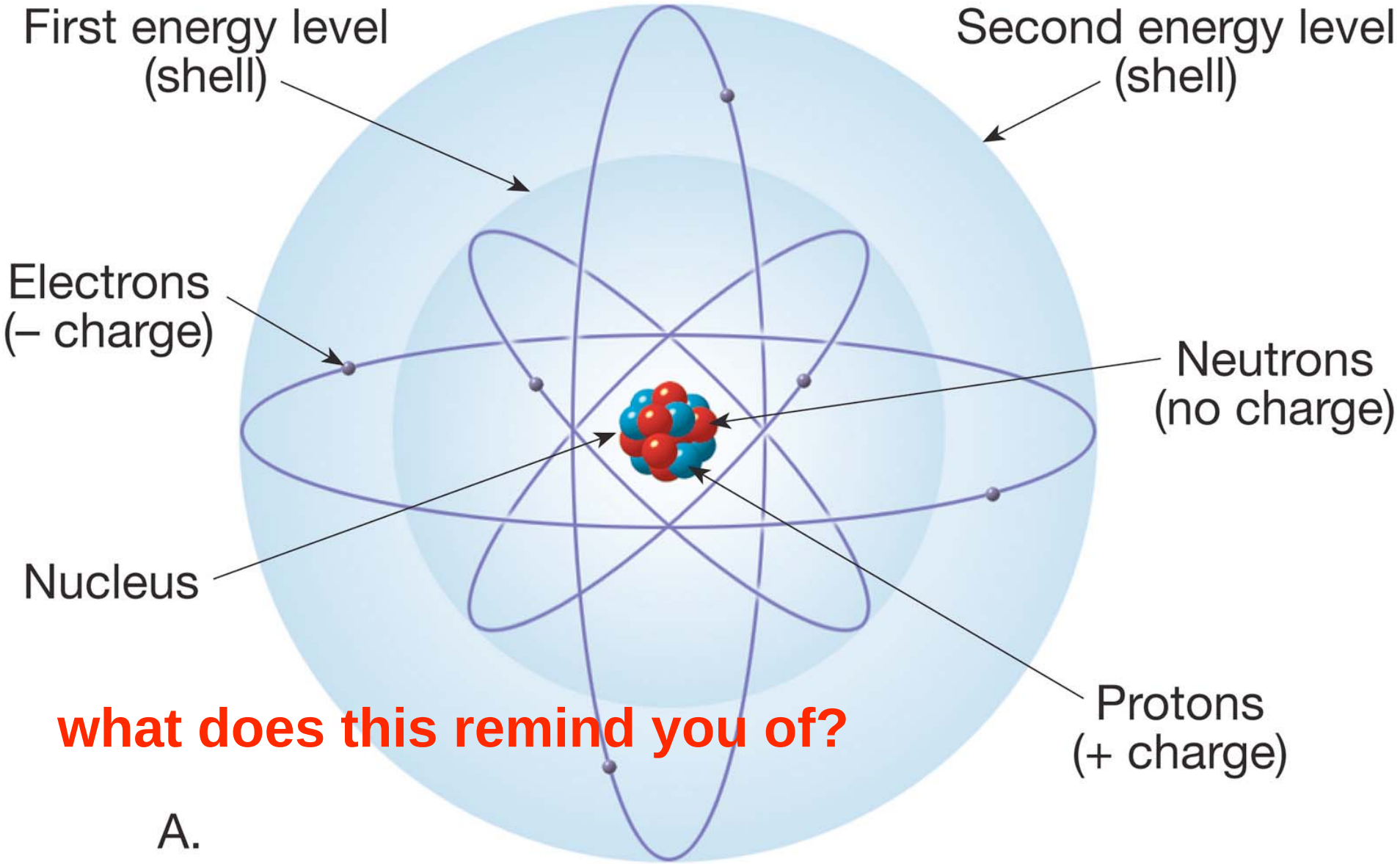
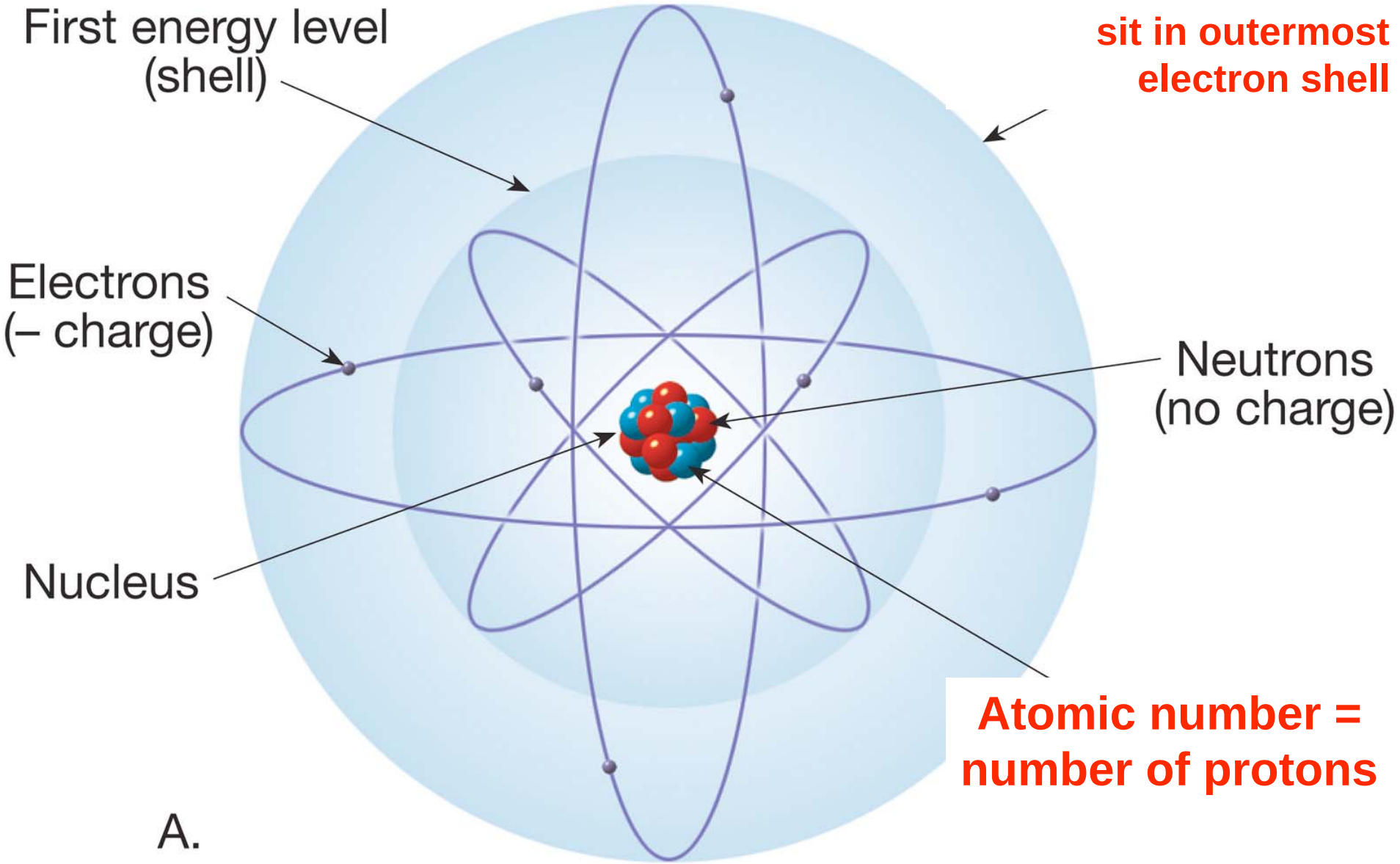
smallest possible particle of a chemical element that retains that element's chemical properties

smallest possible particle of a chemical element that retains its chemical properties = ATOM



what does this remind you of?

Valence electrons
sit in outermost electron shell

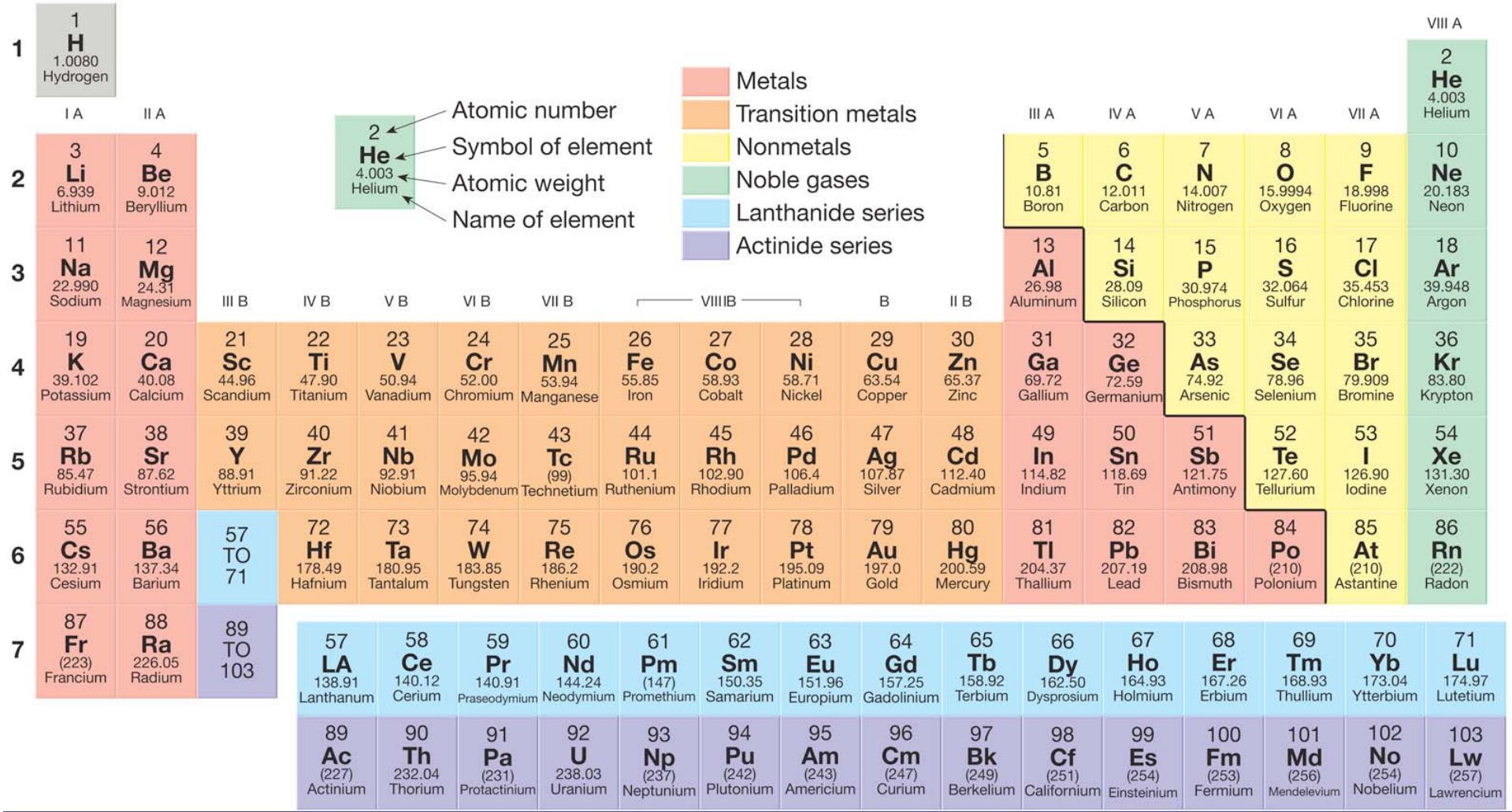


Atomic number = number of protons

particle — smallest possible particle of a chemical element that retains that element's chemical properties
=
ATOM

substance — a substance that cannot be decomposed or transformed into other chemical substances by ordinary chemical processes
=
?

a substance that cannot be decomposed or transformed into other chemical substances by ordinary chemical processes = ELEMENT



	I A	II A	III B	IV B	V B	VI B	VII B	VIII B			B	II B	III A	IV A	V A	VI A	VII A	VIII A
1	1 H 1.0080 Hydrogen																	2 He 4.003 Helium
2	3 Li 6.939 Lithium	4 Be 9.012 Beryllium											5 B 10.81 Boron	6 C 12.011 Carbon	7 N 14.007 Nitrogen	8 O 15.9994 Oxygen	9 F 18.998 Fluorine	10 Ne 20.183 Neon
3	11 Na 22.990 Sodium	12 Mg 24.31 Magnesium											13 Al 26.98 Aluminum	14 Si 28.09 Silicon	15 P 30.974 Phosphorus	16 S 32.064 Sulfur	17 Cl 35.453 Chlorine	18 Ar 39.948 Argon
4	19 K 39.102 Potassium	20 Ca 40.08 Calcium	21 Sc 44.96 Scandium	22 Ti 47.90 Titanium	23 V 50.94 Vanadium	24 Cr 52.00 Chromium	25 Mn 53.94 Manganese	26 Fe 55.85 Iron	27 Co 58.93 Cobalt	28 Ni 58.71 Nickel	29 Cu 63.54 Copper	30 Zn 65.37 Zinc	31 Ga 69.72 Gallium	32 Ge 72.59 Germanium	33 As 74.92 Arsenic	34 Se 78.96 Selenium	35 Br 79.909 Bromine	36 Kr 83.80 Krypton
5	37 Rb 85.47 Rubidium	38 Sr 87.62 Strontium	39 Y 88.91 Yttrium	40 Zr 91.22 Zirconium	41 Nb 92.91 Niobium	42 Mo 95.94 Molybdenum	43 Tc (99) Technetium	44 Ru 101.1 Ruthenium	45 Rh 102.90 Rhodium	46 Pd 106.4 Palladium	47 Ag 107.87 Silver	48 Cd 112.40 Cadmium	49 In 114.82 Indium	50 Sn 118.69 Tin	51 Sb 121.75 Antimony	52 Te 127.60 Tellurium	53 I 126.90 Iodine	54 Xe 131.30 Xenon
6	55 Cs 132.91 Cesium	56 Ba 137.34 Barium	57 TO 71	72 Hf 178.49 Hafnium	73 Ta 180.95 Tantalum	74 W 183.85 Tungsten	75 Re 186.2 Rhenium	76 Os 190.2 Osmium	77 Ir 192.2 Iridium	78 Pt 195.09 Platinum	79 Au 197.0 Gold	80 Hg 200.59 Mercury	81 Tl 204.37 Thallium	82 Pb 207.19 Lead	83 Bi 208.98 Bismuth	84 Po (210) Polonium	85 At (210) Astantine	86 Rn (222) Radon
7	87 Fr (223) Francium	88 Ra 226.05 Radium	89 TO 103															

57 LA 138.91 Lanthanum	58 Ce 140.12 Cerium	59 Pr 140.91 Praseodymium	60 Nd 144.24 Neodymium	61 Pm (147) Promethium	62 Sm 150.35 Samarium	63 Eu 151.96 Europium	64 Gd 157.25 Gadolinium	65 Tb 158.92 Terbium	66 Dy 162.50 Dysprosium	67 Ho 164.93 Holmium	68 Er 167.26 Erbium	69 Tm 168.93 Thullium	70 Yb 173.04 Ytterbium	71 Lu 174.97 Lutetium
89 Ac (227) Actinium	90 Th 232.04 Thorium	91 Pa (231) Protactinium	92 U 238.03 Uranium	93 Np (237) Neptunium	94 Pu (242) Plutonium	95 Am (243) Americium	96 Cm (247) Curium	97 Bk (249) Berkelium	98 Cf (251) Californium	99 Es (254) Einsteinium	100 Fm (253) Fermium	101 Md (256) Mendelevium	102 No (254) Nobelium	103 Lw (257) Lawrencium

Periodic Table first created in 1869 by the Russian chemist Dmitri Mendeleev

The New York Times

Science

WORLD | U.S. | N.Y. / REGION | BUSINESS | TECHNOLOGY | SCIENCE | HEALTH | SPORTS | OPINION

ENVIRONMENT | SPACE & COSMOS

Scientists Gather to Finalize Climate Report



Maya Vidon/European Pressphoto Agency

Rajendra Pachauri, the chairman of the Intergovernmental Panel on Climate Change, spoke to delegates today in Paris.

By JAMES KANTER and ANDREW C. REVKIN
Published: January 29, 2007

PARIS, Jan 29 — Scientists from across the world gathered here today to hammer out the final details of an authoritative report on climate change that is expected to project centuries of rising temperatures and sea levels unless curbs are placed on emissions of carbon dioxide and other gases that trap heat in the atmosphere.

E-MAIL
PRINT
SINGLE PAGE
REPRINTS
SAVE
SHARE

World's biggest producer of greenhouse gases?

Intergovernmental Panel on Climate Change (IPCC)

90% certainty that humans have caused observed global warming since 1950

Arctic Ocean will be without summer sea ice before end of century

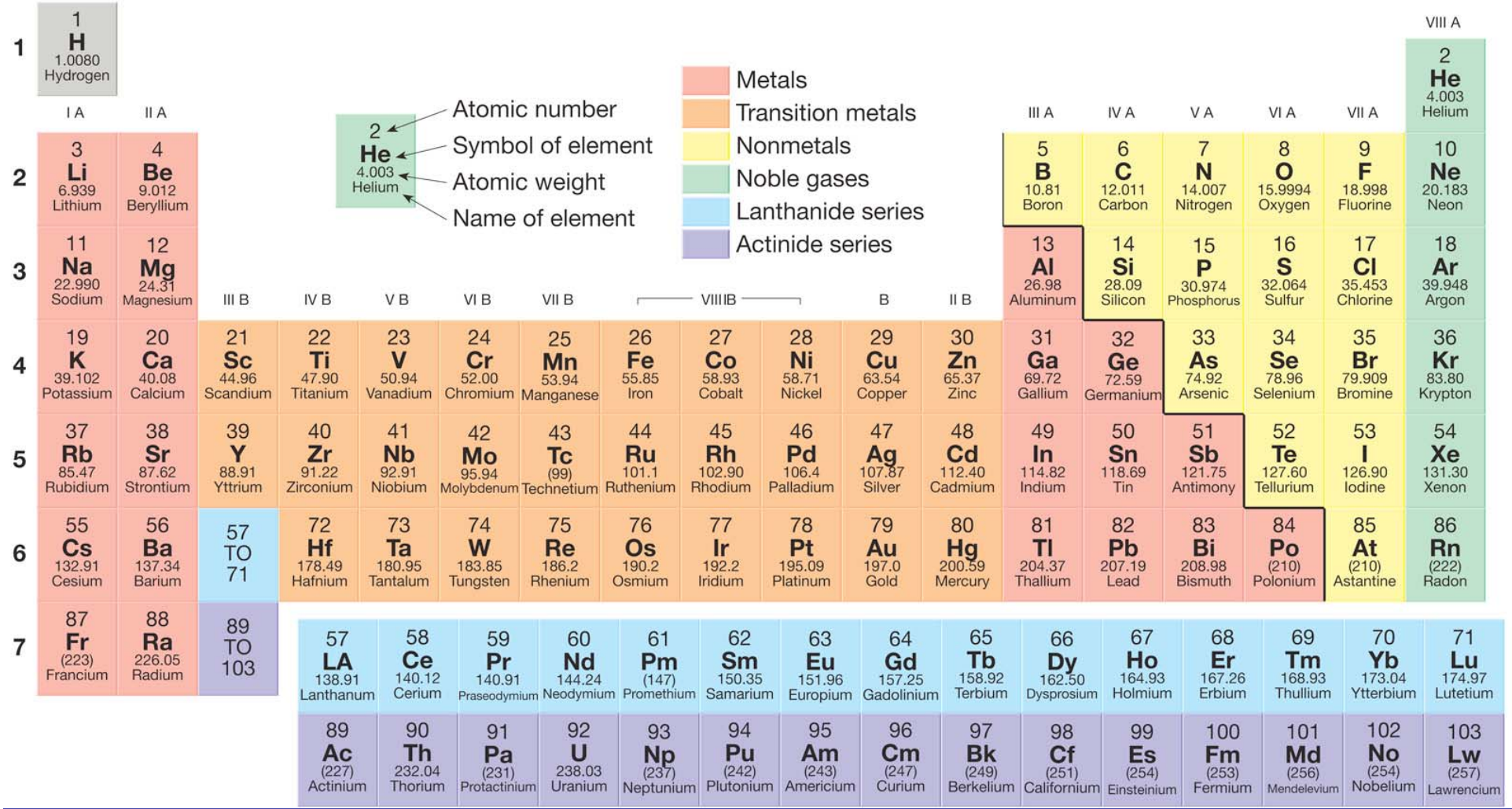
Mediterranean shores nearly uninhabitable in summer, Alps too warm to support ski industry

Growing seasons in temperate regions will expand, droughts worse in southern Africa/Asia

Sea level will rise for 1000+ years

In Indonesia alone, 2000 islands under water

Organized by: 1) atomic number / atomic weight



	I A	II A	III B	IV B	V B	VI B	VII B	VIII B			B	II B	III A	IV A	V A	VI A	VII A	VIII A
1	1 H 1.0080 Hydrogen																	2 He 4.003 Helium
2	3 Li 6.939 Lithium	4 Be 9.012 Beryllium											5 B 10.81 Boron	6 C 12.011 Carbon	7 N 14.007 Nitrogen	8 O 15.9994 Oxygen	9 F 18.998 Fluorine	10 Ne 20.183 Neon
3	11 Na 22.990 Sodium	12 Mg 24.31 Magnesium											13 Al 26.98 Aluminum	14 Si 28.09 Silicon	15 P 30.974 Phosphorus	16 S 32.064 Sulfur	17 Cl 35.453 Chlorine	18 Ar 39.948 Argon
4	19 K 39.102 Potassium	20 Ca 40.08 Calcium	21 Sc 44.96 Scandium	22 Ti 47.90 Titanium	23 V 50.94 Vanadium	24 Cr 52.00 Chromium	25 Mn 53.94 Manganese	26 Fe 55.85 Iron	27 Co 58.93 Cobalt	28 Ni 58.71 Nickel	29 Cu 63.54 Copper	30 Zn 65.37 Zinc	31 Ga 69.72 Gallium	32 Ge 72.59 Germanium	33 As 74.92 Arsenic	34 Se 78.96 Selenium	35 Br 79.909 Bromine	36 Kr 83.80 Krypton
5	37 Rb 85.47 Rubidium	38 Sr 87.62 Strontium	39 Y 88.91 Yttrium	40 Zr 91.22 Zirconium	41 Nb 92.91 Niobium	42 Mo 95.94 Molybdenum	43 Tc (99) Technetium	44 Ru 101.1 Ruthenium	45 Rh 102.90 Rhodium	46 Pd 106.4 Palladium	47 Ag 107.87 Silver	48 Cd 112.40 Cadmium	49 In 114.82 Indium	50 Sn 118.69 Tin	51 Sb 121.75 Antimony	52 Te 127.60 Tellurium	53 I 126.90 Iodine	54 Xe 131.30 Xenon
6	55 Cs 132.91 Cesium	56 Ba 137.34 Barium	57 TO 71	72 Hf 178.49 Hafnium	73 Ta 180.95 Tantalum	74 W 183.85 Tungsten	75 Re 186.2 Rhenium	76 Os 190.2 Osmium	77 Ir 192.2 Iridium	78 Pt 195.09 Platinum	79 Au 197.0 Gold	80 Hg 200.59 Mercury	81 Tl 204.37 Thallium	82 Pb 207.19 Lead	83 Bi 208.98 Bismuth	84 Po (210) Polonium	85 At (210) Astantine	86 Rn (222) Radon
7	87 Fr (223) Francium	88 Ra 226.05 Radium	89 TO 103															

57 LA 138.91 Lanthanum	58 Ce 140.12 Cerium	59 Pr 140.91 Praseodymium	60 Nd 144.24 Neodymium	61 Pm (147) Promethium	62 Sm 150.35 Samarium	63 Eu 151.96 Europium	64 Gd 157.25 Gadolinium	65 Tb 158.92 Terbium	66 Dy 162.50 Dysprosium	67 Ho 164.93 Holmium	68 Er 167.26 Erbium	69 Tm 168.93 Thullium	70 Yb 173.04 Ytterbium	71 Lu 174.97 Lutetium
89 Ac (227) Actinium	90 Th 232.04 Thorium	91 Pa (231) Protactinium	92 U 238.03 Uranium	93 Np (237) Neptunium	94 Pu (242) Plutonium	95 Am (243) Americium	96 Cm (247) Curium	97 Bk (249) Berkelium	98 Cf (251) Californium	99 Es (254) Einsteinium	100 Fm (253) Fermium	101 Md (256) Mendelevium	102 No (254) Nobelium	103 Lw (257) Lawrencium

How are these related?

Organized by: 2) rows – indicate how many electron shells total

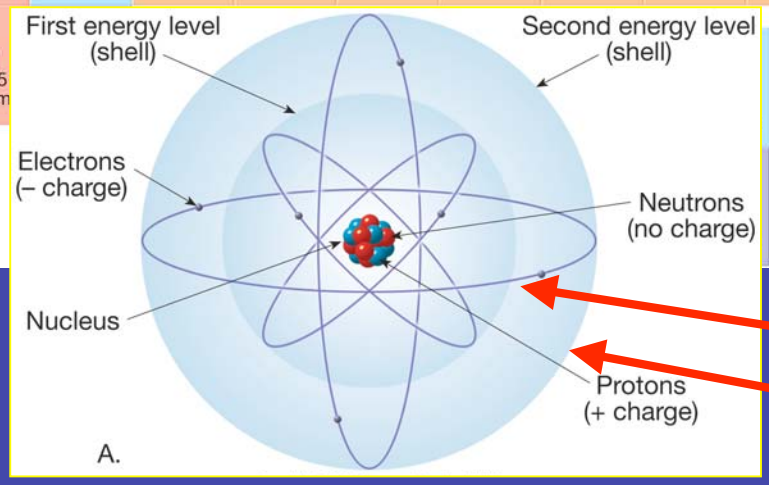
	I A	II A	III B	IV B	V B	VI B	VII B	VIIIB			B	II B	III A	IV A	V A	VI A	VII A	VIII A
1	1 H 1.0080 Hydrogen																	2 He 4.003 Helium
2	3 Li 6.939 Lithium	4 Be 9.012 Beryllium											5 B 10.81 Boron	6 C 12.011 Carbon	7 N 14.007 Nitrogen	8 O 15.9994 Oxygen	9 F 18.998 Fluorine	10 Ne 20.183 Neon
3	11 Na 22.990 Sodium	12 Mg 24.31 Magnesium											13 Al 26.98 Aluminum	14 Si 28.09 Silicon	15 P 30.974 Phosphorus	16 S 32.064 Sulfur	17 Cl 35.453 Chlorine	18 Ar 39.948 Argon
4	19 K 39.102 Potassium	20 Ca 40.08 Calcium	21 Sc 44.96 Scandium	22 Ti 47.90 Titanium	23 V 50.94 Vanadium	24 Cr 52.00 Chromium	25 Mn 53.94 Manganese	26 Fe 55.85 Iron	27 Co 58.93 Cobalt	28 Ni 58.71 Nickel	29 Cu 63.54 Copper	30 Zn 65.37 Zinc	31 Ga 69.72 Gallium	32 Ge 72.59 Germanium	33 As 74.92 Arsenic	34 Se 78.96 Selenium	35 Br 79.909 Bromine	36 Kr 83.80 Krypton
5	37 Rb 85.47 Rubidium	38 Sr 87.62 Strontium	39 Y 88.91 Yttrium	40 Zr 91.22 Zirconium	41 Nb 92.91 Niobium	42 Mo 95.94 Molybdenum	43 Tc (99) Technetium	44 Ru 101.1 Ruthenium	45 Rh 102.90 Rhodium	46 Pd 106.4 Palladium	47 Ag 107.87 Silver	48 Cd 112.40 Cadmium	49 In 114.82 Indium	50 Sn 118.69 Tin	51 Sb 121.75 Antimony	52 Te 127.60 Tellurium	53 I 126.90 Iodine	54 Xe 131.30 Xenon
6	55 Cs 132.91 Cesium	56 Ba 137.34 Barium	57 TO 71	72 Hf 178.49 Hafnium	73 Ta 180.95 Tantalum	74 W 183.85 Tungsten	75 Re 186.2 Rhenium	76 Os 190.2 Osmium	77 Ir 192.2 Iridium	78 Pt 195.09 Platinum	79 Au 197.0 Gold	80 Hg 200.59 Mercury	81 Tl 204.37 Thallium	82 Pb 207.19 Lead	83 Bi 208.98 Bismuth	84 Po (210) Polonium	85 At (210) Astantine	86 Rn (222) Radon
7	87 Fr (223) Francium	88 Ra 226.05 Radium																

2 He 4.003 Helium

- Atomic number
- Symbol of element
- Atomic weight
- Name of element

- Metals
- Transition metals
- Nonmetals
- Noble gases
- Lanthanide series
- Actinide series

63 Eu 151.96 Europium	64 Gd 157.25 Gadolinium	65 Tb 158.92 Terbium	66 Dy 162.50 Dysprosium	67 Ho 164.93 Holmium	68 Er 167.26 Erbium	69 Tm 168.93 Thullium	70 Yb 173.04 Ytterbium	71 Lu 174.97 Lutetium
95 Am (243) Americium	96 Cm (247) Curium	97 Bk (249) Berkelium	98 Cf (251) Californium	99 Es (254) Einsteinium	100 Fm (253) Fermium	101 Md (256) Mendelevium	102 No (254) Nobelium	103 Lw (257) Lawrencium

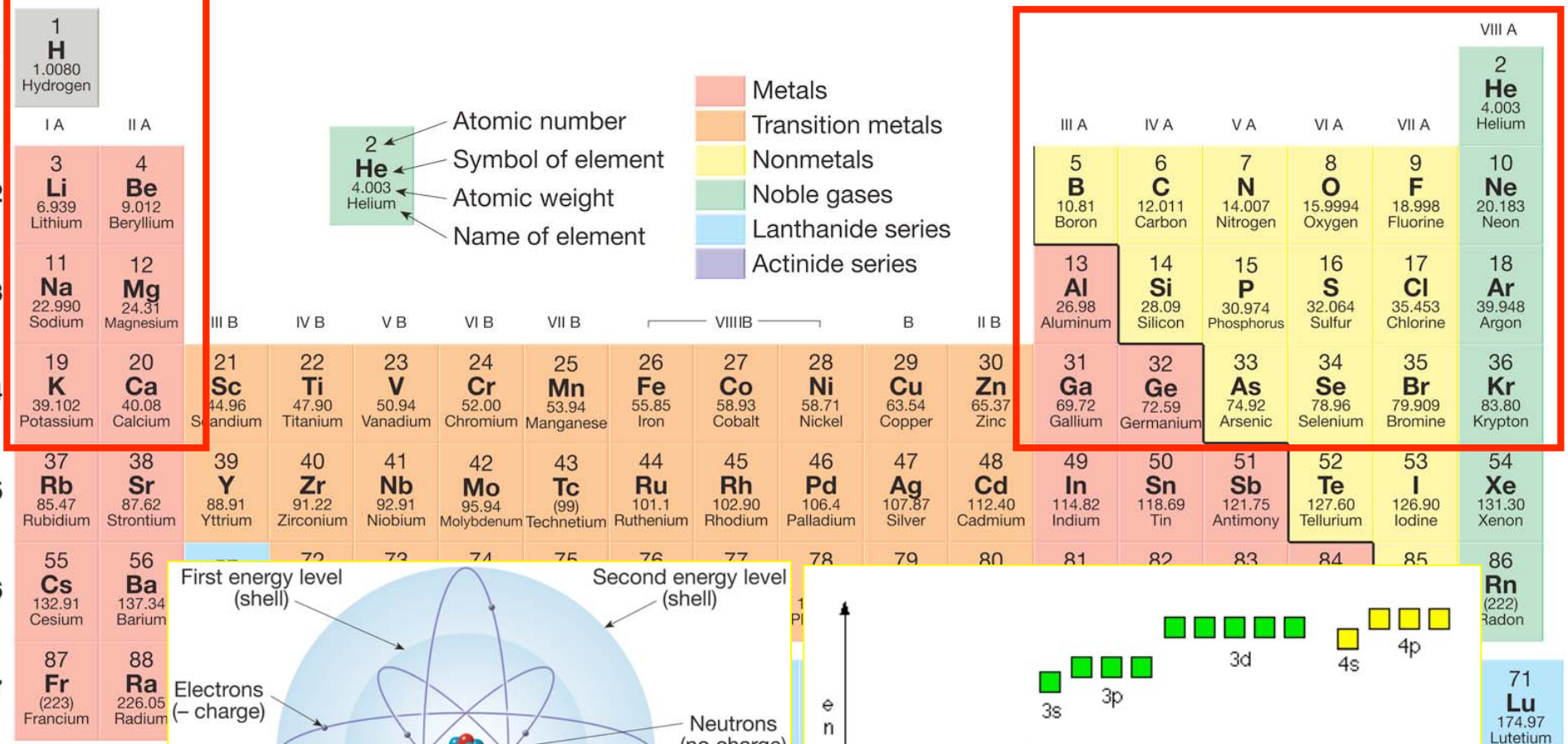


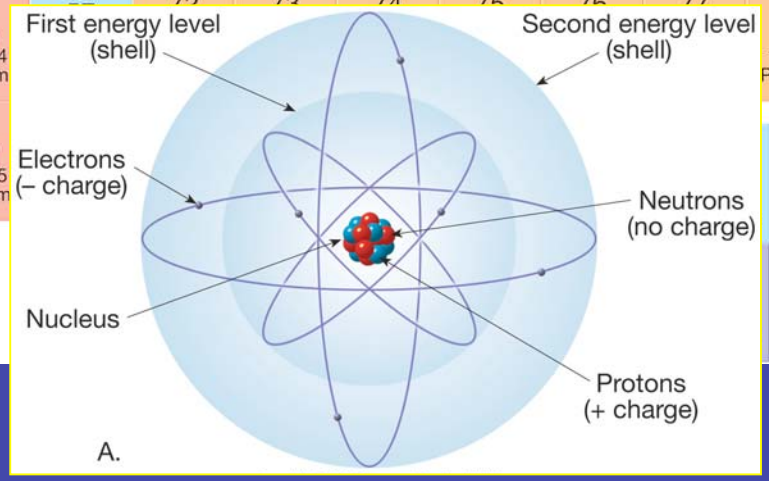
shell one

shell two (valance shell)

Organized by: 3) columns – # of electrons in the outermost shell

1 2 3 4 5 6 7 8



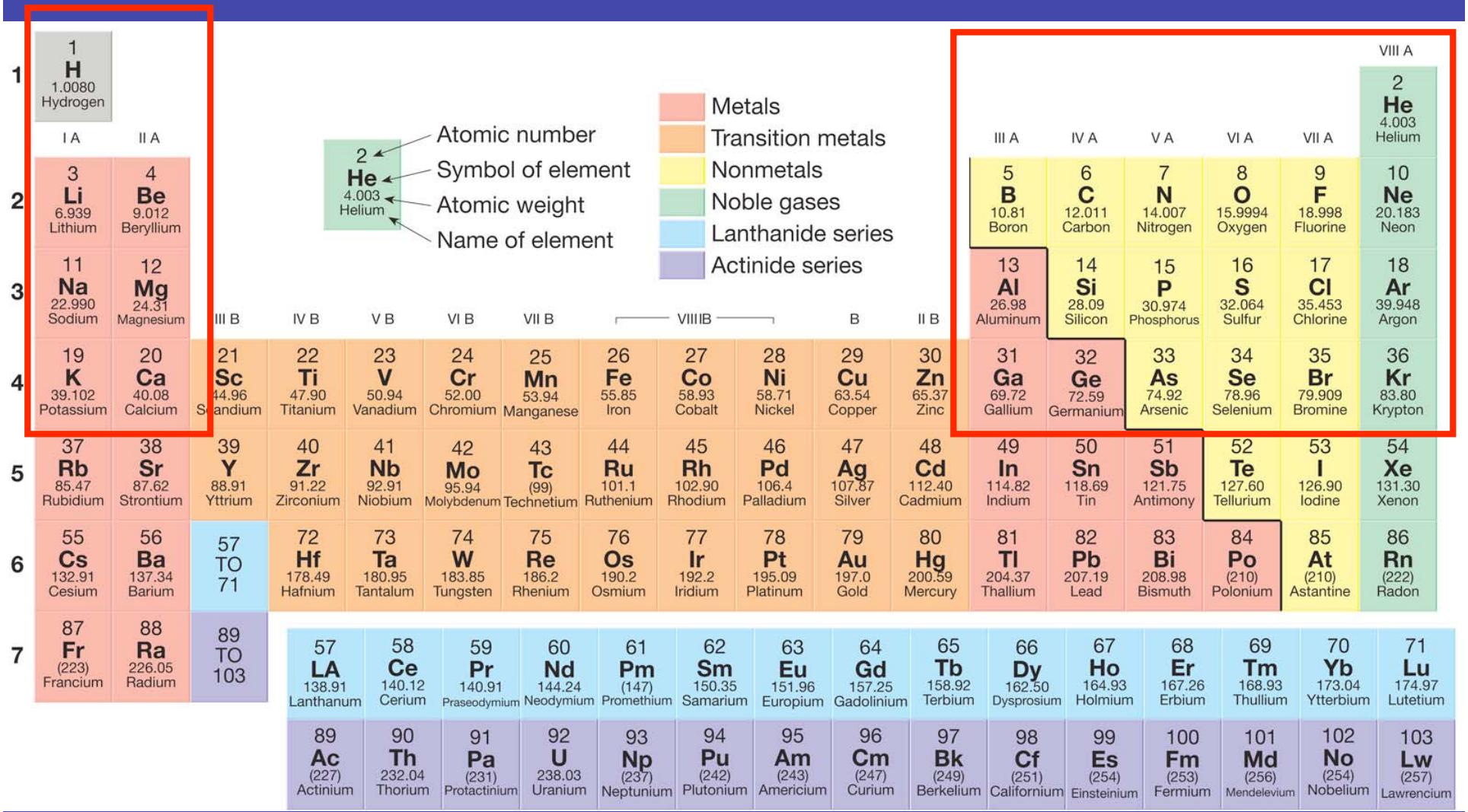




Starts out simple, then gets complicated!

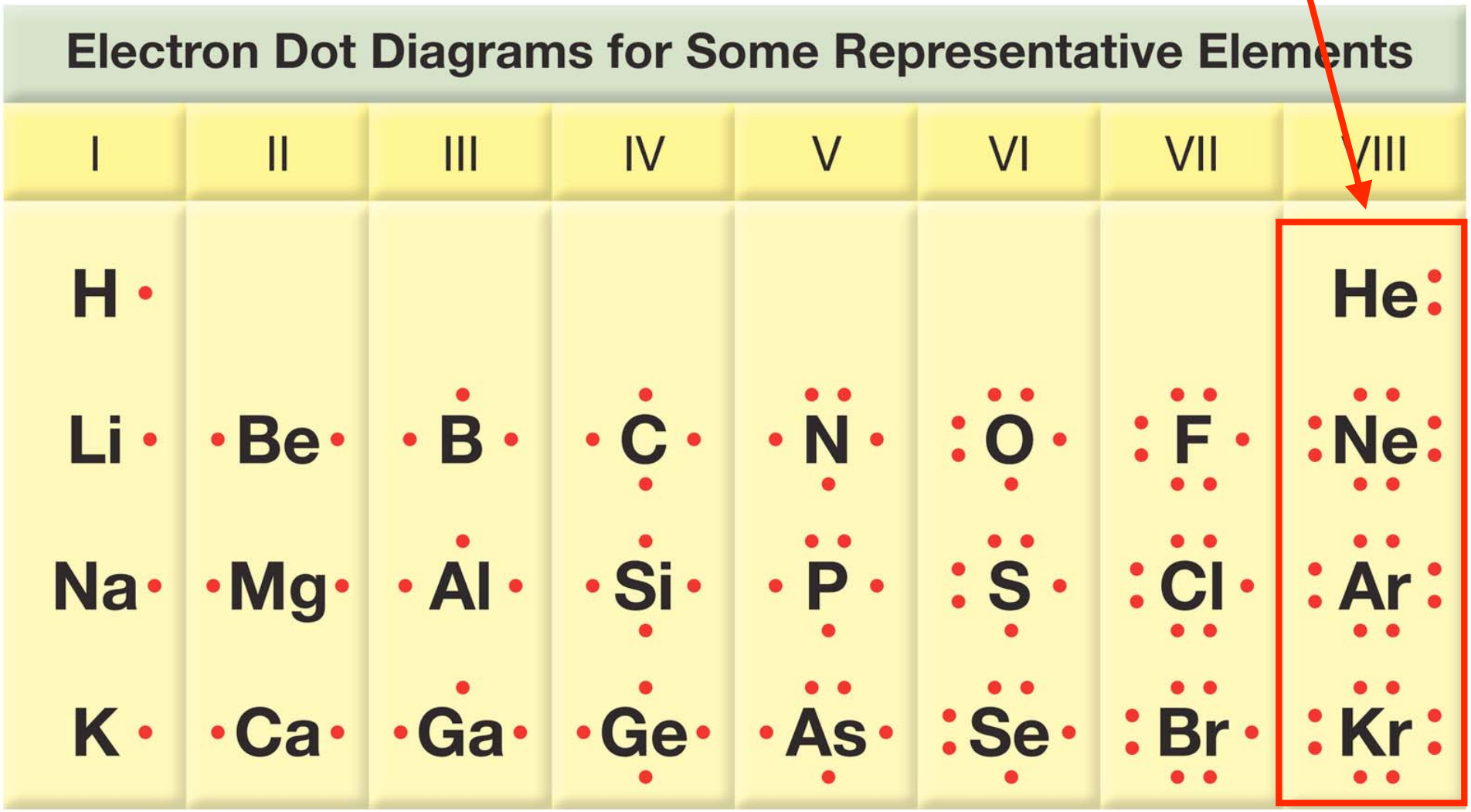
Which of these elements are the most STABLE?

1 2 3 4 5 6 7 8



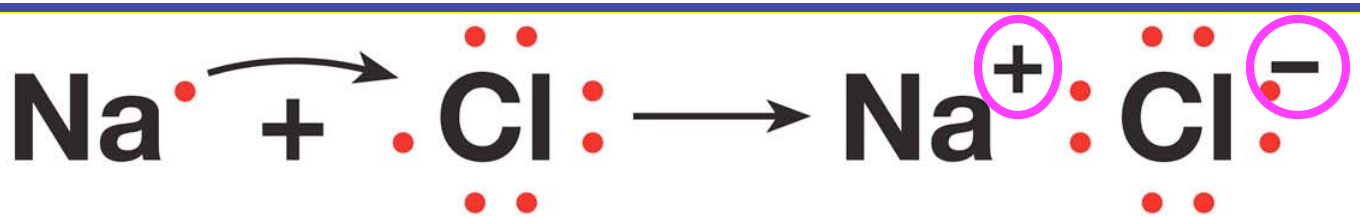
stable configuration: valence shell contains maximum electrons

noble gases



how do <u>other</u> elements <u>gain</u> stability?

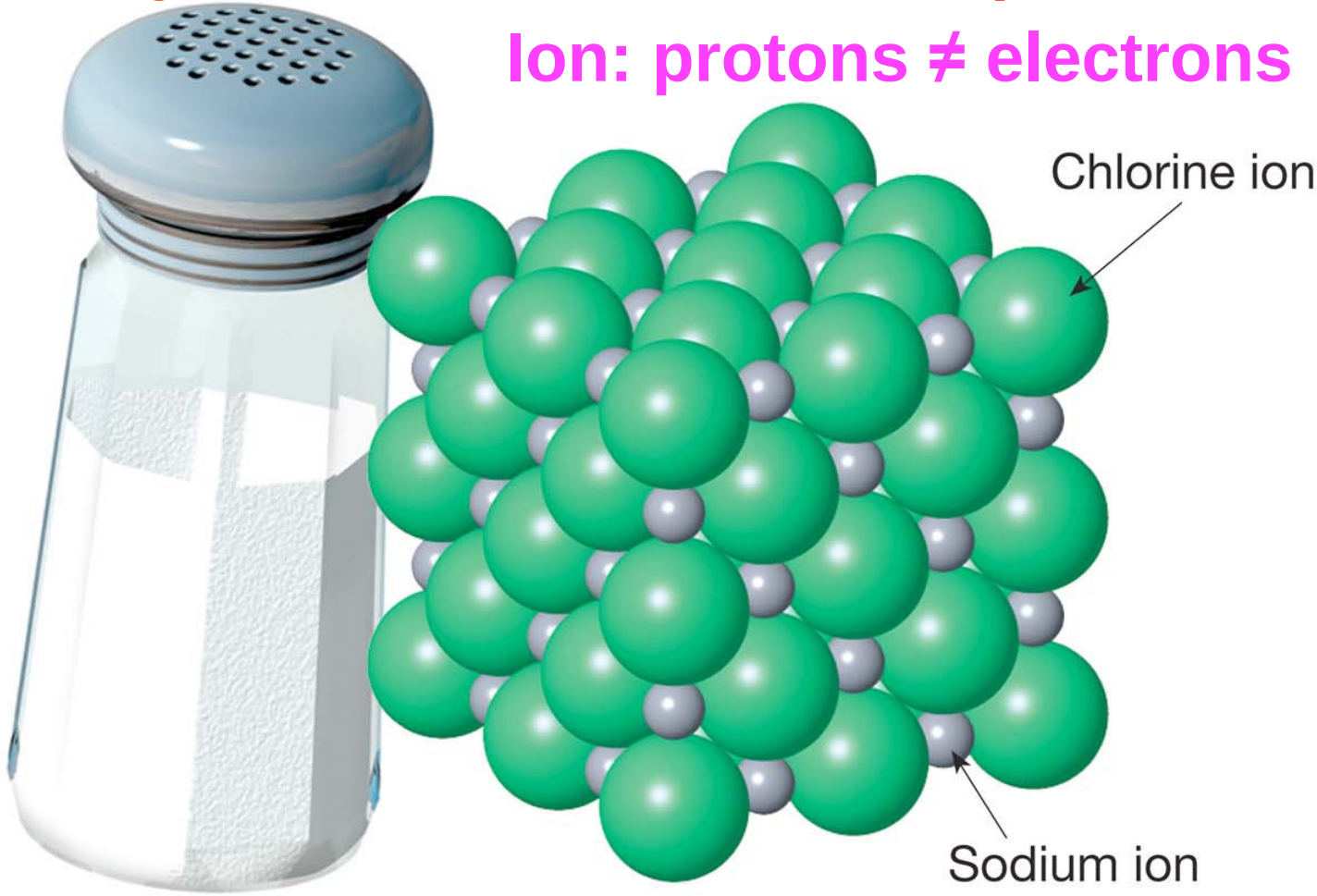
A.



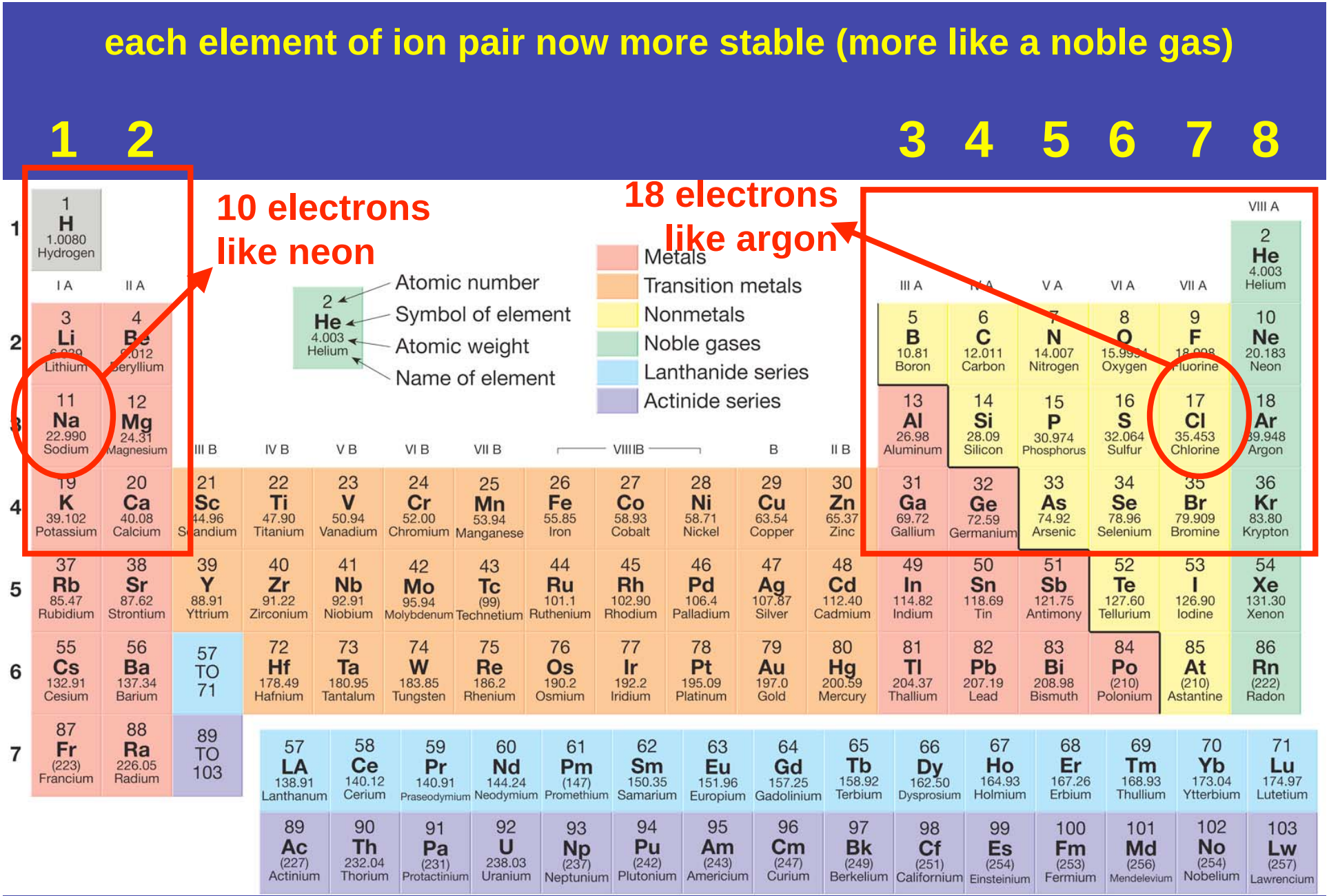
<u>Ionic bond</u>: electrons transferred (usually from metal to non-metal)

Ion: protons ≠ electrons

B.

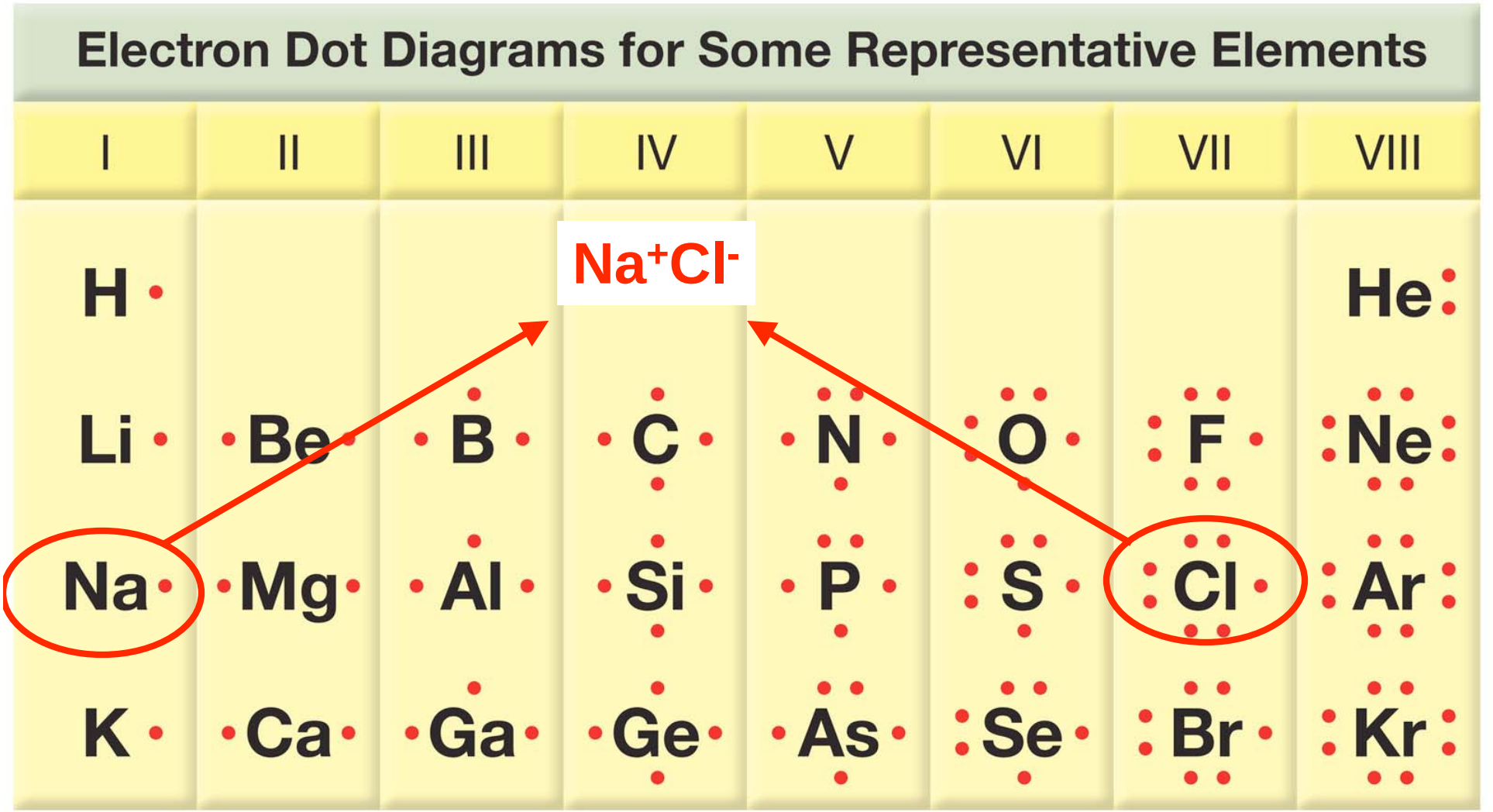


each element of ion pair now more stable (more like a noble gas)



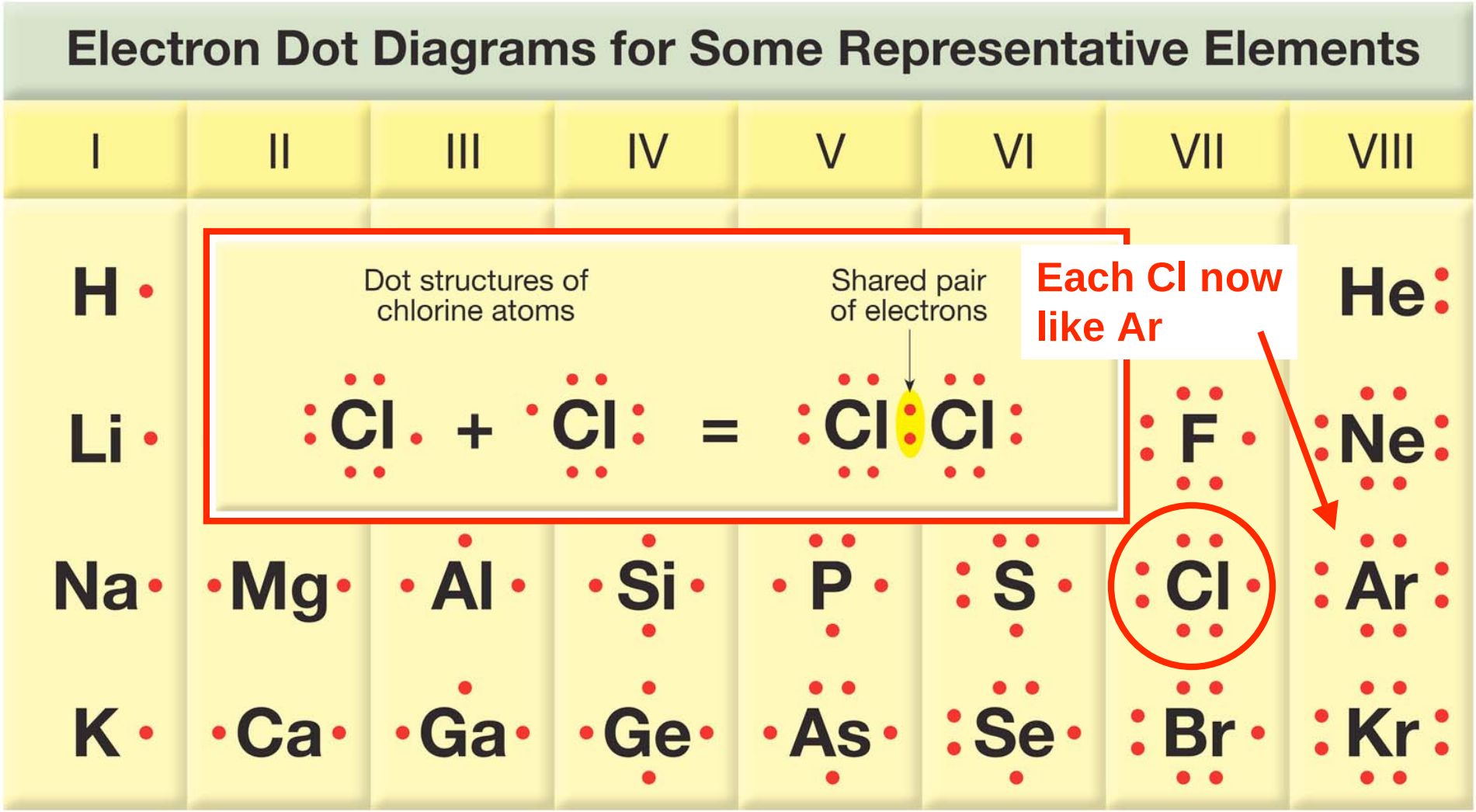
stable configuration: valence shell contains maximum electrons

1. **ionic bonding…electron transfer**
2. **_____**



stable configuration: valence shell contains maximum electrons

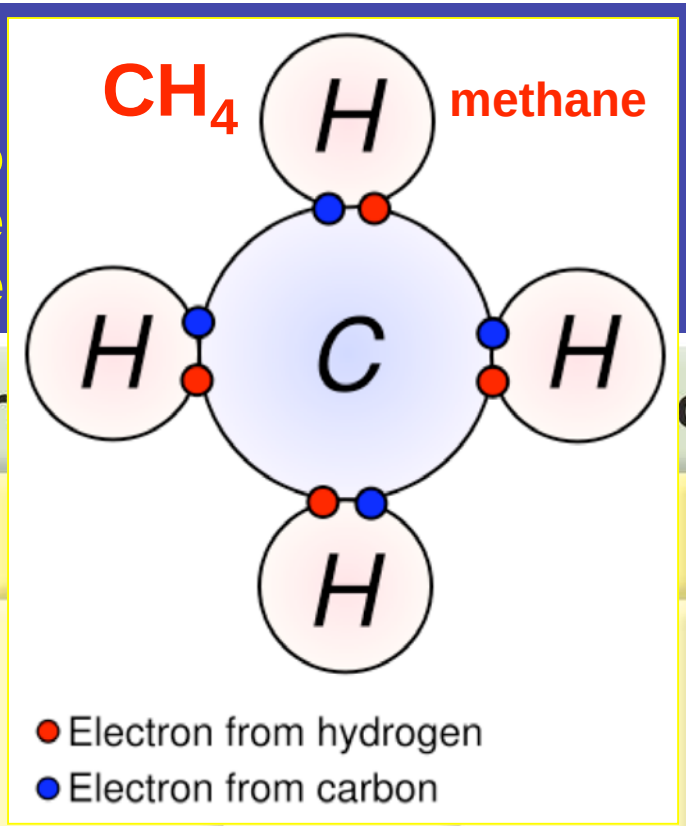
2. covalent bonding…electron sharing



no charge change

stable configuration: valence shell contains maximum electrons

covalent bonding…electron sharing



Electr ome Representative Elements

I	V	VI	VII	VIII
H				He
Li	N	O	F	Ne
Na	P	S	Cl	Ar
K	As	Se	Br	Kr

Each H now like He
Each C now like Ne

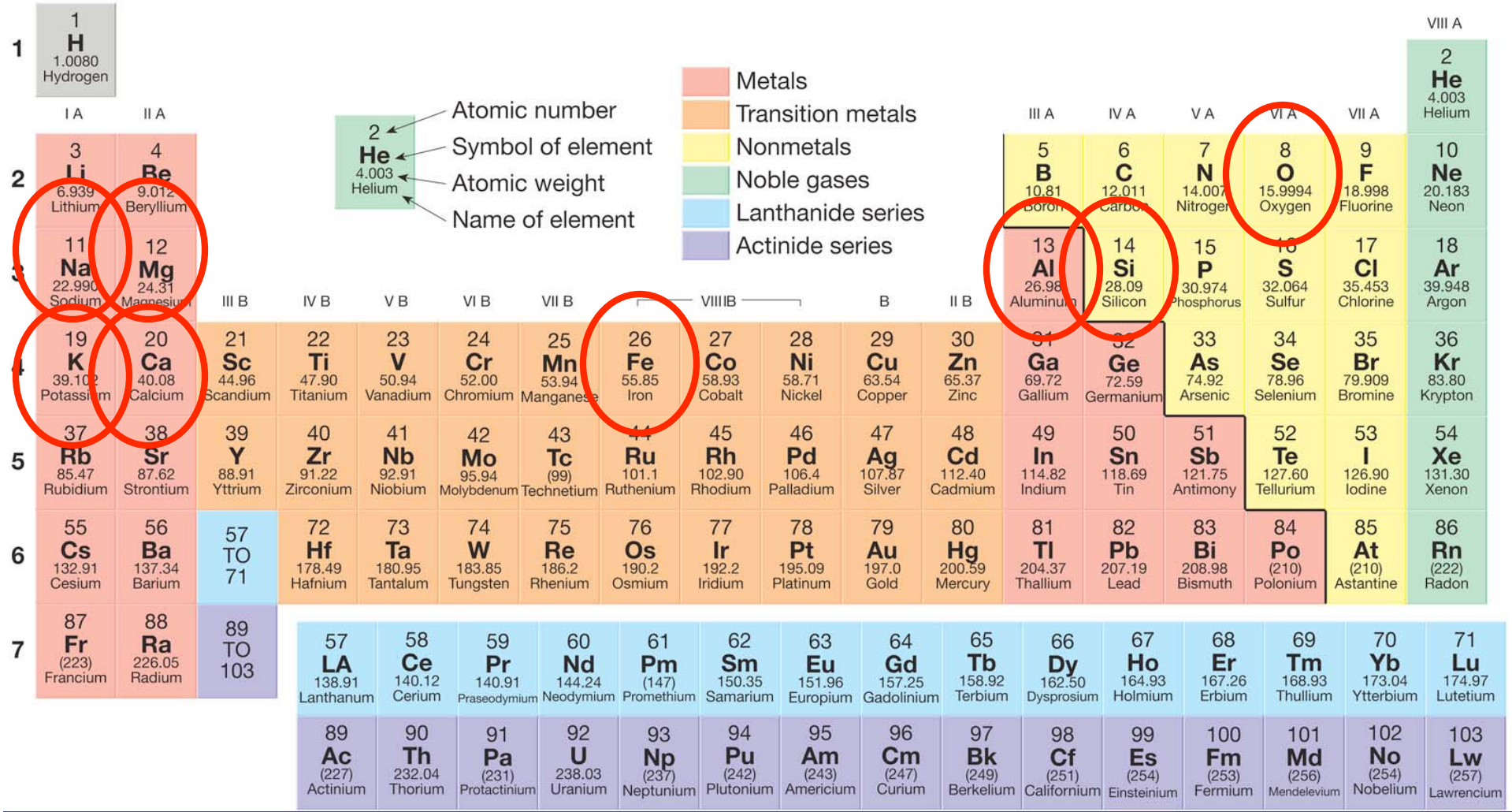
Take-home message:

Most of Earth's elements PREFER (chemically) to exist in combination with other elements

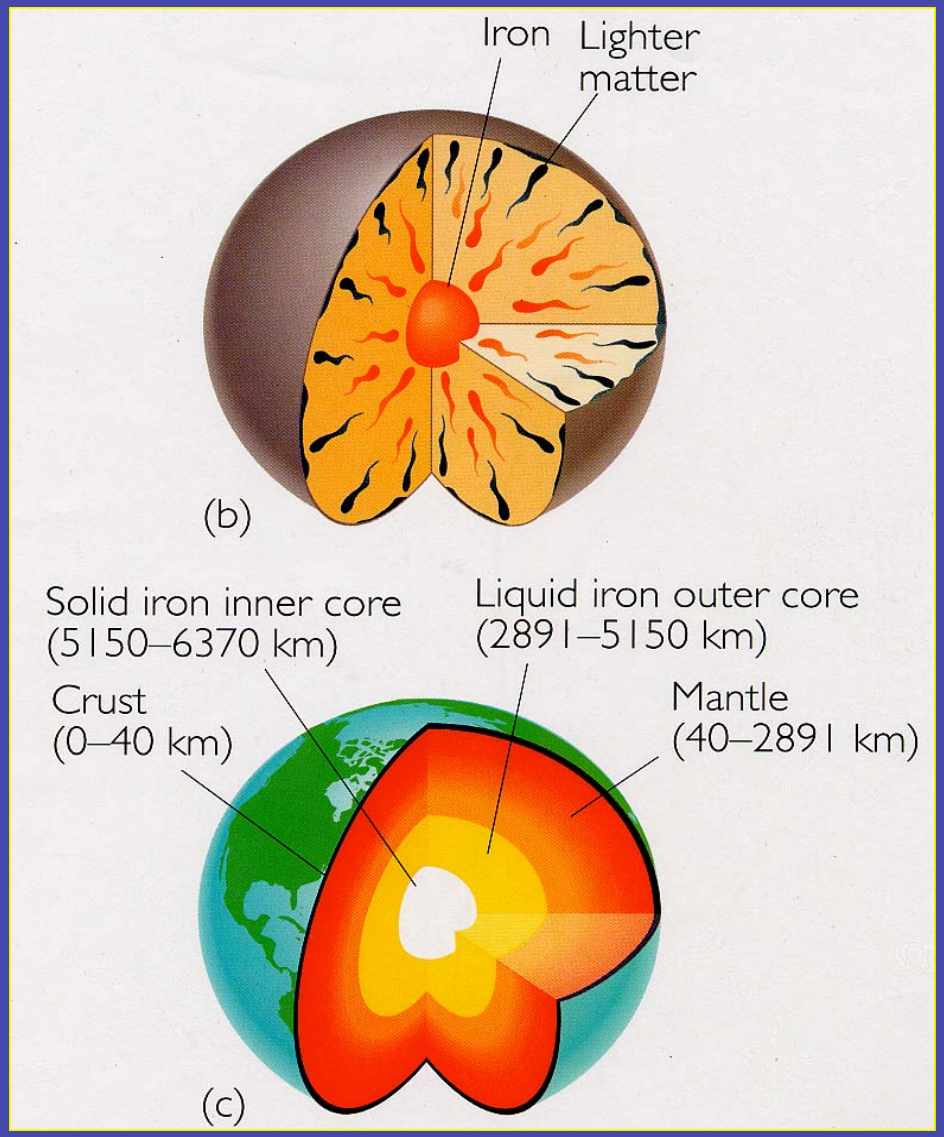
~

accomplished via electrostatic bonding
(ionic, covalent, and many other types)

only eight elements make up
98% of Earth's crust
(by weight)



Lightest element most abundant

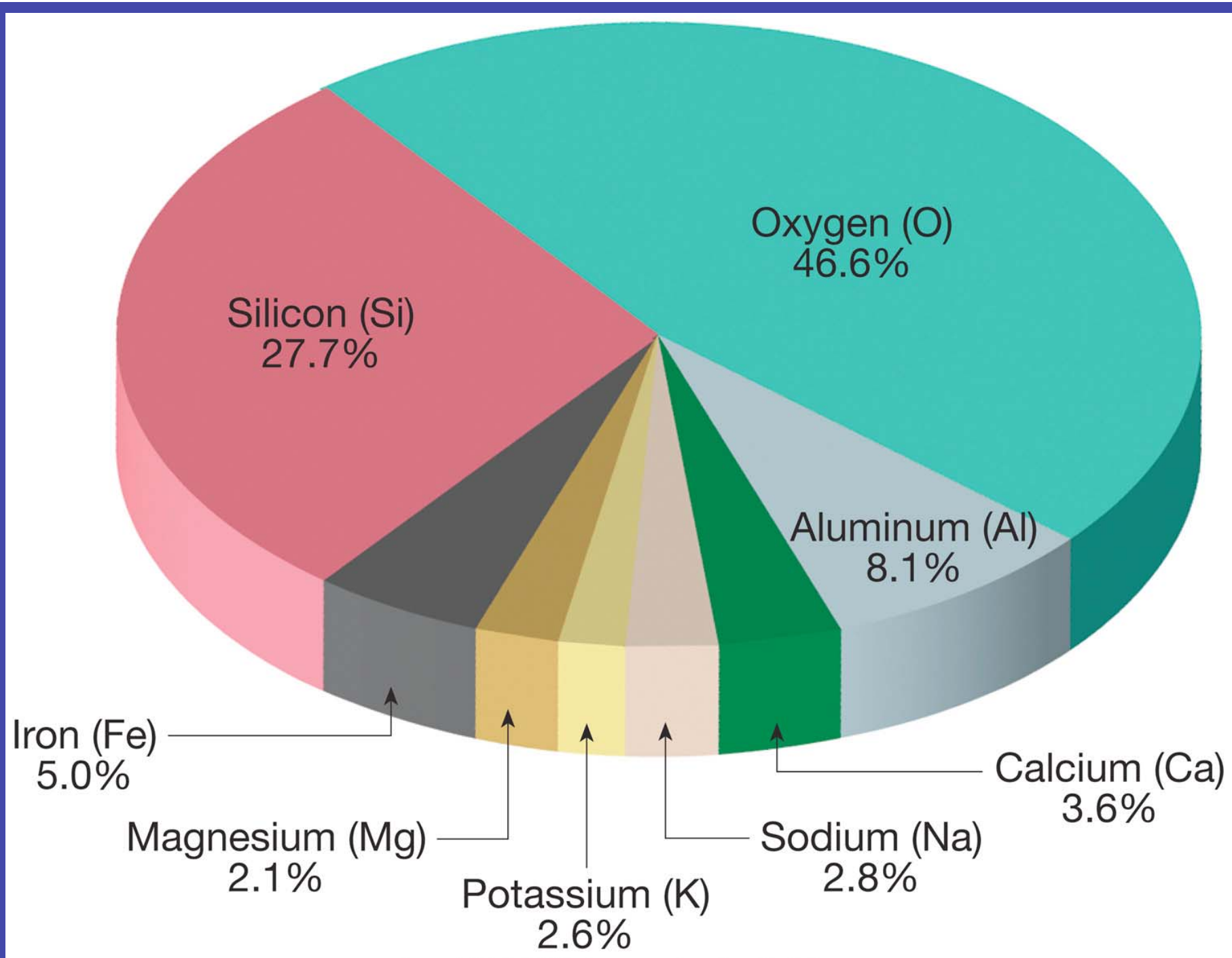


"Iron Catastrophe"

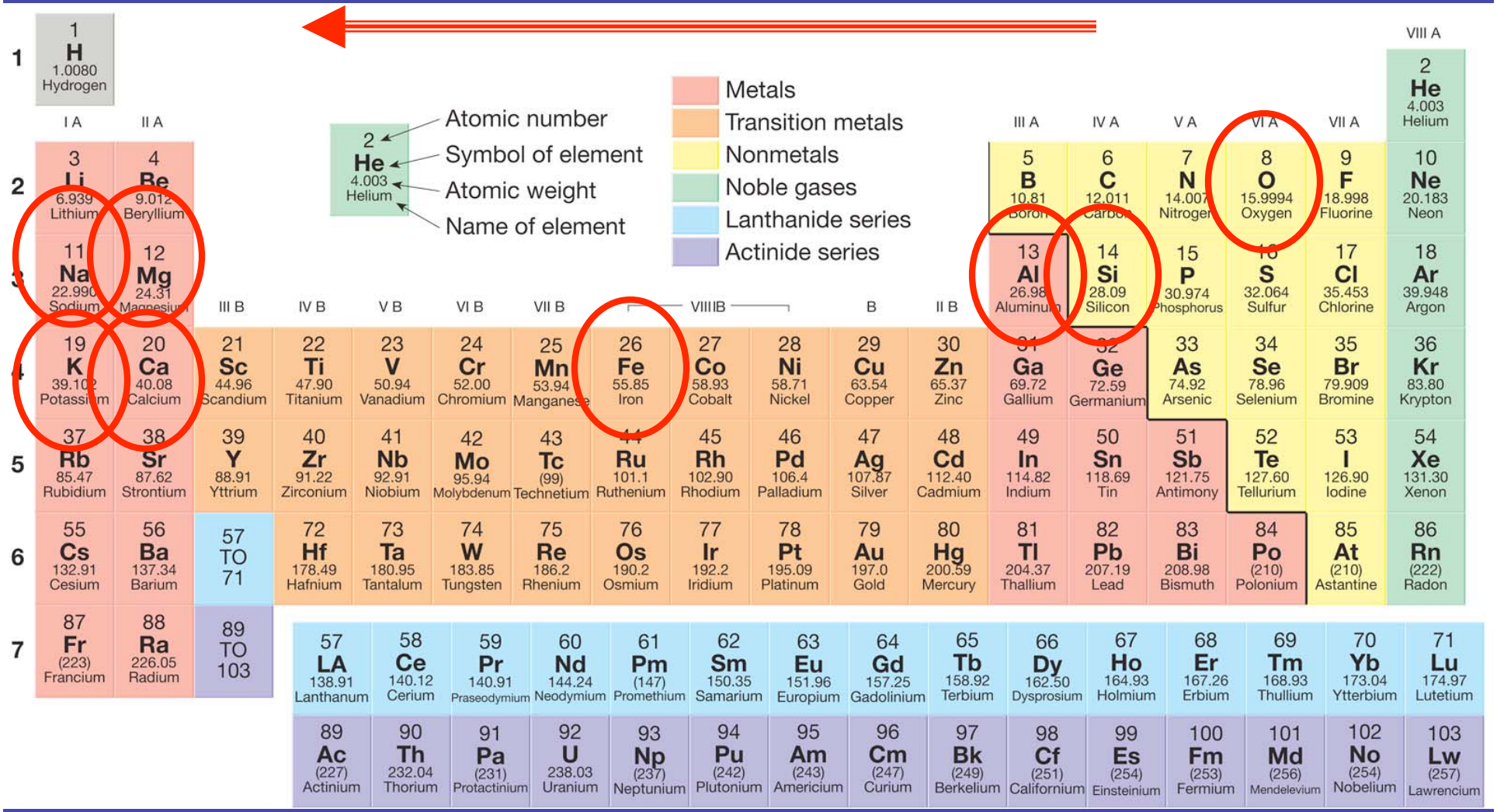
Planet became chemically differentiated

Increasing Fe/Mg toward core

Increasing Si/O toward crust

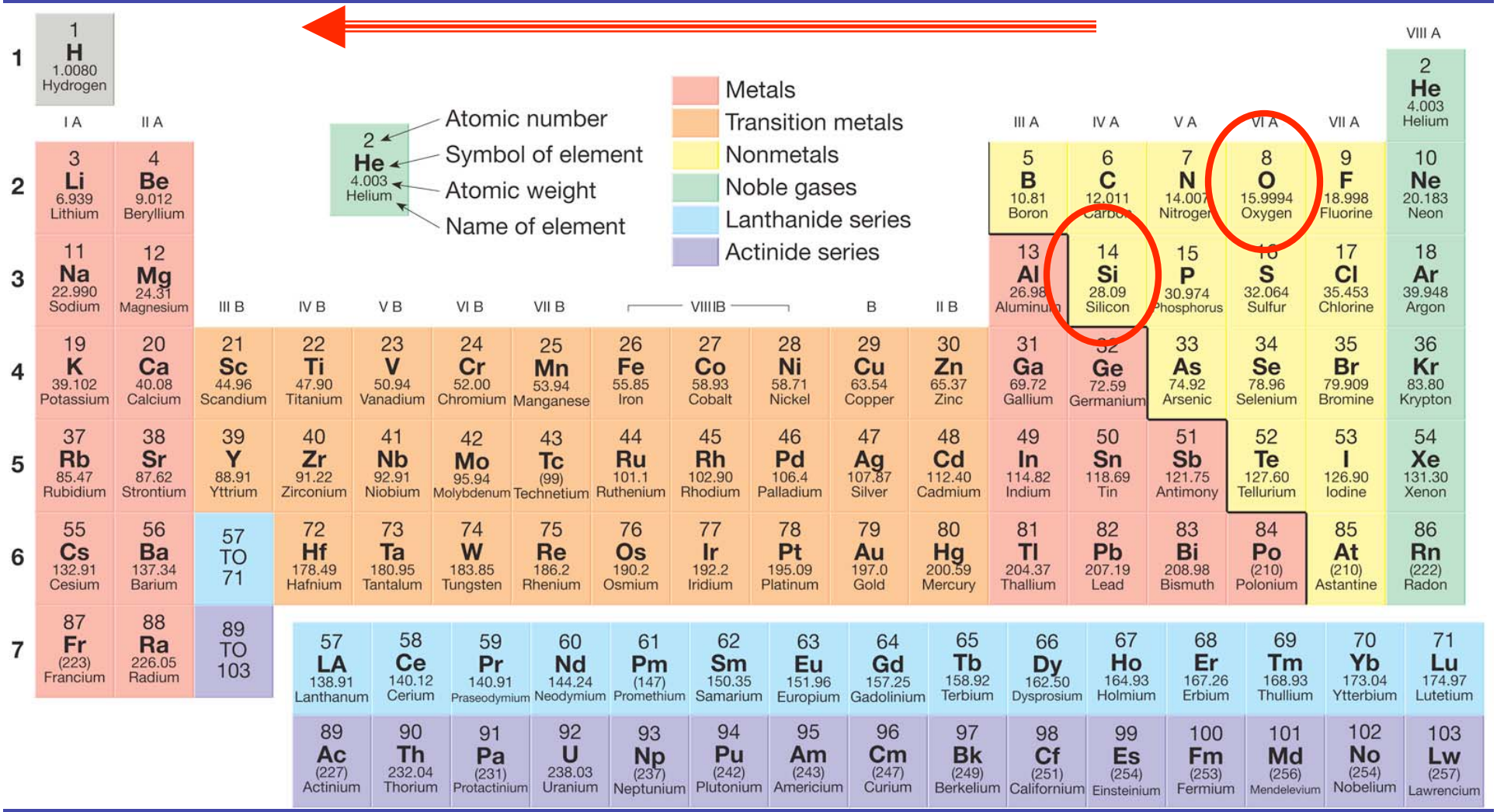

Oxygen (O)
46.6%
Silicon (Si)
27.7%
Aluminum (Al)
8.1%
Iron (Fe)
5.0%
Magnesium (Mg)
2.1%
Potassium (K)
2.6%
Sodium (Na)
2.8%
Calcium (Ca)
3.6%

less abundant most abundant



What is most common mineral group going to be made up of?

less abundant most abundant



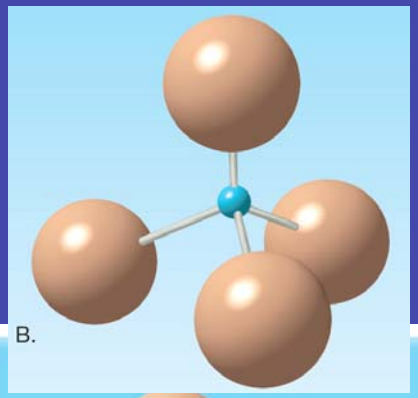
What is most common mineral group going to be made up of?

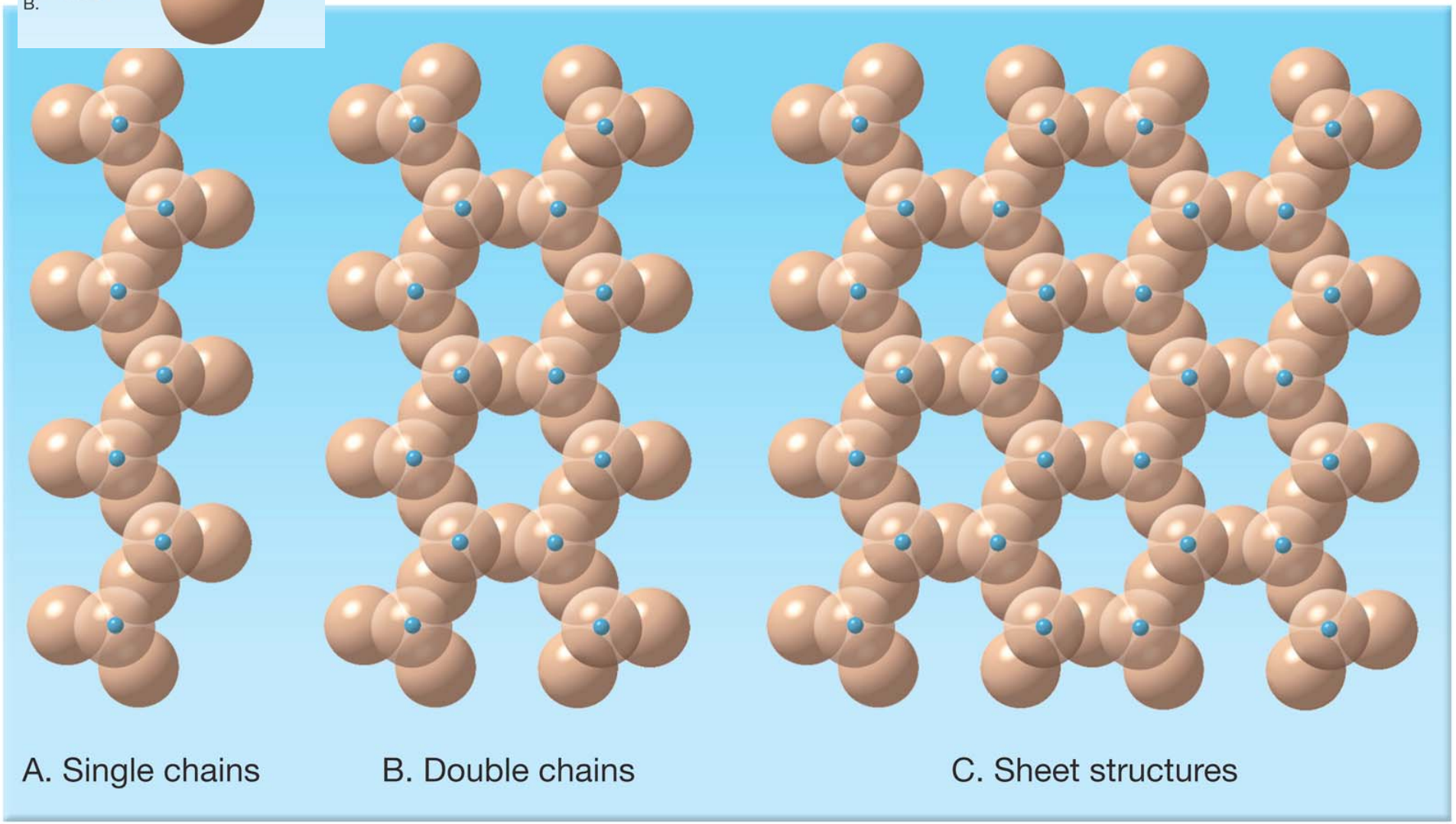
Oxygen, Silica – Silicates (90% of Earth's crust)

Ratio of oxygen to silica changes

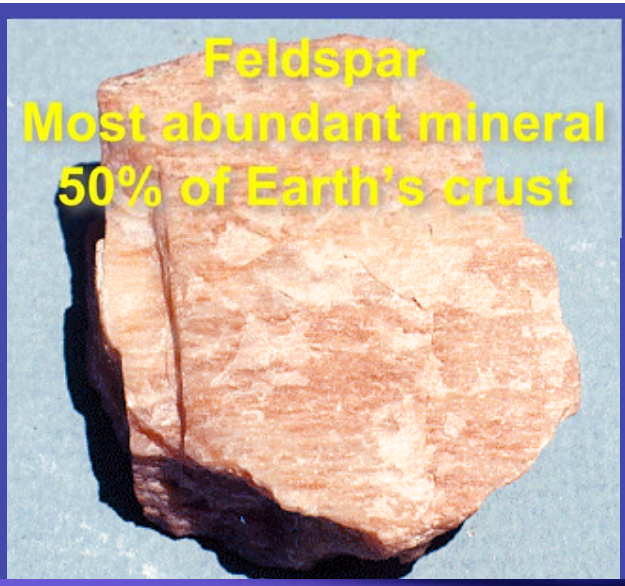
4:1, 3:1, (2:1)

% silica controls physical properties of magma





Mineral/Formula	Cleavage	Silicate Structure	Example
Olivine $(Mg, Fe)_2SiO_4$	None	Single tetrahedron	Olivine
Pyroxene group (Augite) $(Mg,Fe)SiO_3$	Two planes at right angles	Single chains	Augite
Amphibole group (Hornblende) $Ca_2(Fe,Mg)_5Si_8O_{22}(OH)_2$	Two planes at 60° and 120°	Double chains	Hornblend
Micas: Biotite $K(Mg,Fe)_3AlSi_3O_{10}(OH)_2$	One plane	Sheets	Biotite
Micas: Muscovite $KAl_2(AlSi_3O_{10})(OH)_2$	One plane	Sheets	Muscovite
Feldspars: Potassium feldspar (Orthoclase) $KAlSi_3O_8$	Two planes at 90°	Three-dimensional networks	Potassium feldspar
Feldspars: Plagioclase feldspar $(Ca,Na)AlSi_3O_8$	Two planes at 90°	Three-dimensional networks	
Quartz SiO_2	None	Three-dimensional networks	Quartz





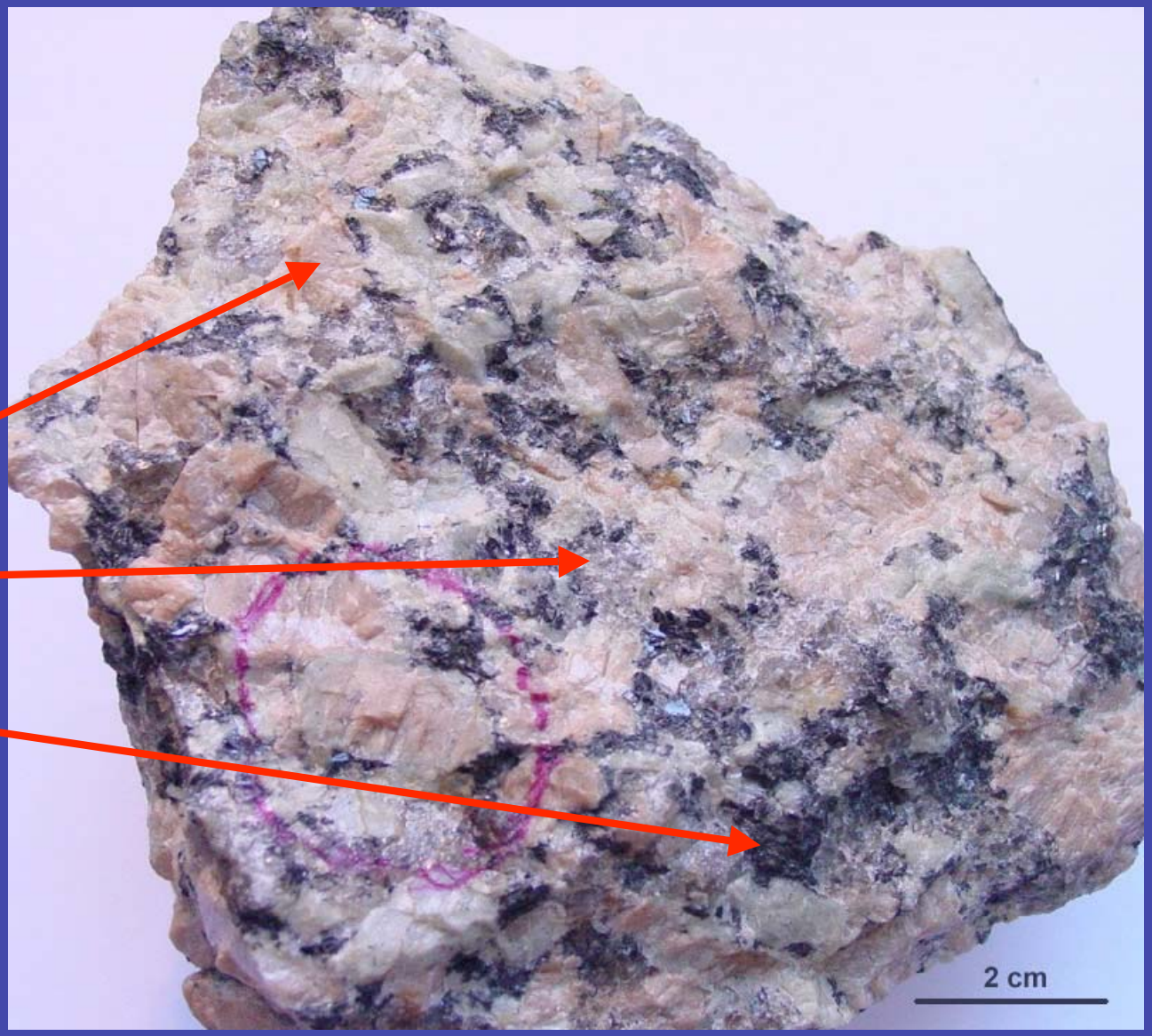



2 cm

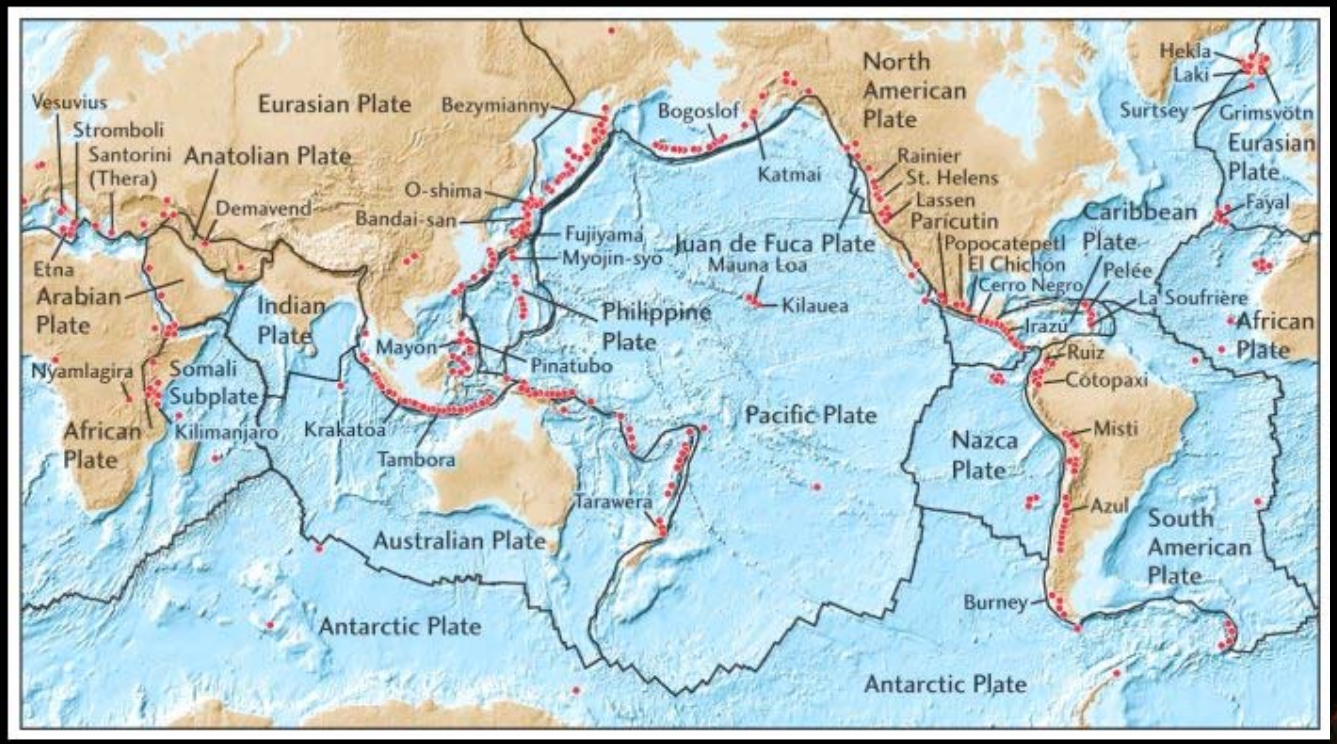


Granite

most common rock in continental crust



The World's Active Volcanoes



Silicates have volcanic origin

Plate tectonics controls lava chemistry



Summary

Silicates: 90% of Earth's Crust, volcanic origin

1) Continental crust

- **High silica, low density**
- **Granite most common rock**
  - **Feldspars and quartz most common minerals (light silicates)**

2) Oceanic crust

- **Lower silica, higher density**
- **Basalt most common rock**
  - **Olivine and pyroxene most common minerals (dark silicates)**

Non-silicates: <10% of Earth's crust





Non-silicates: Non-volcanic, commercially useful



1) Halides



2) Sulfates

3) Carbonates

Building blocks…of ROCKS!

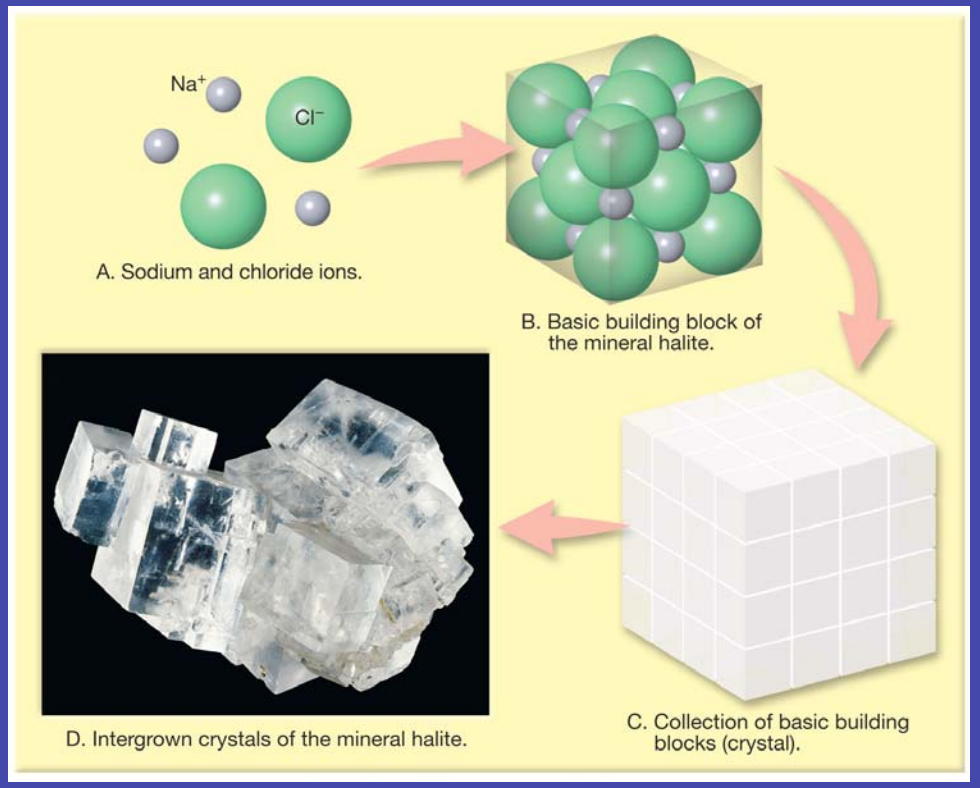
Made up of:	Description:
1. (Quarks, photons, neutrinos……	Subatomic)
2. Protons, neutrons, electrons……..	Atom
(Atoms: elements)	
3. Atom → molecule/compound……	Mineral
4. Minerals……..	Rock

Increasing size, complexity

Geologists' definition of "mineral"…



1. Naturally occurring (no synthetics)
2. Solid substance (on Earth)
3. Orderly crystalline structure
4. Definite chemical composition
5. Generally inorganic



How do you identify a mineral?

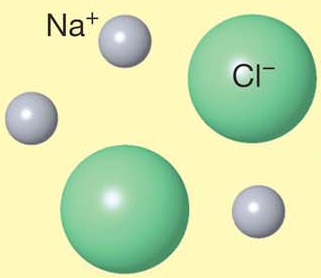
Physical properties of minerals

1. Crystal form
2. Luster
3. Color
4. Streak
5. Hardness
6. Cleavage
7. Fracture
8. Density/specific gravity
9. Other

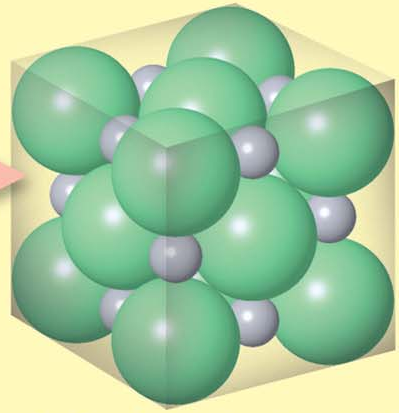
1. Crystal form.....



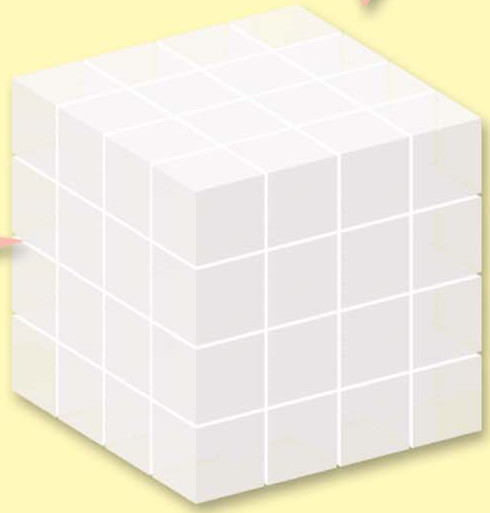




A. Sodium and chloride ions.



B. Basic building block of the mineral halite.



C. Collection of basic building blocks (crystal).



D. Intergrown crystals of the mineral halite.

2. Luster.....



3. Color.....



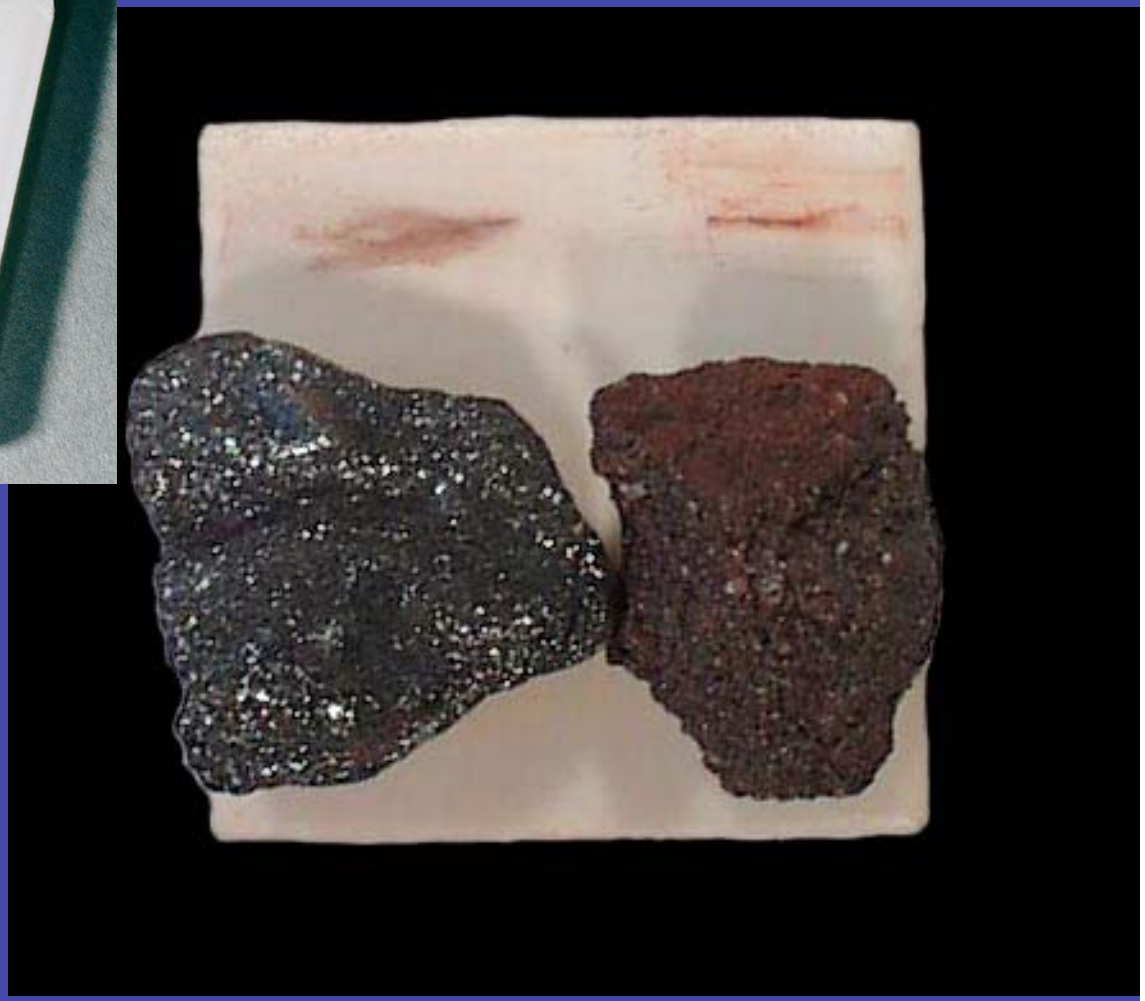






4. Streak.....



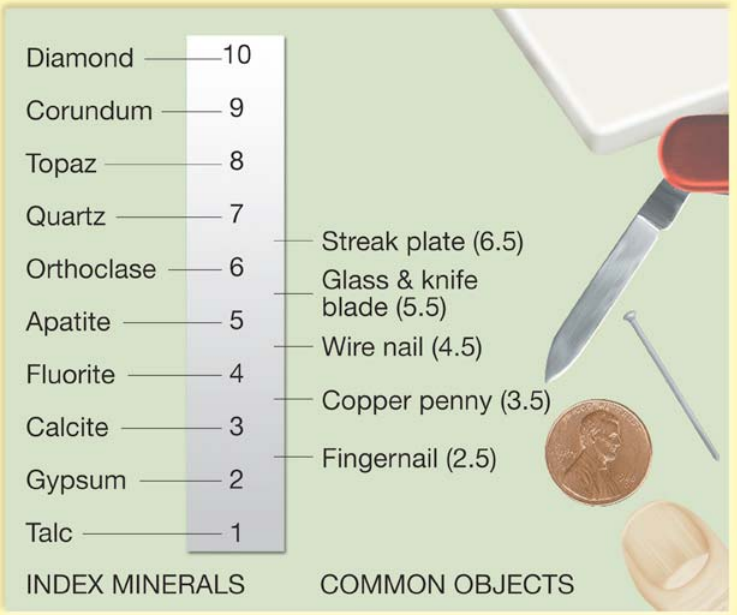


5. Hardness…

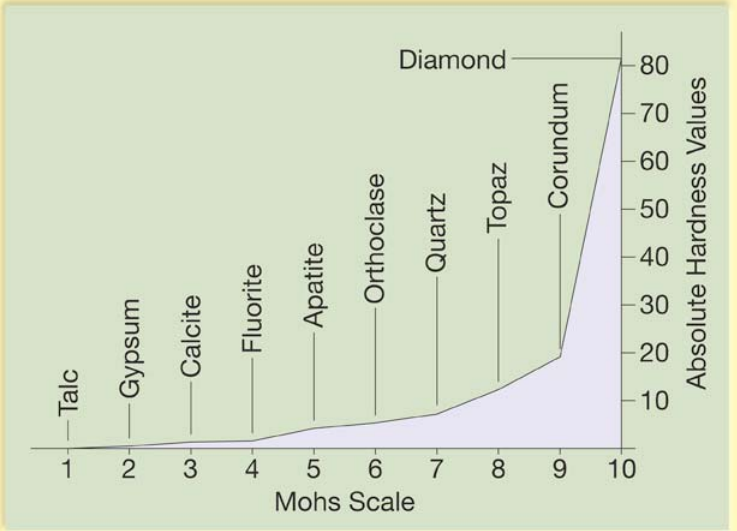




A. Mohs scale (Relative hardness)

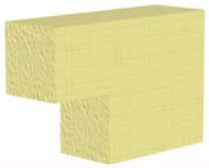
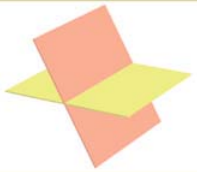
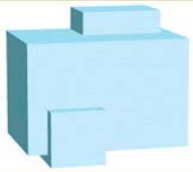


B. Comparison of Mohs scale and an absolute scale



6. Cleavage



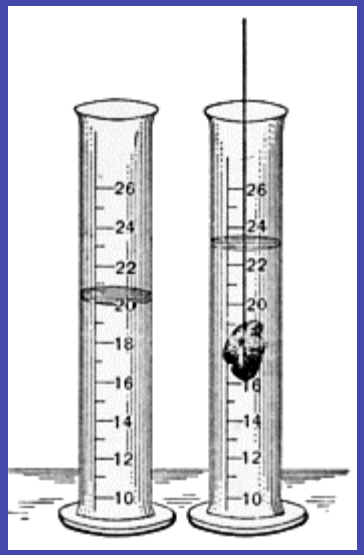
Number of Cleavage Directions	Shape	Sketch	Directions of Cleavage	Sample
1	Flat sheets			 Muscovite
	Elongated form with rectangle cross section (prism)			 Feldspar
	Elongated form with parallelogram cross section (prism)			 Hornblende
	Cube			 Halite
	Rhombohedron			 Calcite
4	Octahedron			 Fluorite

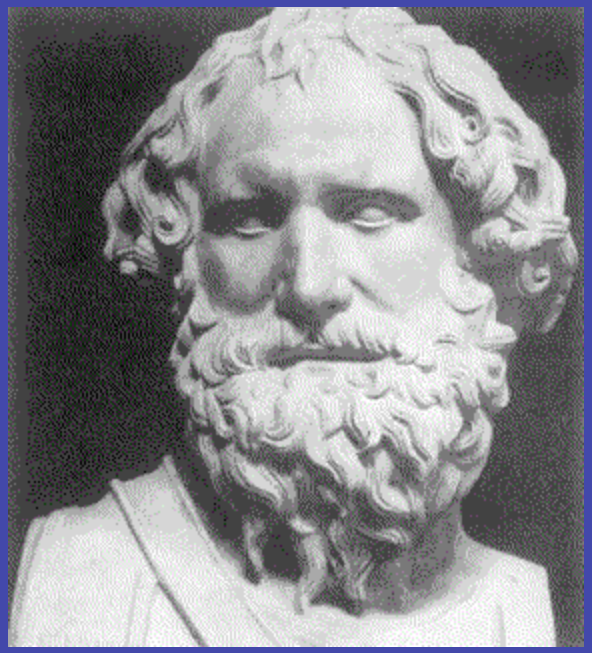
7. Fracture…





8. Specific gravity/density…





Asbestos = 2.45
Basalt = 3.01
Coral = 2.12
Granite = 2.69
Etc…

weight of mineral
vs.
weight of equal volume of water

9. Other…



Taste
Elasticity
Malleability
Feel (greasy, soapy)
Magnetism
Double refraction
Etc…

Take-home message:

Physical properties of minerals can be used in combination to determine mineral type