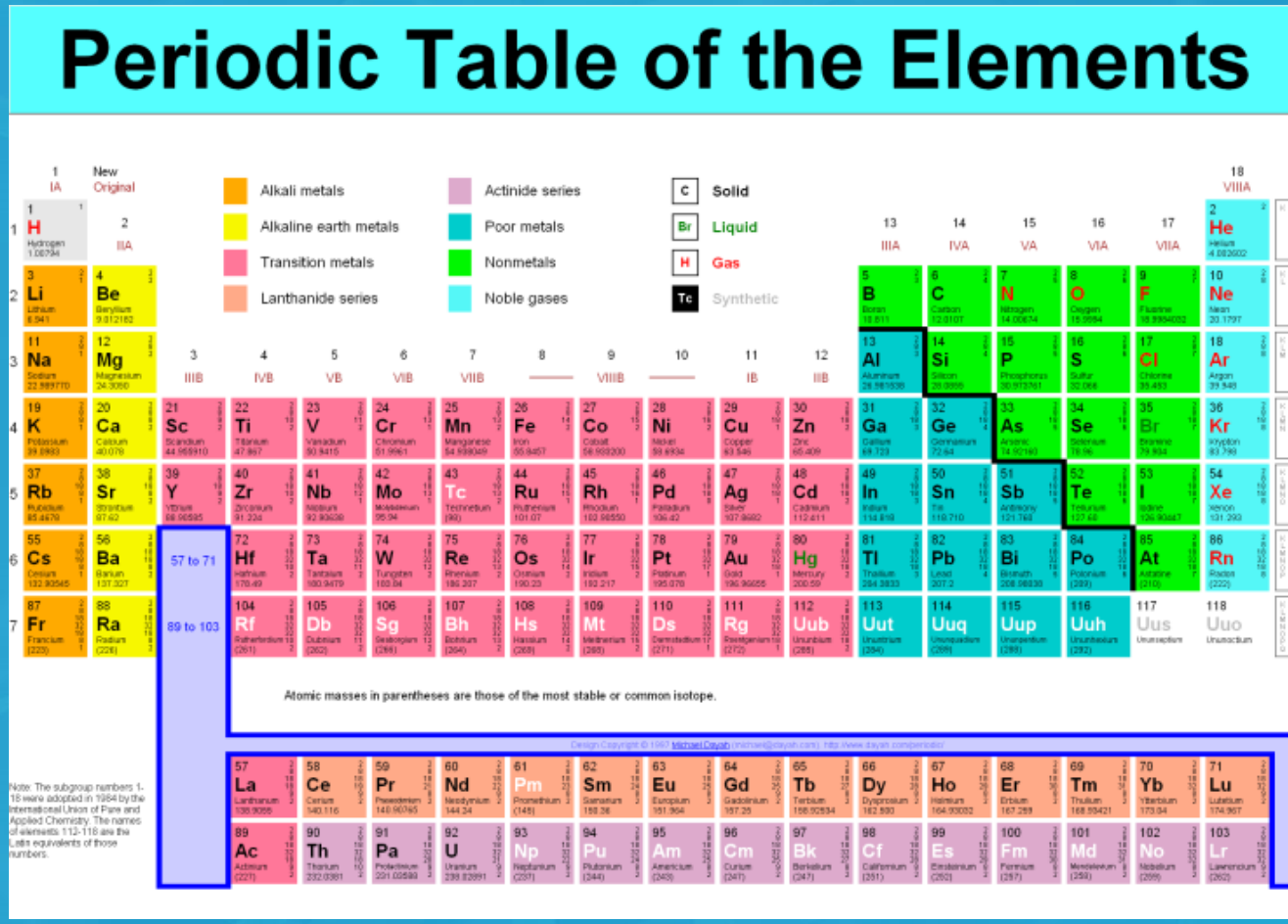
- By the year 1869, sixty three elements had been discovered.
- A Russian scientist named Dmitri Mendeleev discovered that the elements followed certain patterns.



Discovering the Elements

- He noticed that if he put the elements in order of <u>increasing atomic mass</u>, patterns appeared.
- He also noticed that the properties of the elements repeated.
- He put these elements in order by atomic mass, but also grouped them according to properties.

Each color is a different "group" on the Periodic Table.
The elements in these groups share common properties
and will react in similar ways.



Mendeleev's Periodic Table (1872)

TABELLE II

REIHEN	GRUPPE I. — R^2O	GRUPPE II. — RO	GRUPPE III. — R^2O^3	GRUPPE IV. RH^4 RO^2	GRUPPE V. RH^3 R^2O^5	GRUPPE VI. RH^2 RO^3	GRUPPE VII. RH R^2O^7	GRUPPE VIII. — RO^4
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, Cu=63.
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, Ag=108.
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, Au=199.
11	(Au=199)	Hg=200	Tl=204	Pb=207	Bi=208	—	—	
12	—	—	—	Th=231	—	U=240	—	— — — —

Figure 2.5 Dmitri Mendeleev's 1872 periodic table. The spaces marked with blank lines represent elements that Mendeleev deduced existed but were unknown at the time, so he left places for them in the table. The symbols at the top of the columns (e.g., R^2O and RH^4) are molecular formulas written in the style of the 19th century.

Dmitri Mendeleev 1st to publish an organized table of elements.

- Grouped elements by similar chemical properties.
- Arranged elements by increasing mass.

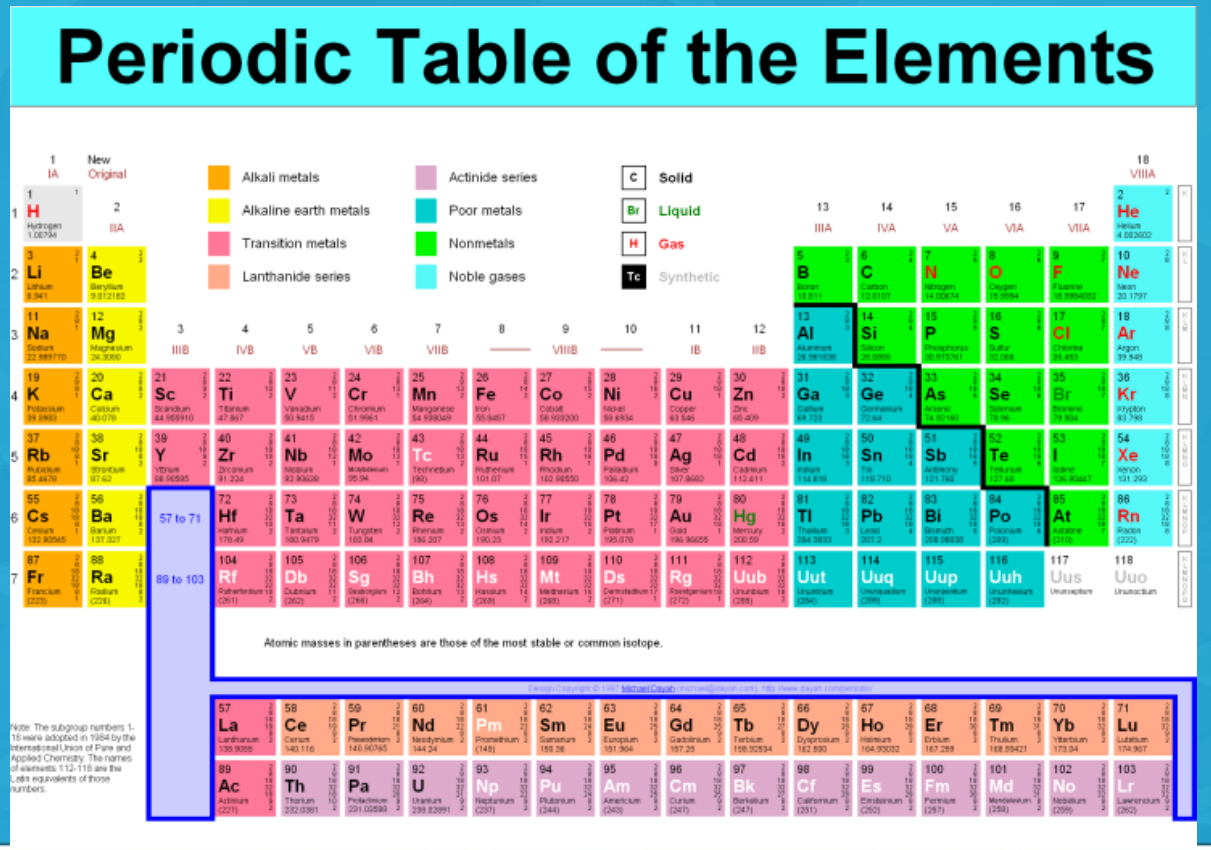
The Modern Periodic Table

-The only major change occurred in 1913, when a scientist named Henry Moseley discovered how to measure an atom's atomic number.

-The Periodic Table was rearranged in order of atomic number instead of atomic mass.

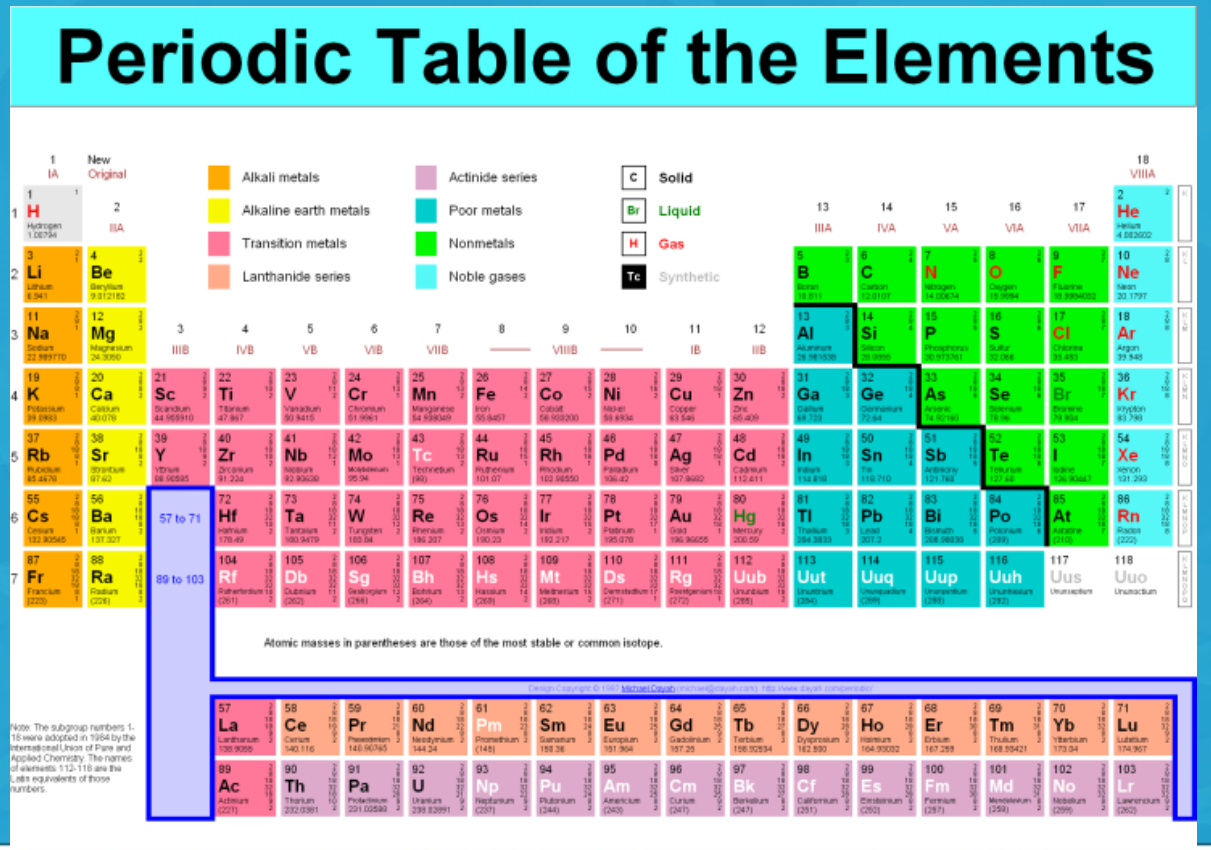
The Modern Periodic Table

- The Periodic Table that we use today is very similar to Mendeleev's first version.
- New elements have been added as they have been discovered.



The Modern Periodic Table

- By definition the periodic table is an arrangement of the elements in order of their atomic numbers so that elements with similar properties fall in the same column or group.



Periodic Law

- -

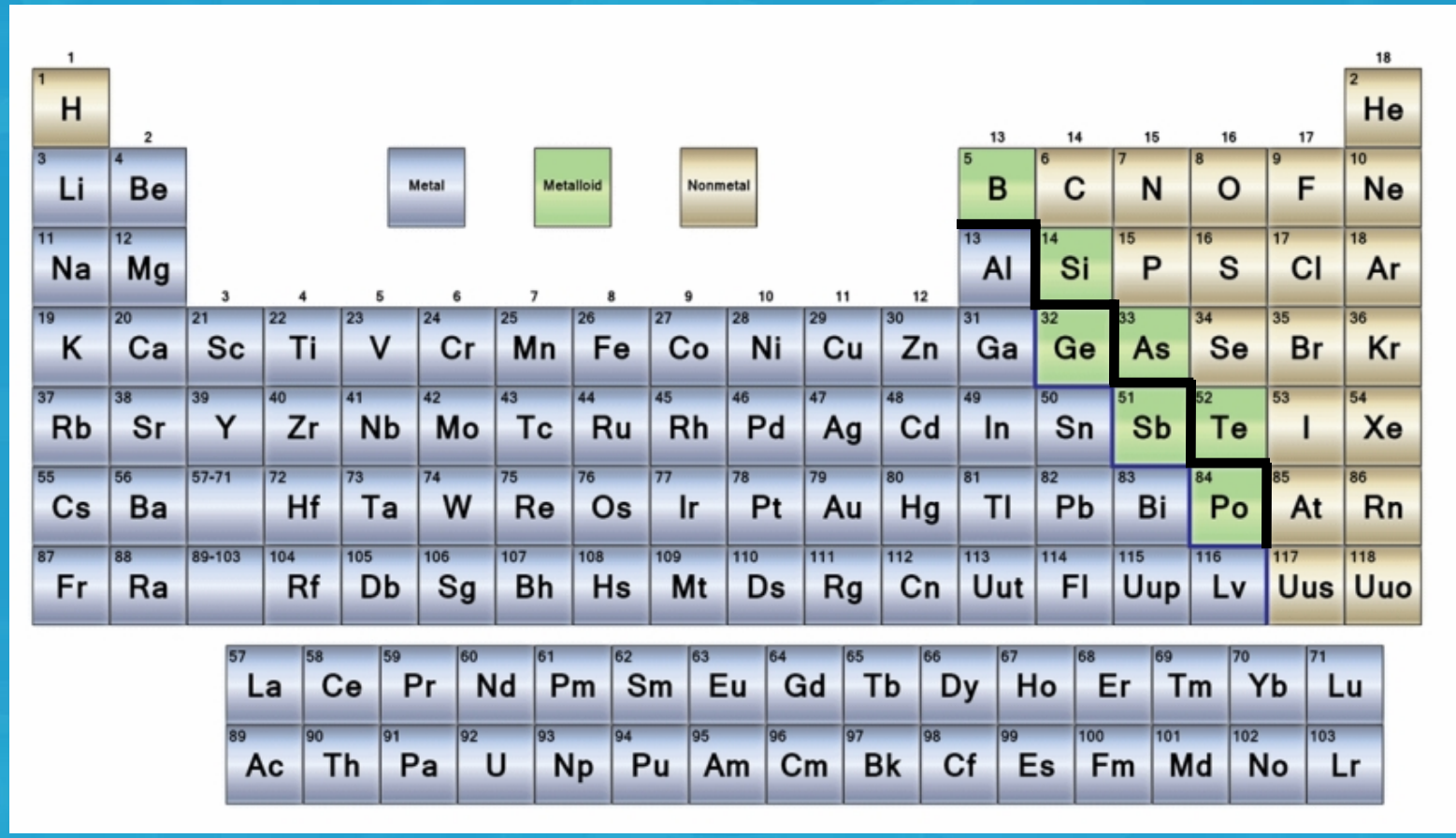
- When elements are arranged in order of increasing atomic number, there is a periodic repetition of their physical and chemical properties.

Elements can be divided into three categories:

Metals – left of the staircase. Form positive ions (cations). Have luster, good conductors, malleable, ductile, most are solids

Nonmetals – right of the staircase
Form negative ions (anions)
Good insulators, dull, brittle, shatter easily

Metalloids (Semi-metals) – either side of the staircase. Intermediate characteristics

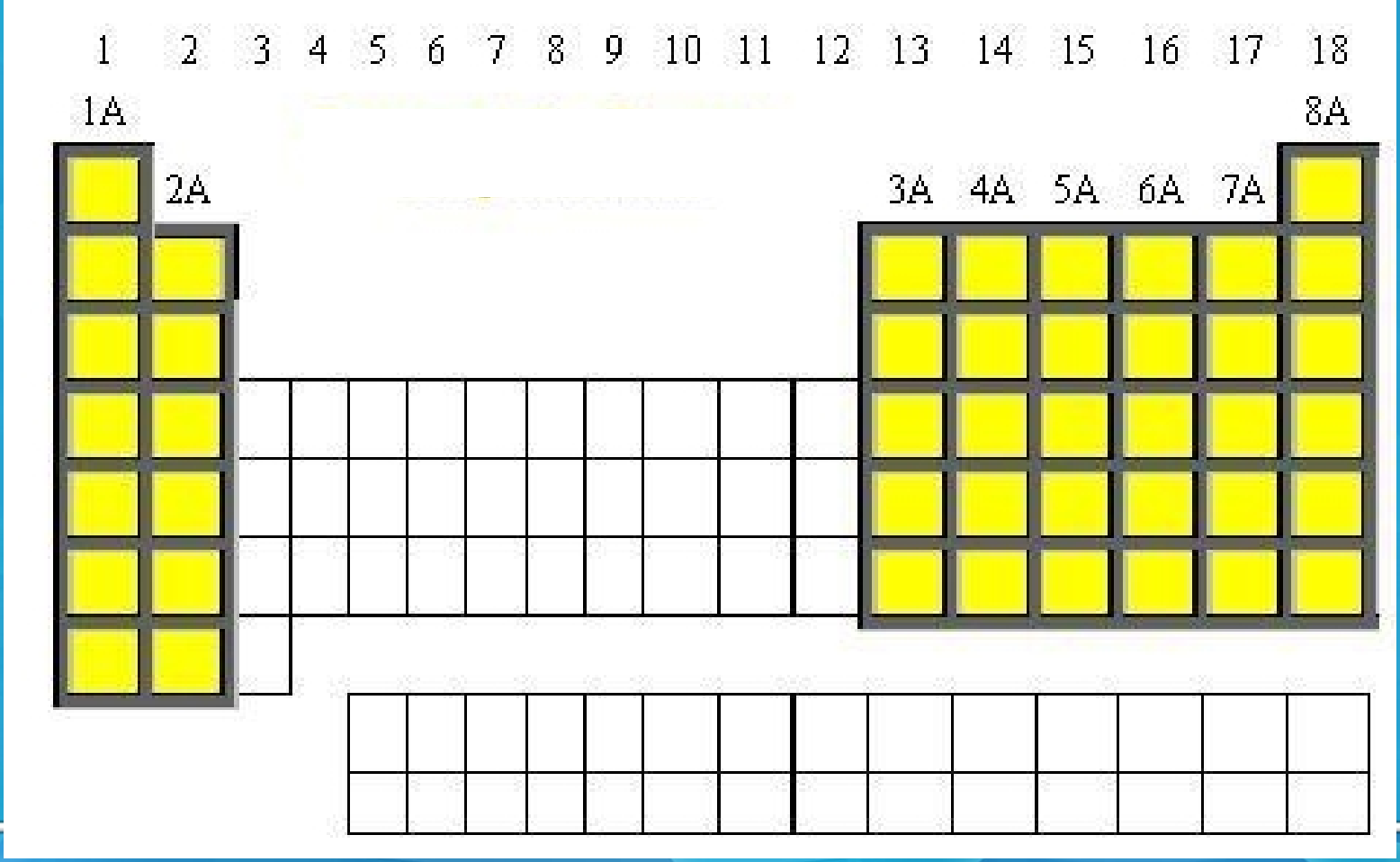


Periodic Table Structure

- The periodic table is arranged in periods (horizontal rows) and families/groups (vertical columns).
- Each new period adds another energy level for electrons.
- Groups may be identified by 1-18 or by Group A/B numbers.

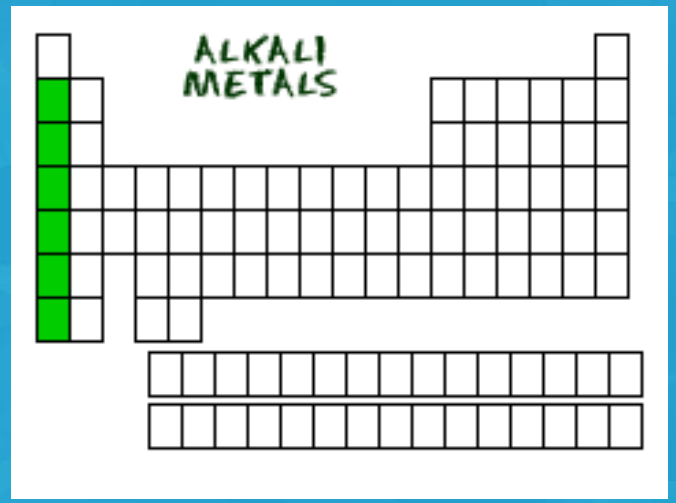
Periodic Table Structure

- Main group elements (representative elements) are groups 1A,2A, 3A-8A



Periodic Table Families

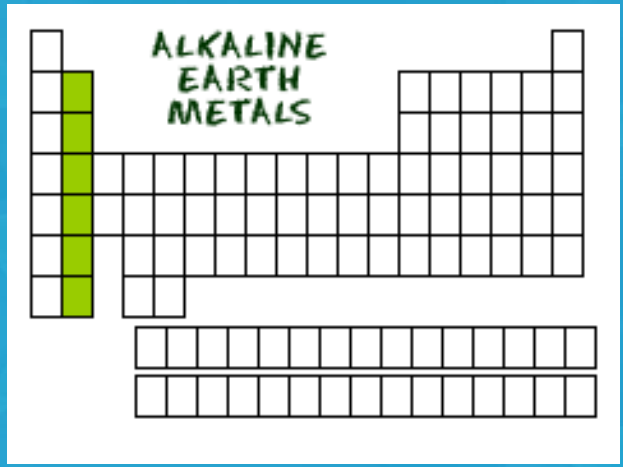
- Alkali Metals (Group 1A)
- One valence electron
- The most reactive metals, therefore usually found in compounds in nature (rarely found by themselves)
- Always form cations with +1 charge



3 Li 6.941	LEAST REACTIVE
11 Na 22.99	
19 K 39.10	
37 Rb 85.47	
55 Cs 132.9	MOST REACTIVE
87 Fr 223	

Periodic Table Families

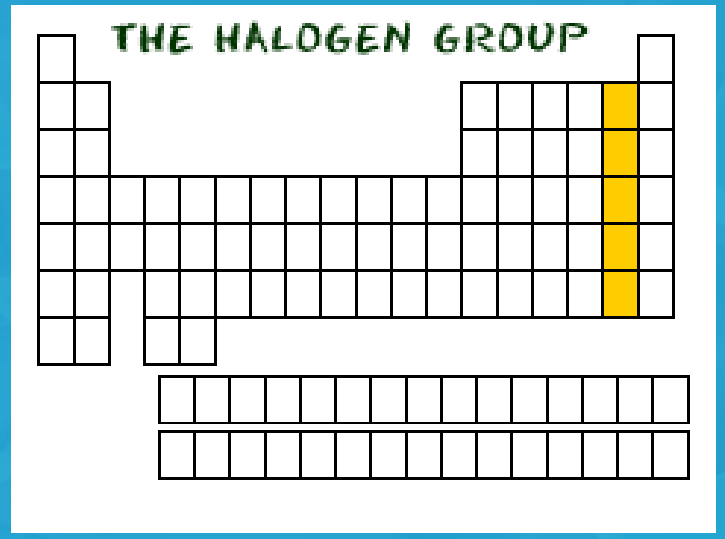
- Alkaline Earth Metals (Group 2A)
- Two valence electrons
- Reactive metals, therefore usually found in compounds in nature (rarely found by themselves)
- Always form cations with a +2 charge.

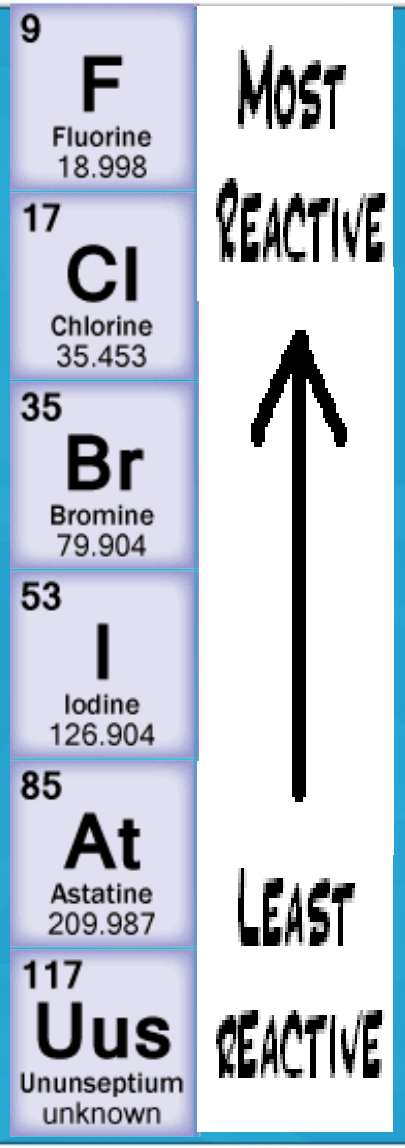


4 Be 9.0122	LEAST REACTIVE
12 Mg 24.305	
20 Ca 40.08	
38 Sr 87.62	
56 Ba 137.53	
88 Ra 226.0254	MOST REACTIVE

Periodic Table Families

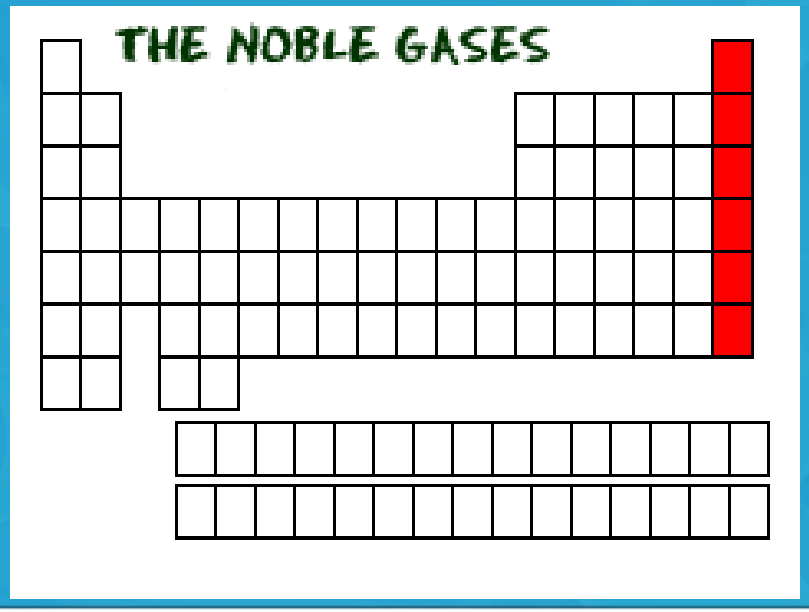
- Halogens (Group 7A)
- Seven valence electrons
- Very reactive nonmetals, therefore usually found in compounds in nature
- Always form anions with a -2 charge.





Periodic Table Families

- Noble Gases (Group 8A)
- Eight valence electrons (full)
- Most are nonreactive/inert
- Do not form ions since it's valence electrons are full



2
He
Helium
4.003

10
Ne
Neon
20.180

18
Ar
Argon
39.948

36
Kr
Krypton
84.798

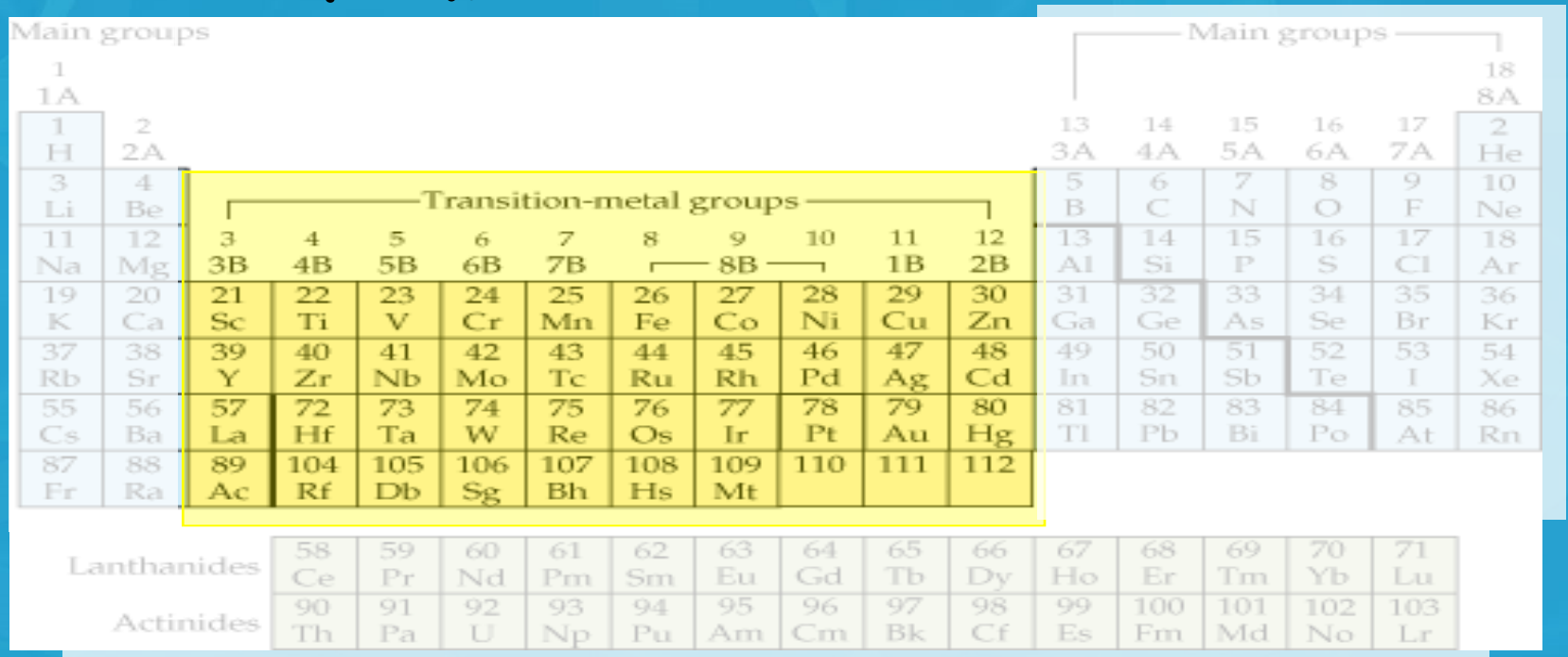
54
Xe
Xenon
131.294

86
Rn
Radon
222.018

118
Uuo
Ununoctium
unknown

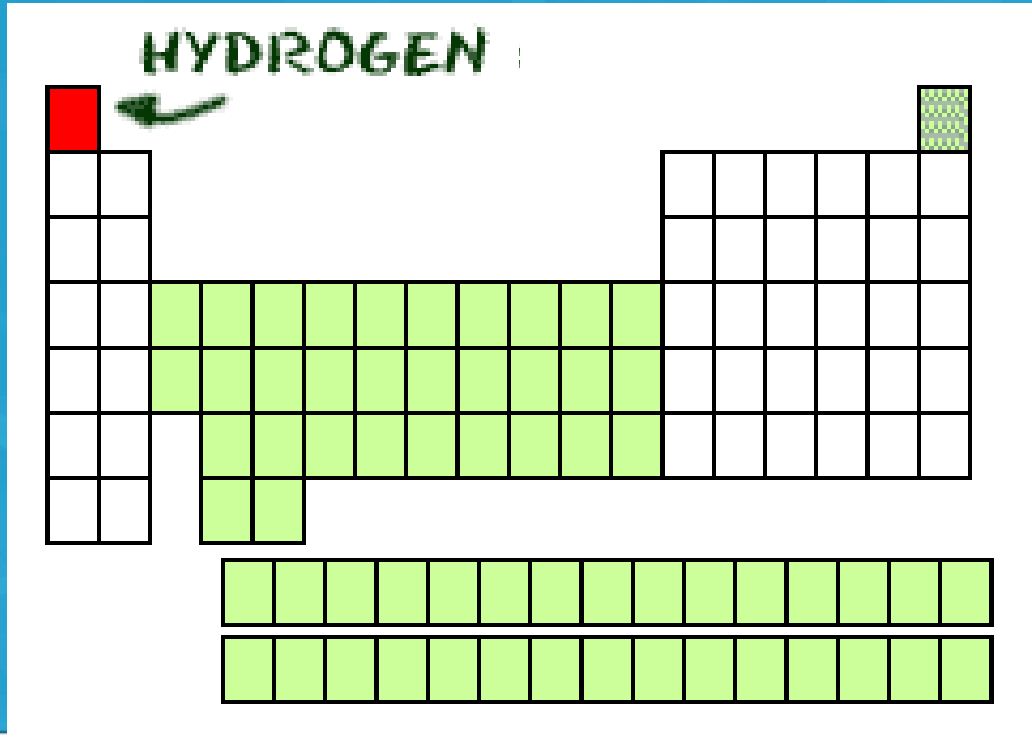
Periodic Table Families

- Transition Metals, B Group (Group 3B-2B)
- Most common metals, known as d block metals
- Can form ions with multiple charges
- Example Cu can form a +1 or +2 cation



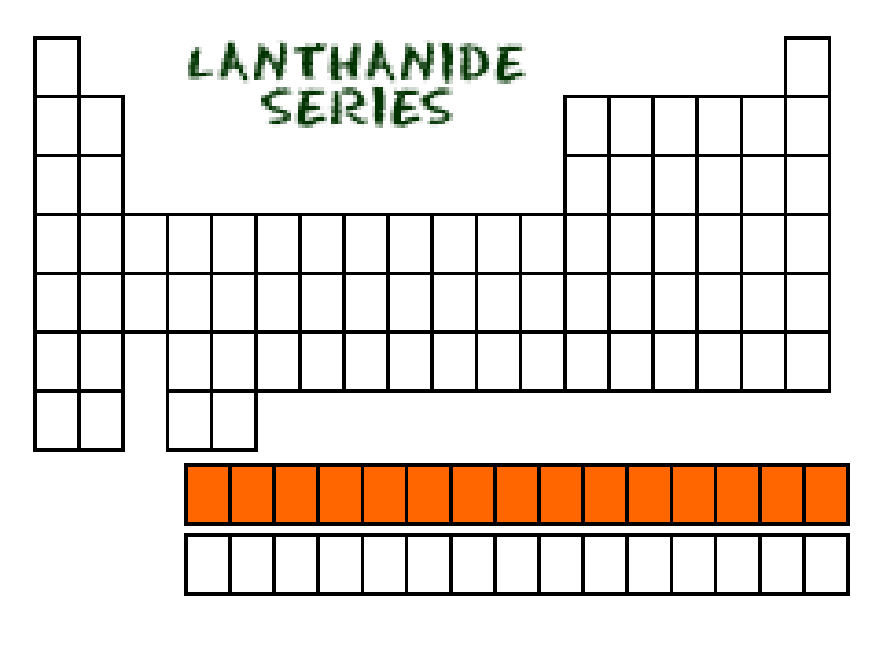
Periodic Table Families

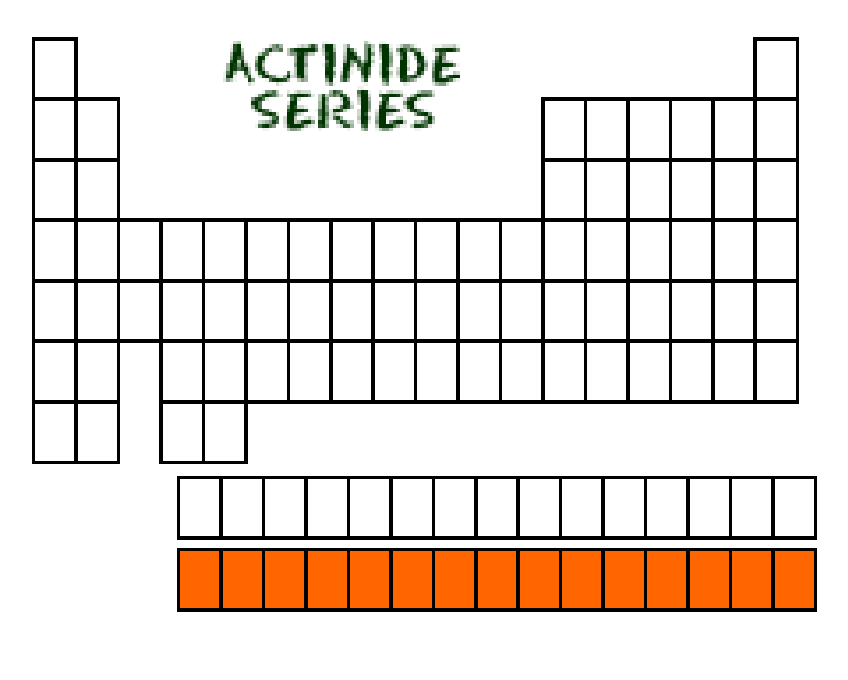
- Hydrogen can behave as a metal (Alkali family) or nonmetal (Halogen family)
- It can form a cation with a +1 charge or an anion with a -1 charge



Periodic Table Families

- Inner Transition Metals (Lanthanide & Actinide Series)
- Most are radioactive
- Also called the rare earth elements





Periodic Table Trends

- Certain patterns seen usually in the main group elements related to particular properties.

Periodic Table Trends

- Atomic radius one half the distance between the nuclei of identical atoms that are bonded together
- Atoms get larger going down a group because each period down adds one energy level (n).
- Atoms get smaller going across a period because more protons pull the electrons closer to the nucleus.
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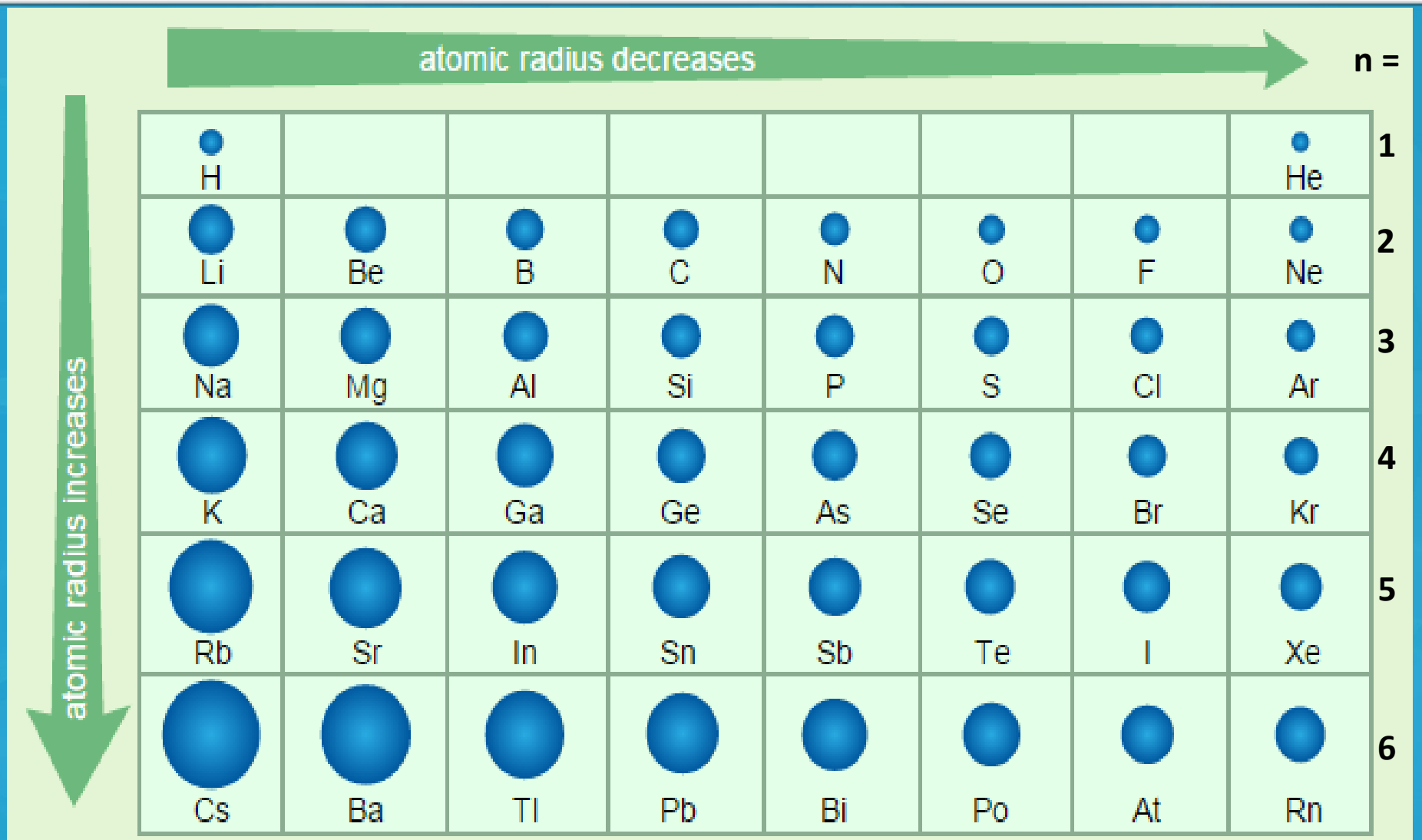
Periodic Table Trends



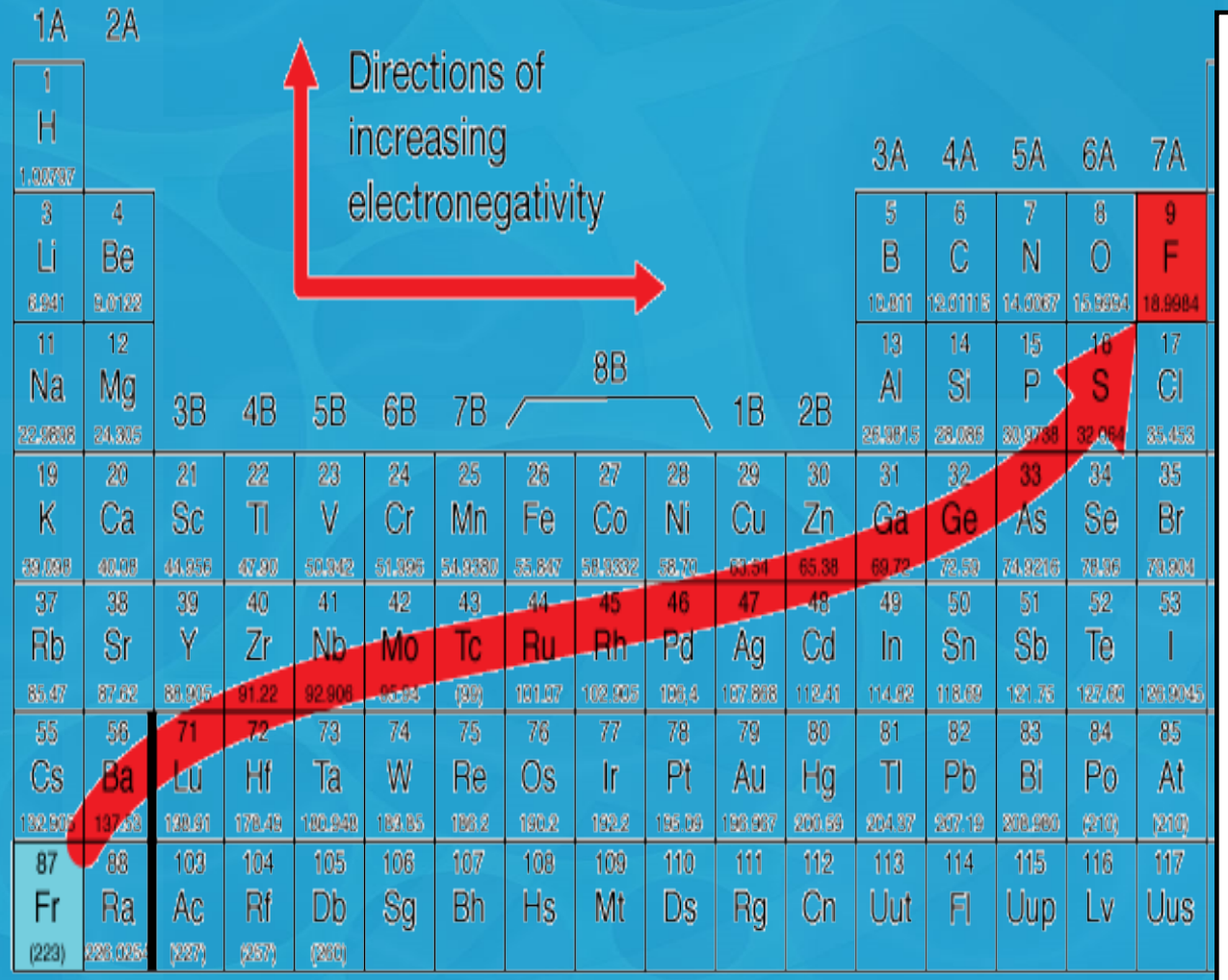
Periodic Table Trends

Electronegativity

- An atom's ability, in a chemical compound, to attract electrons from another atom in a compound.
- Most electronegative → F Least electronegative → Fr
- The more electrons an element has in its valence shell the higher the electronegativity.
- As you move down groups, valence electrons get further away from the positive nucleus.

Periodic Table Trends

- Increases across periods left to right
- Decreases down a group

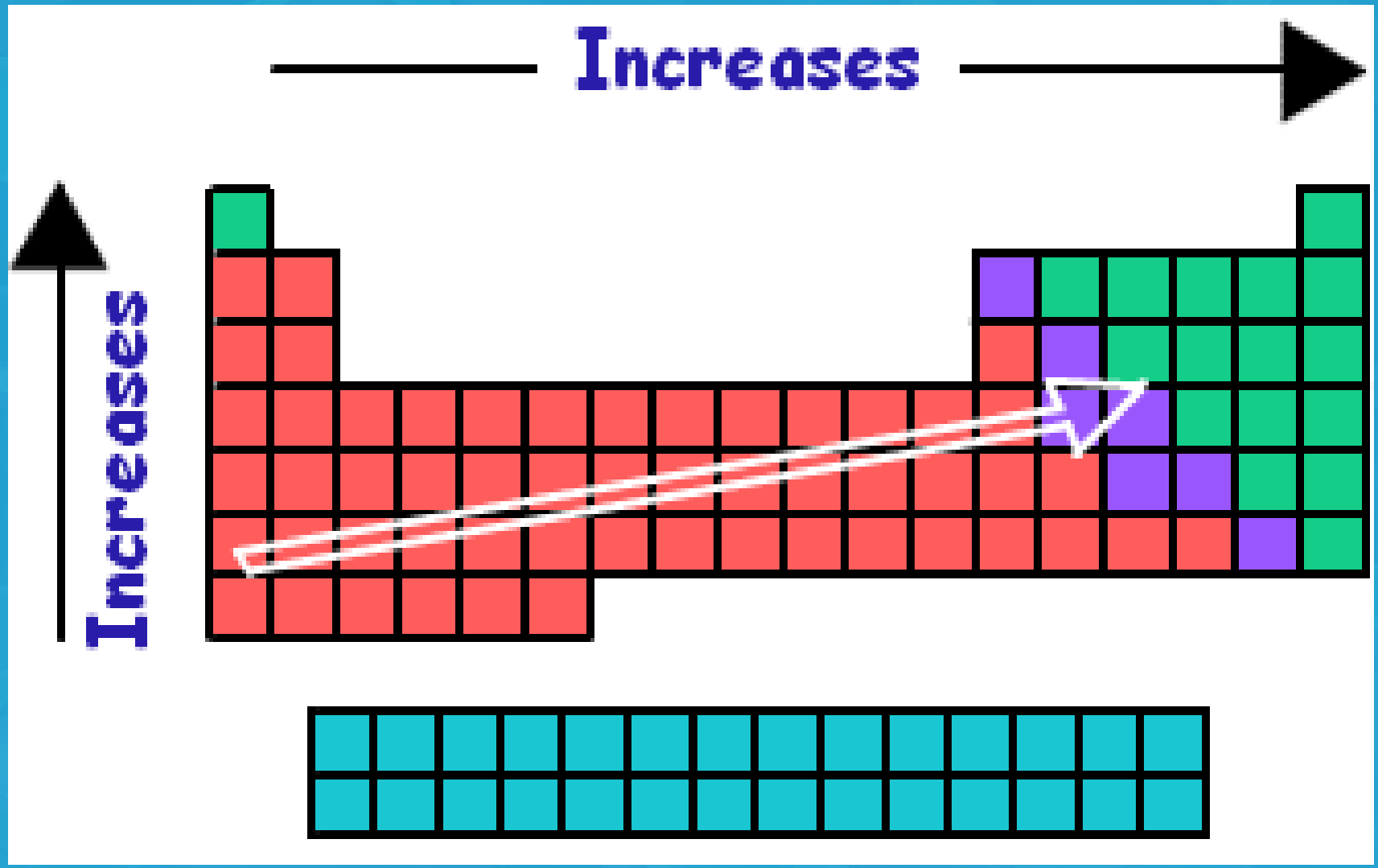


Periodic Table Trends

Ionization energy

- Energy required to remove an electron to create an ion.
- The higher the IE, the harder it is to remove an electron
- Small atoms have a large IE because the electrons are very close to the positive nucleus
- Atoms with a large EN have a large IE because if it is easy for the atom to grab electrons it will be very difficult to remove the electrons it has.

Periodic Table Trends



Chemical Bonding

- Chemical bond: A mutual electrical attraction between the nuclei & valence electrons of different atoms that bind the atoms together.

Two Types

- Ionic results from the electrical attraction between cations and anions

- Covalent results from the sharing of electron pairs between two atoms

Chemical Bonding

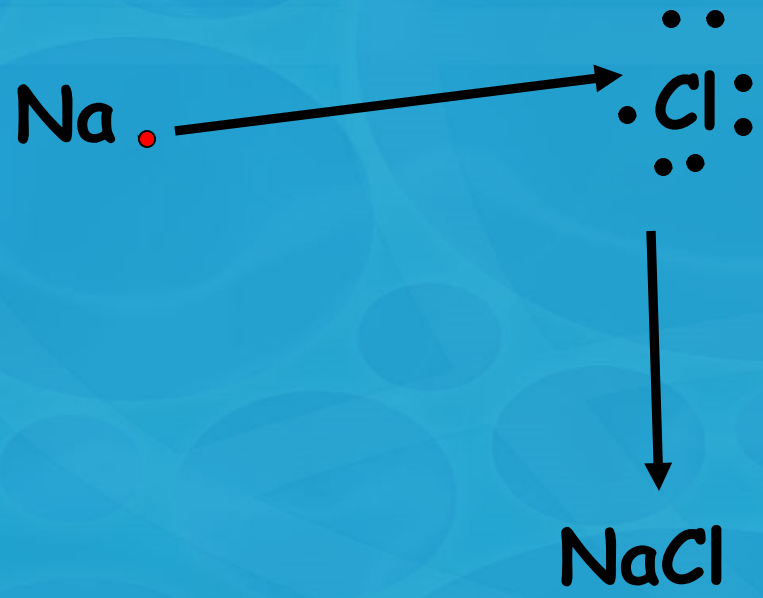
Ionic Bonding

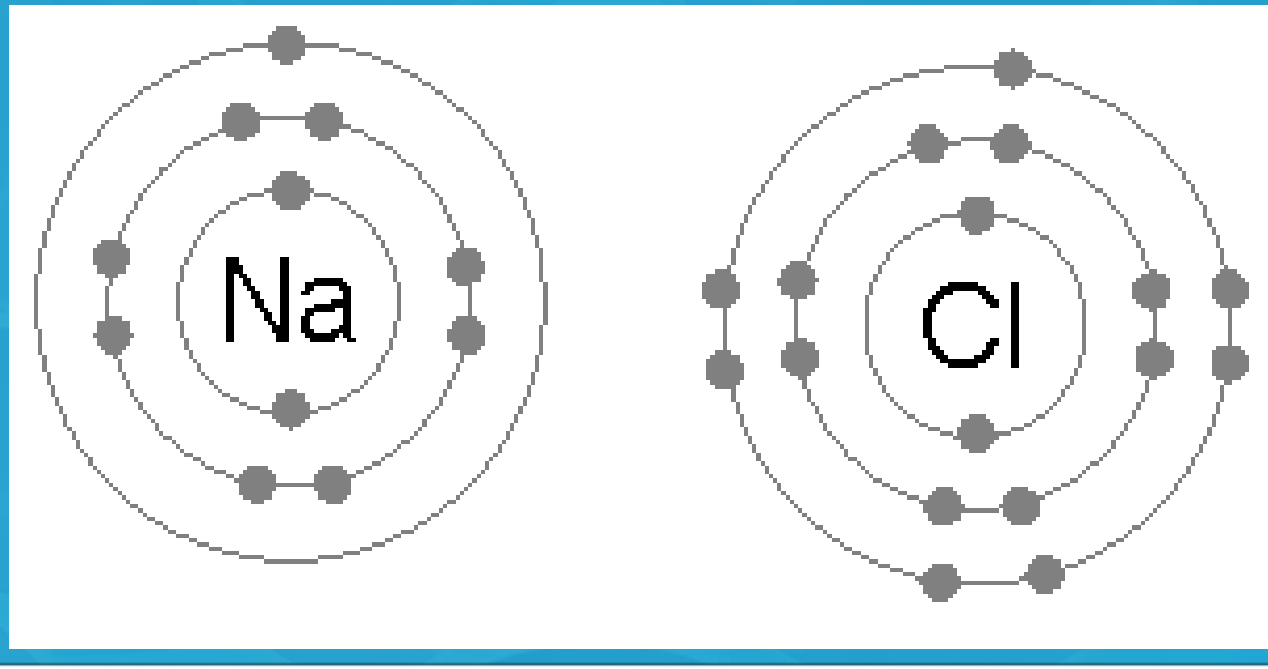
- Atoms are stable when their outermost shell is full (8 electrons
- Atoms need to gain or lose electrons in order to gain the octet
- Results in formation of cations (metals), losing electrons and anions (non-metals), gaining electrons

Chemical Bonding

Ionic Bonding

- Valence electrons are lost by the metal and gained by the non-metal





Ionic Bonds Properties

- High melting and boiling points
- Good conductors of heat and electricity
- Form crystalline structures
- Ionic bonds are usually strong and stable

Covalent Bonds

- Occurs between two non-metals
- Electrons are shared by both atoms to attain an octet
- A molecule forms when two or more atoms bond covalently
- Atoms may not share electrons equally

Covalent Bonds

- When this occurs the bond formed between them is a polar covalent bond

- If the covalent bond formed is shared equally between the two atoms it is non-polar covalent

Covalent Bonds Properties

- Low melting and boiling points
- Most are liquids and gases at room temperature
- Non-conductors of heat and electricity