Today

1) Quiz: Chapter 2 Vocabulary/ EC Chapter 2 Questions

2) Exam 1 Postmortem

-You will have ~15 minutes or so to go over the exam and talk within your group about what you missed. I may answer a few questions.

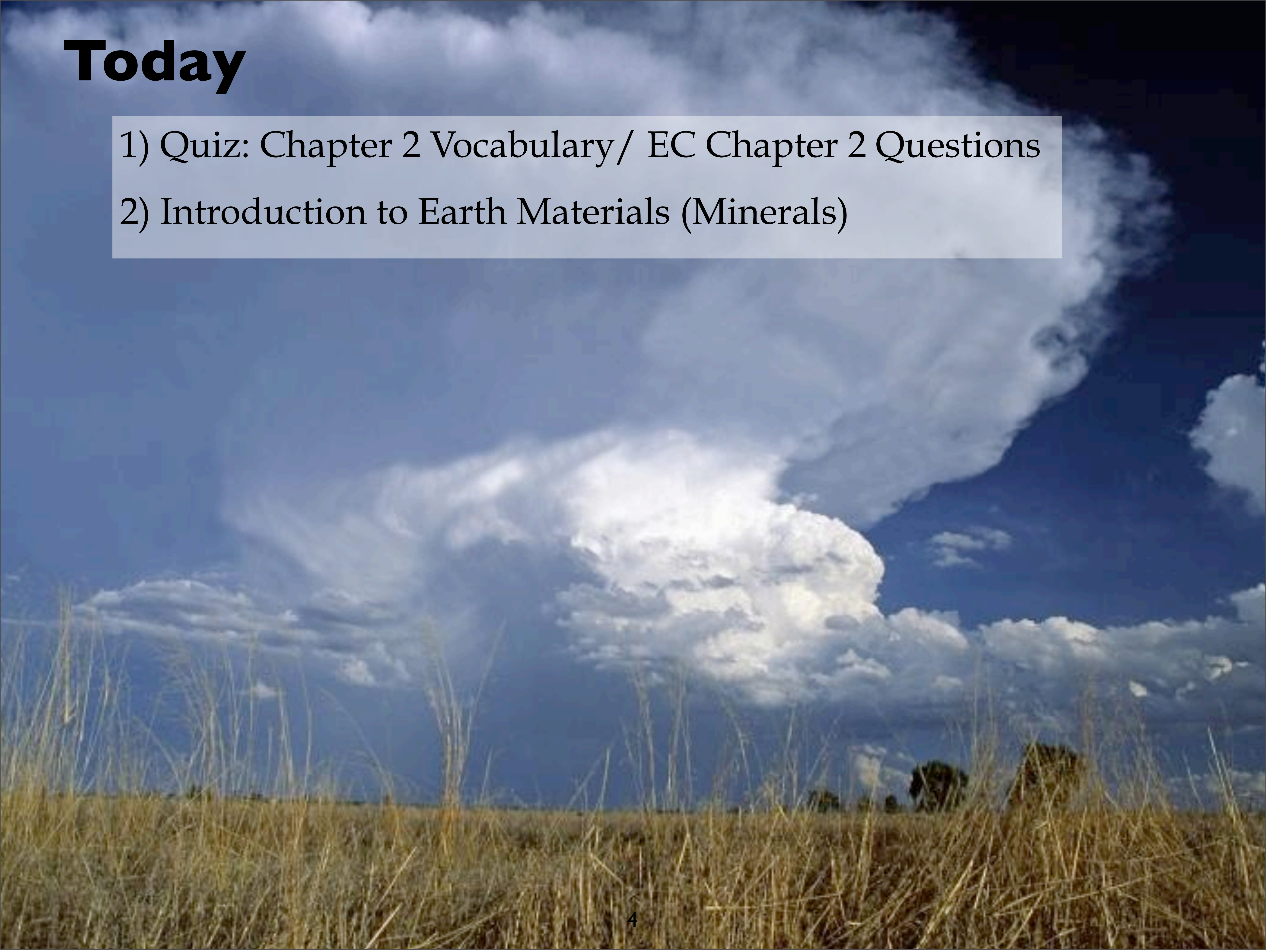
-Then you will return the Better-Than-Pass section to me and keep the Pass Section for yourself. I will hold onto your exams and if you would like more detail on what you did not understand, you will need to meet with me outside of class.

3) Introduction to Earth Materials (Minerals)

Today

1) Quiz: Chapter 2 Vocabulary/ EC Chapter 2 Questions

2) Introduction to Earth Materials (Minerals)



Earth Materials/ Minerals

Chapter 2

Minerals

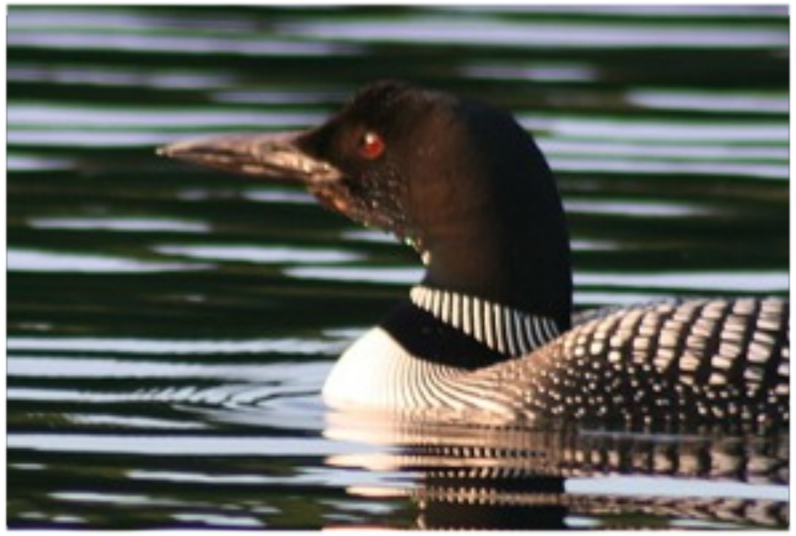
1) Naturally occurring inorganic substance (no O, C, H together)
2) Solid substance
3) Has a defined atomic composition (chemical formula)
4) A systematic internal crystalline structure–atoms are bonded together in a geometric pattern
5) Has defined chemical and physical properties








Bird Watching



Physical Properties

1) Color
2) Crystal Habit
3) Cleavage or fracture
4) Streak
5) Luster
6) Hardness
7) Specific Gravity
8) Special Properties (Effervescence Taste Smell X-Ray diffraction)

Mineral Form by

1) Solidification of melt
2) Precipitation from water
3) Metabolized by organisms
4) Precipitated from a gas.








Mineral Form by

1) Solidification of melt (Silicate minerals)
2) Precipitation from water
3) Metabolized by organisms
4) Precipitated from a gas.








Chemical Compositions

of Silicate Rock Forming Minerals
(90% of the crust)

Olivine $(Mg,Fe)_2\ SiO_4$

Pyroxene $(Mg,Fe, Ca)_2\ Si_2O_6$

Hornblende $(Ca,Na)_2\ (Mg,Fe,Al)_5\ Si_6\ (Si,Al)_2\ O_{22}\ (OH)_2$

Biotite $K(Mg,Fe)_3\ (Al\ Si_3\ O_{10})(OH)_2$

Muscovite $KAl_2\ (Al\ Si_3\ O_{10})\ (OH)_2$

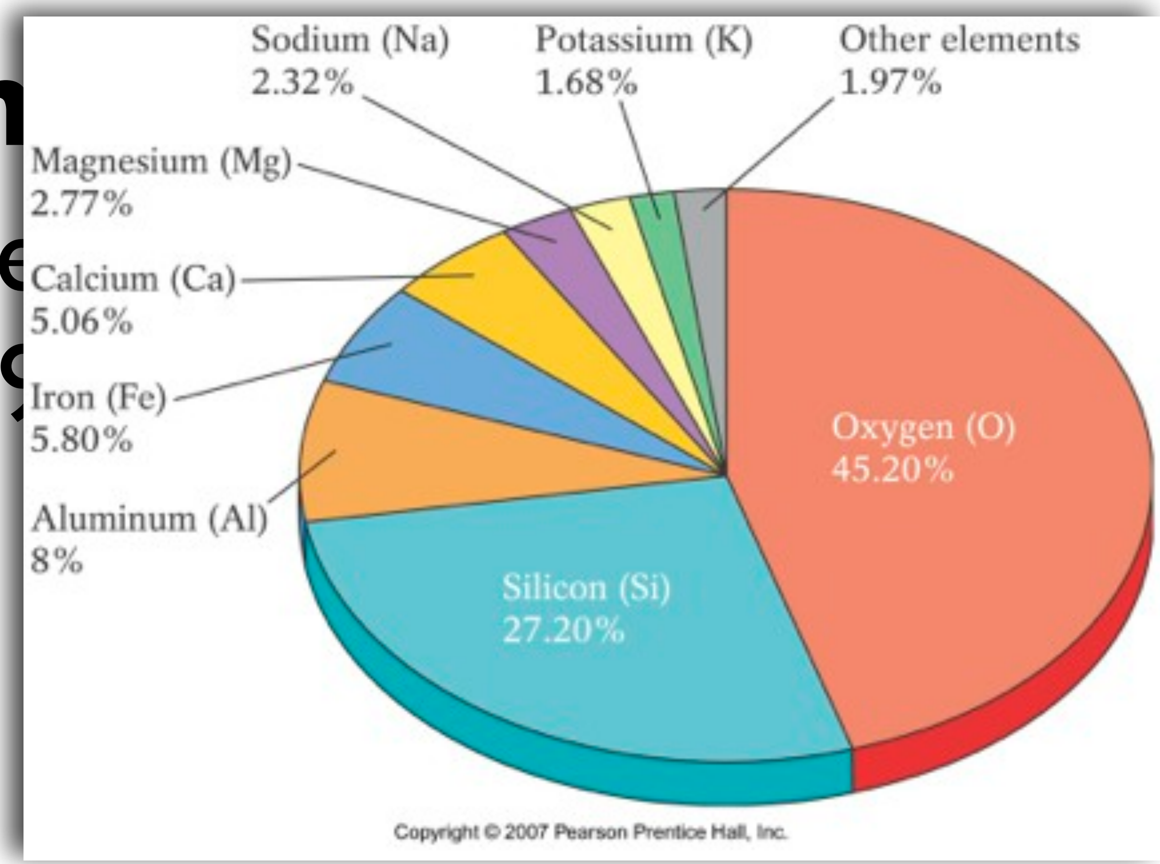
Quartz SiO_2

Feldspar group ($CaAl_2Si_2O_8$ $KAlSi_3O_8$ $NaAlSi_3O_8$)

Chemical Composition

of Silicate

(9



Olivine $(Mg,Fe)_2\ SiO_4$

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Quartz SiO_2

Feldspar group ($CaAl_2Si_2O_8$ $KAlSi_3O_8$ $NaAlSi_3O_8$)

Chemical Compositions

of Silicate Rock Forming Minerals (90% of the crust)

Olivine	$(Mg,Fe)_2\ SiO_4$	**Utramafic**
Pyroxene	$(Mg,Fe,\ Ca)_2\ Si_2O_6$	**Mafic**
Hornblende	$(Ca,Na)_2\ (Mg,Fe,Al)_5\ Si_6\ (Si,Al)_2\ O_{22}\ (OH)_2$	**Intermediate**
Biotite	$K(Mg,Fe)_3\ (Al\ Si_3\ O_{10})(OH)_2$	
Muscovite	$KAl_2\ (Al\ Si_3\ O_{10})\ (OH)_2$	
Quartz	SiO_2	**Felsic**
Feldspar group	($CaAl_2Si_2O_8$ $KAlSi_3O_8$ $NaAlSi_3O_8$)	

Which minerals do you think are common in continental crust?

Olivine	$(Mg,Fe)_2\ SiO_4$	**Utramafic**
Pyroxene	$(Mg,Fe,\ Ca)_2\ Si_2O_6$	**Mafic**
Hornblende	$(Ca,Na)_2\ (Mg,Fe,Al)_5\ Si_6\ (Si,Al)_2\ O_{22}\ (OH)_2$	**Intermediate**
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Quartz	SiO_2	**Felsic**
Feldspar group	$(CaAl_2Si_2O_8$ $KAlSi_3O_8$ $NaAlSi_3O_8)$	

Crustal Compositions

UltaMafic-Mafic Minerals

Olivine

Pyroxene

Intermediate

Hornblende

Biotite

Felsic Minerals

Muscovite

Quartz

Feldspar group

Rocks

Crustal Compositions

UltaMafic-Mafic Minerals

Olivine

Pyroxene

Rocks

Gabbro- Course-grained rock composed of Olivine, Pyroxene, Ca-Feldspar

Intermediate

Hornblende

Biotite

Felsic Minerals

Muscovite

Quartz

Feldspar group

Crustal Compositions

UltaMafic-Mafic Minerals

Olivine

Pyroxene

Rocks

Gabbro- Course-grained rock composed of Olivine, Pyroxene, Ca-Feldspar

Intermediate

Hornblende

Biotite

Diorite- Fine-grained rock composed of Hornblende, Biotite, Ca/Na-Feldspar

Felsic Minerals

Muscovite

Quartz

Feldspar group

Crustal Compositions

UltaMafic-Mafic Minerals

Olivine

Pyroxene

Intermediate

Hornblende

Biotite

Felsic Minerals

Muscovite

Quartz

Feldspar group

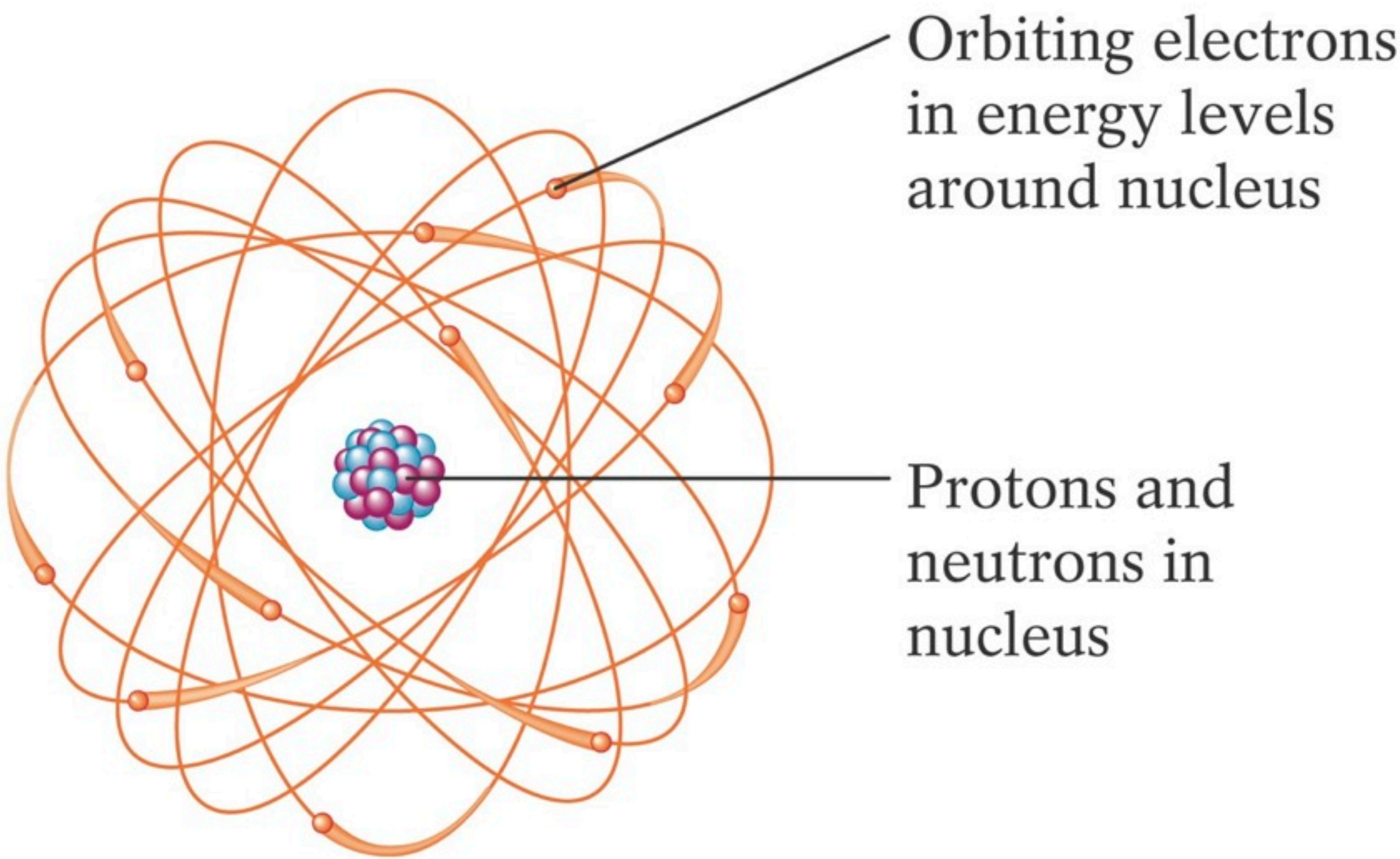
Rocks

Gabbro- Course-grained rock composed of Olivine, Pyroxene, Ca-Feldspar

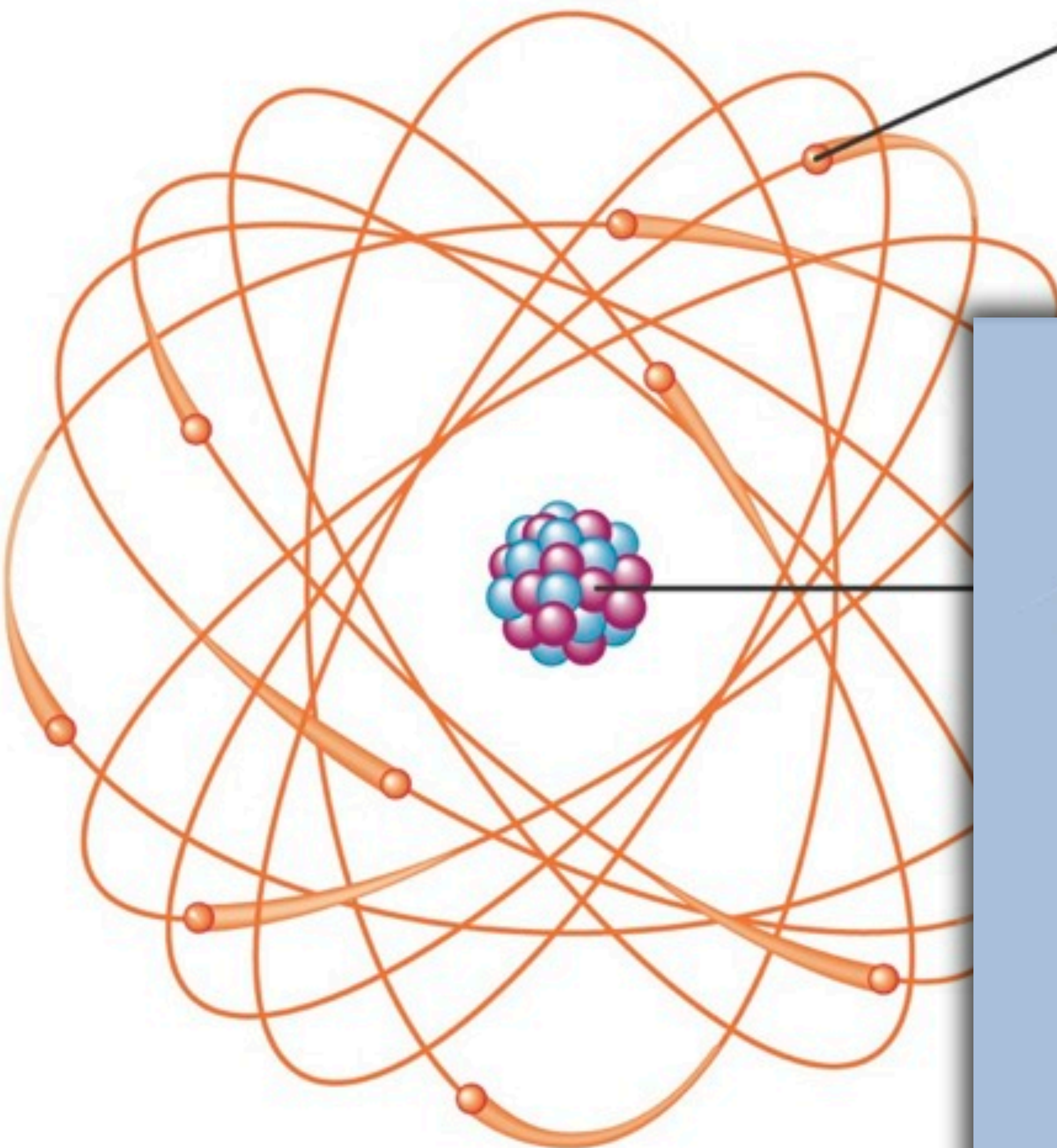
Diorite- Fine-grained rock composed of Hornblende, Biotite, Ca/Na-Feldspar

Granite- course-grained rock composed of Quartz, Plagioclase, Muscovite, Biotite, Hornblende K-Feldspar

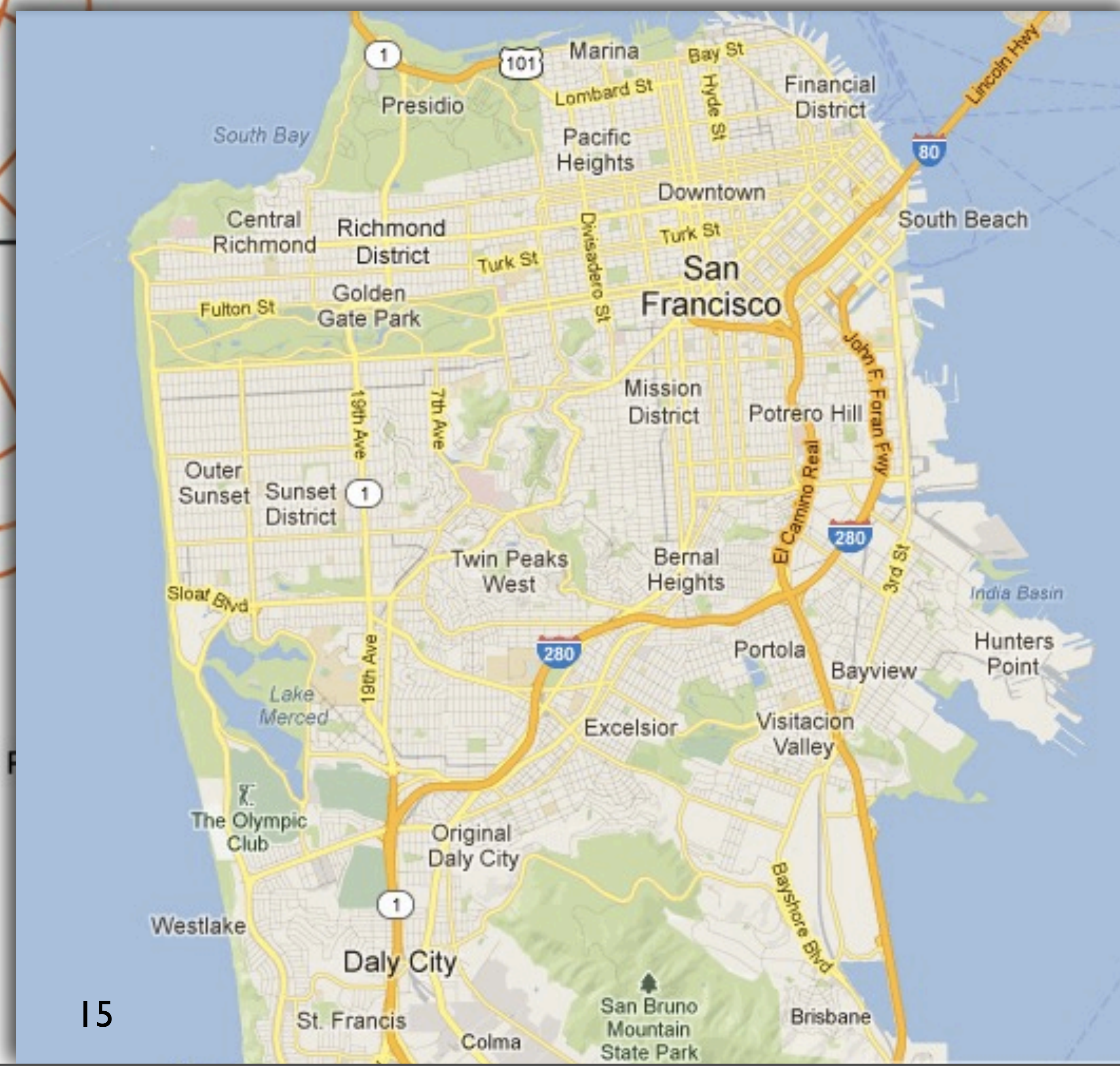
The Atom


Orbiting electrons in energy levels around nucleus
Protons and neutrons in nucleus

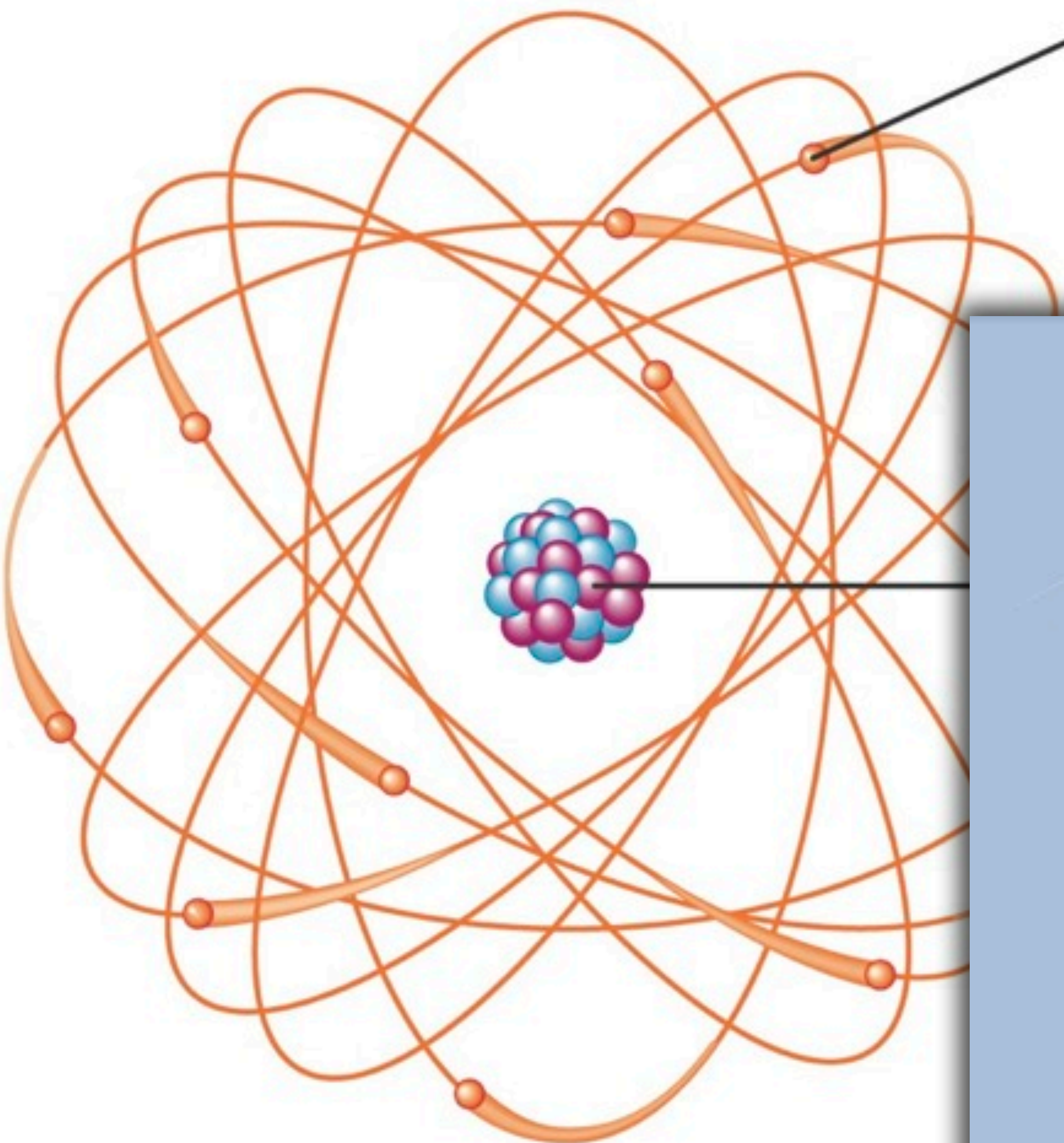
The Atom



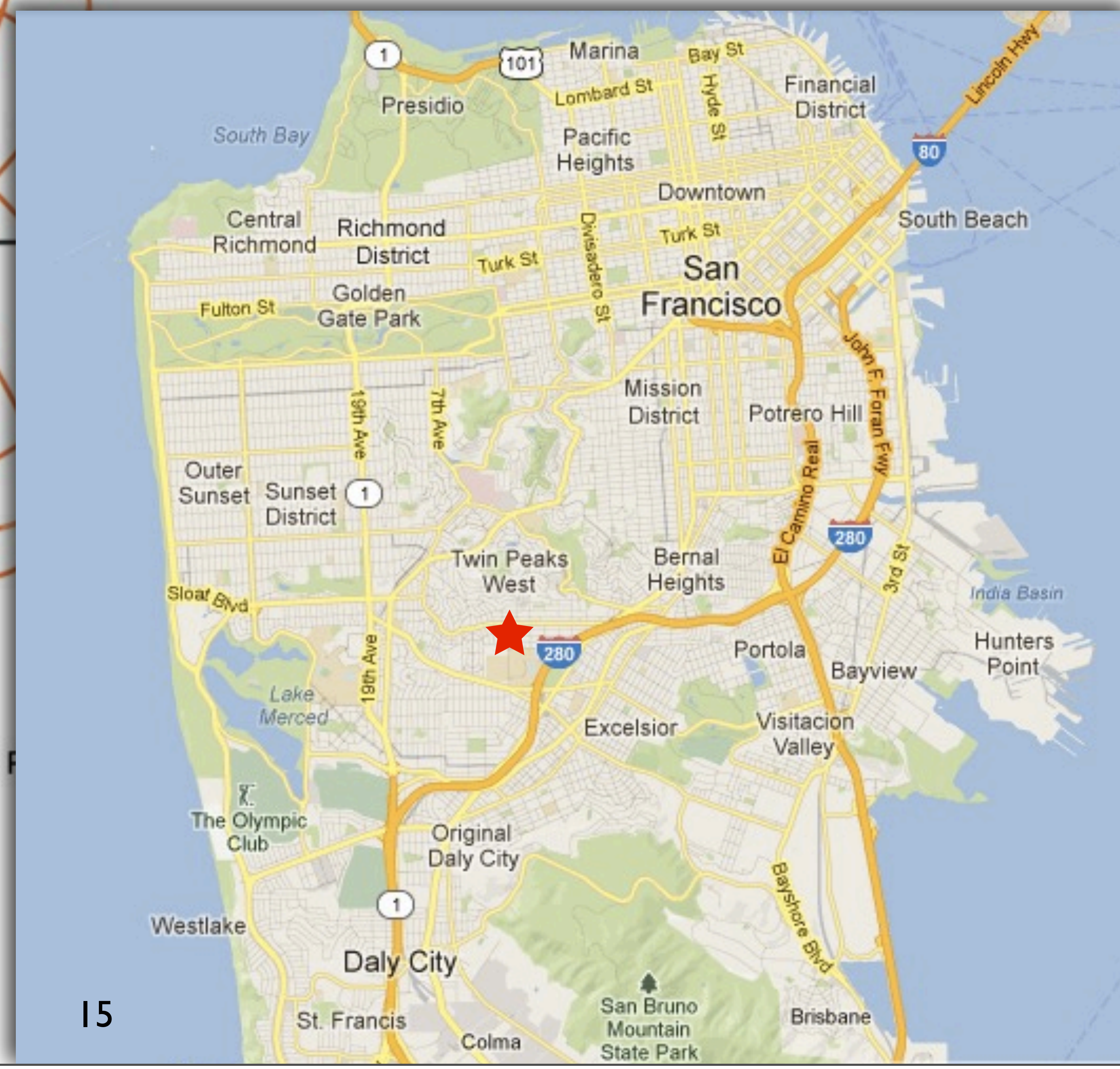
Orbiting electrons in energy levels around nucleus



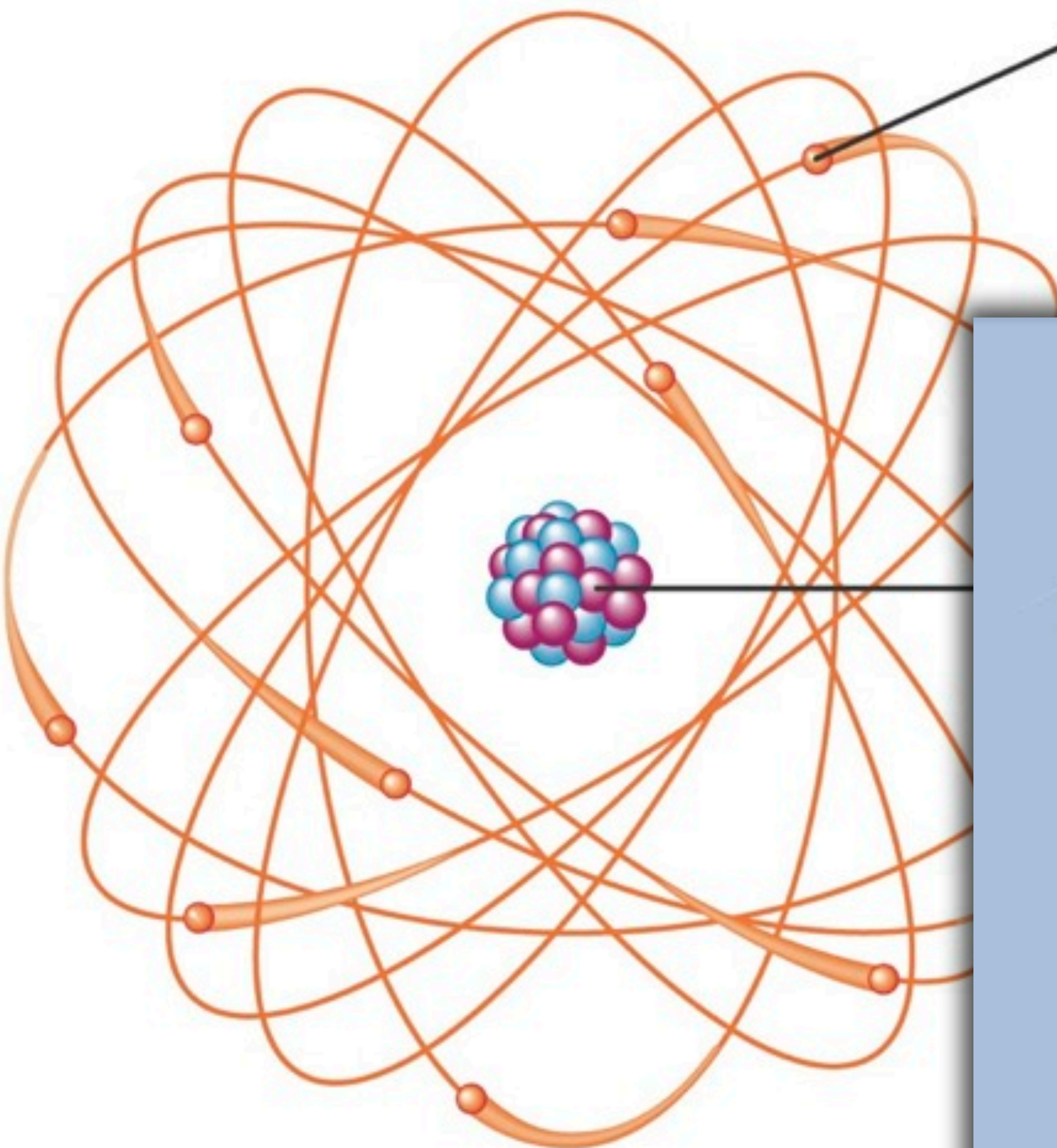
The Atom



Orbiting electrons in energy levels around nucleus



The Atom



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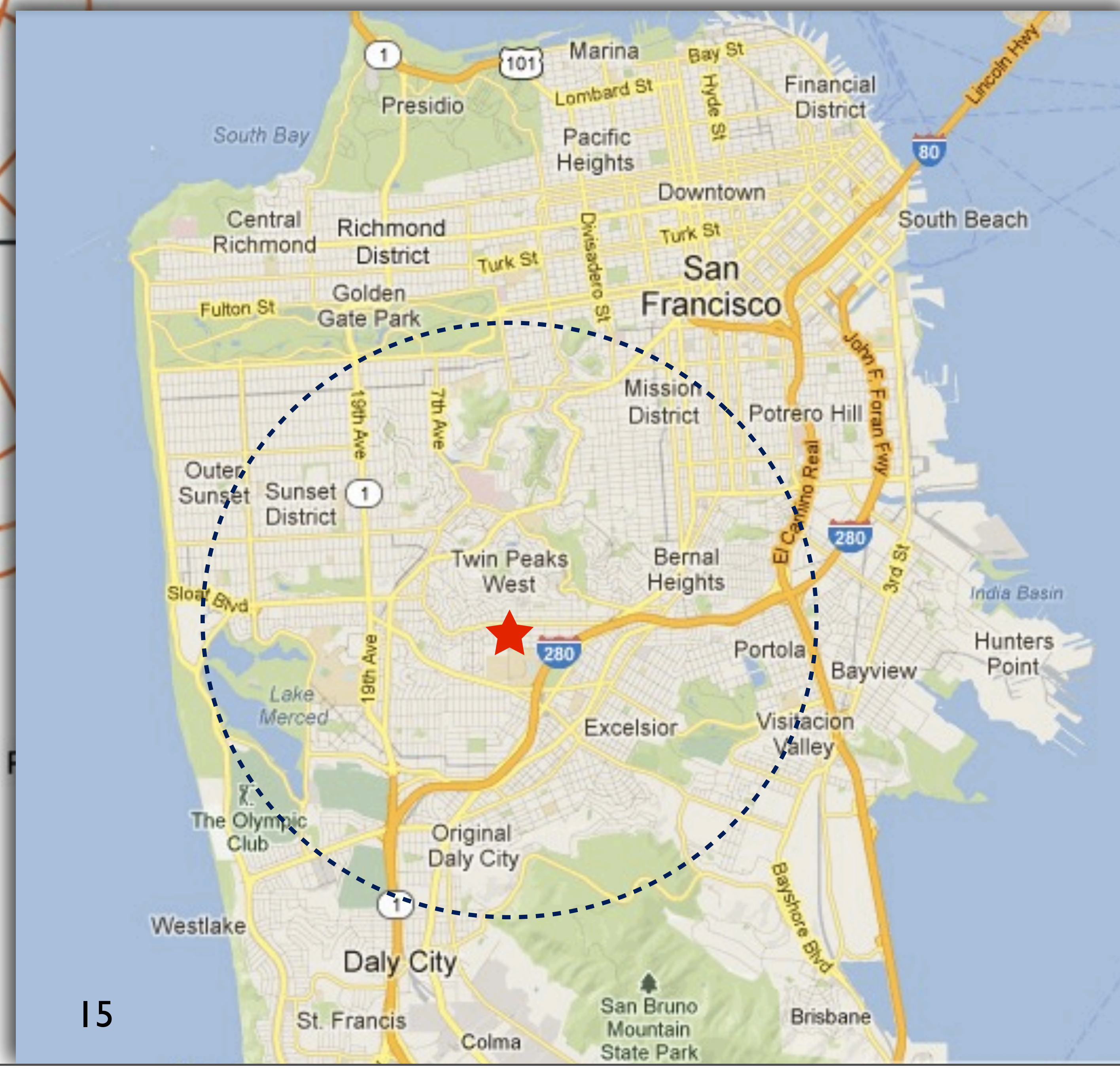
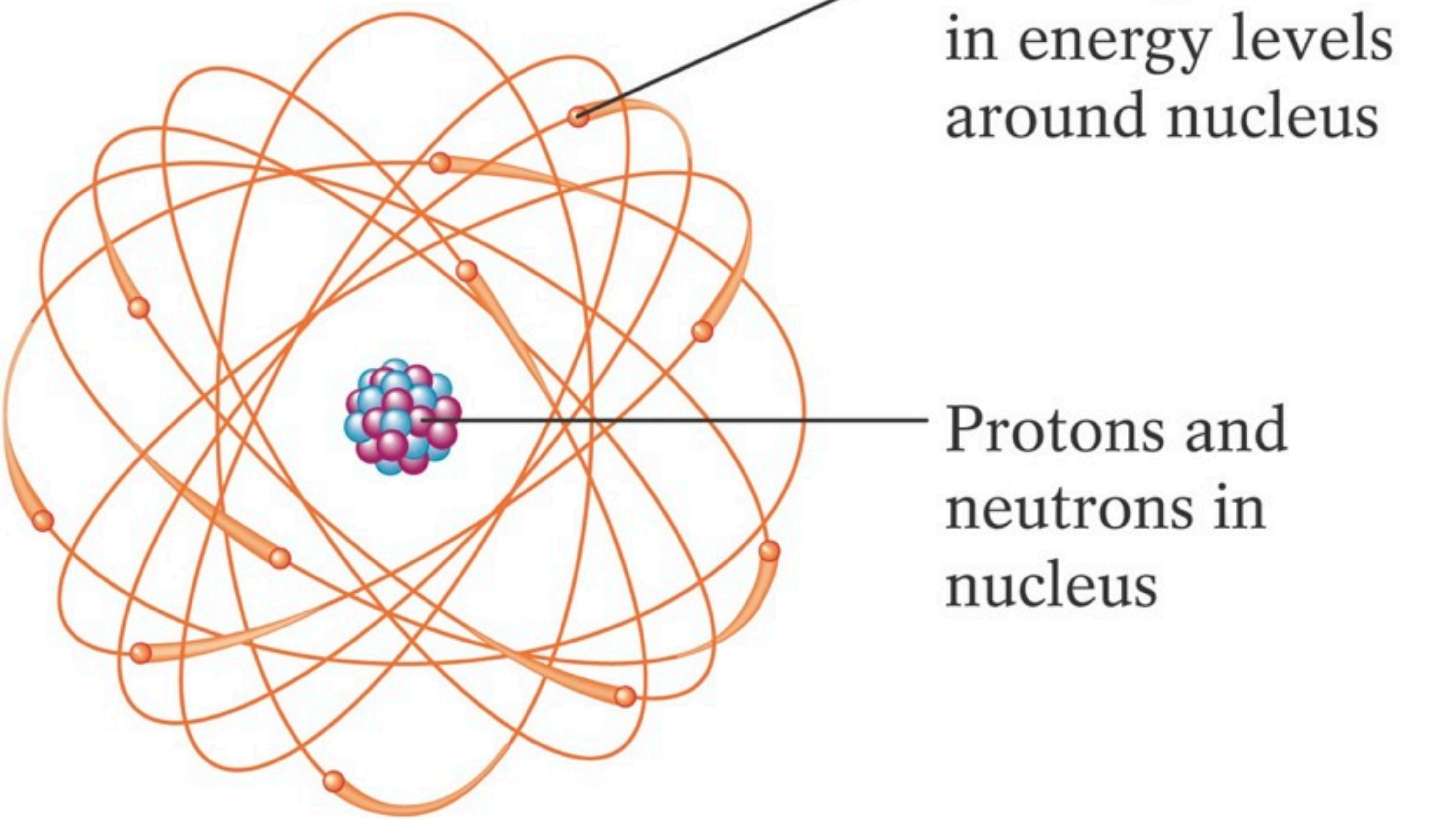
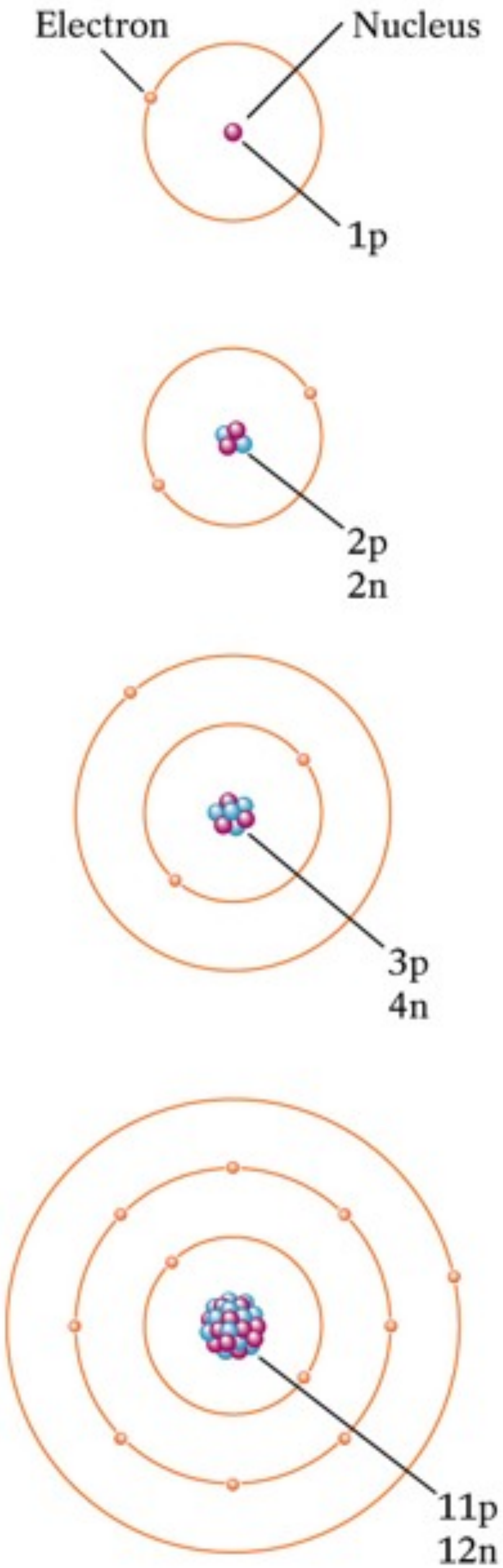


The Atom


Orbiting electrons in energy levels around nucleus
Protons and neutrons in nucleus

The Atom



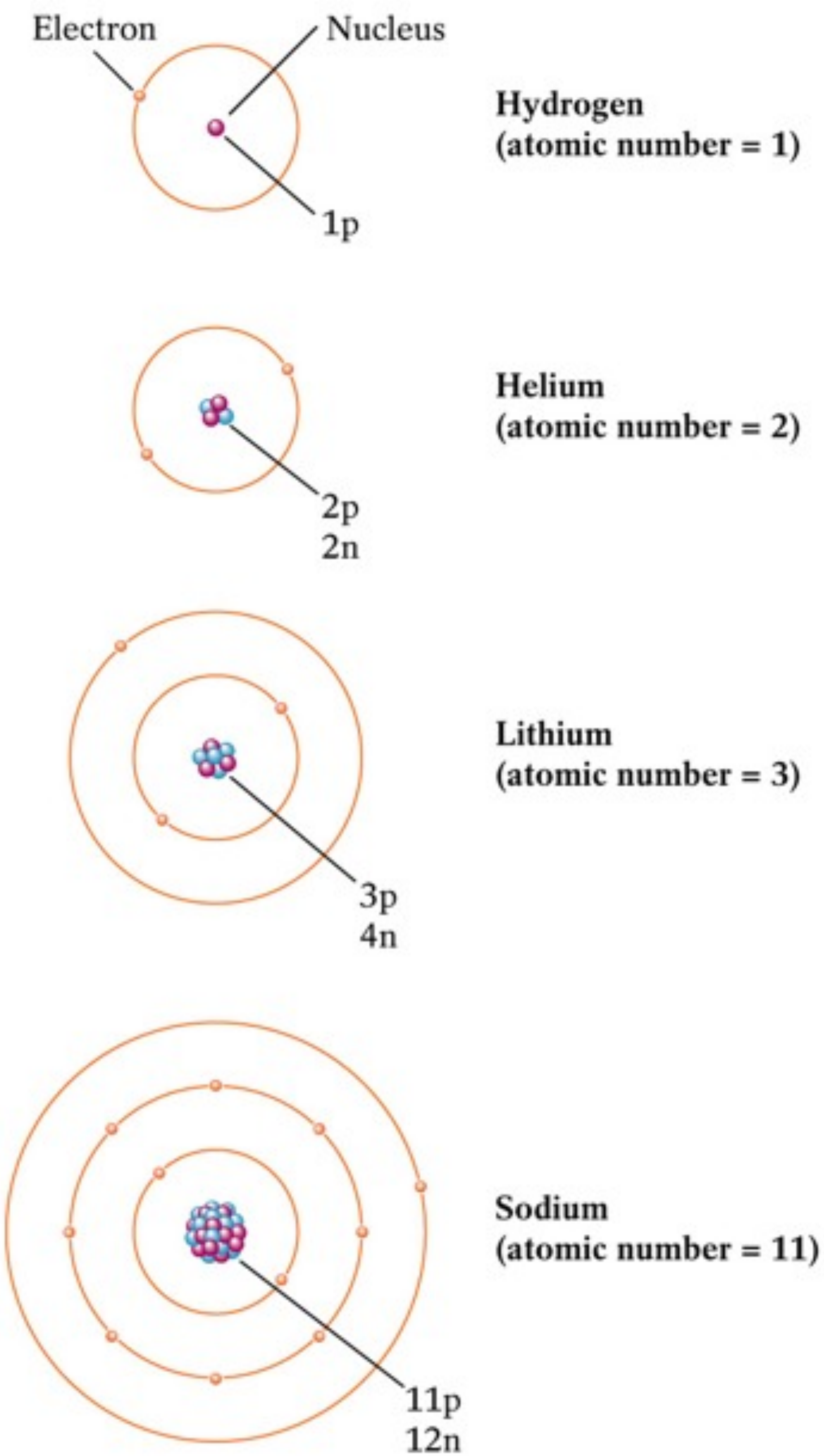
Hydrogen
(atomic number = 1)

Helium
(atomic number = 2)

Lithium
(atomic number = 3)

Sodium
(atomic number = 11)

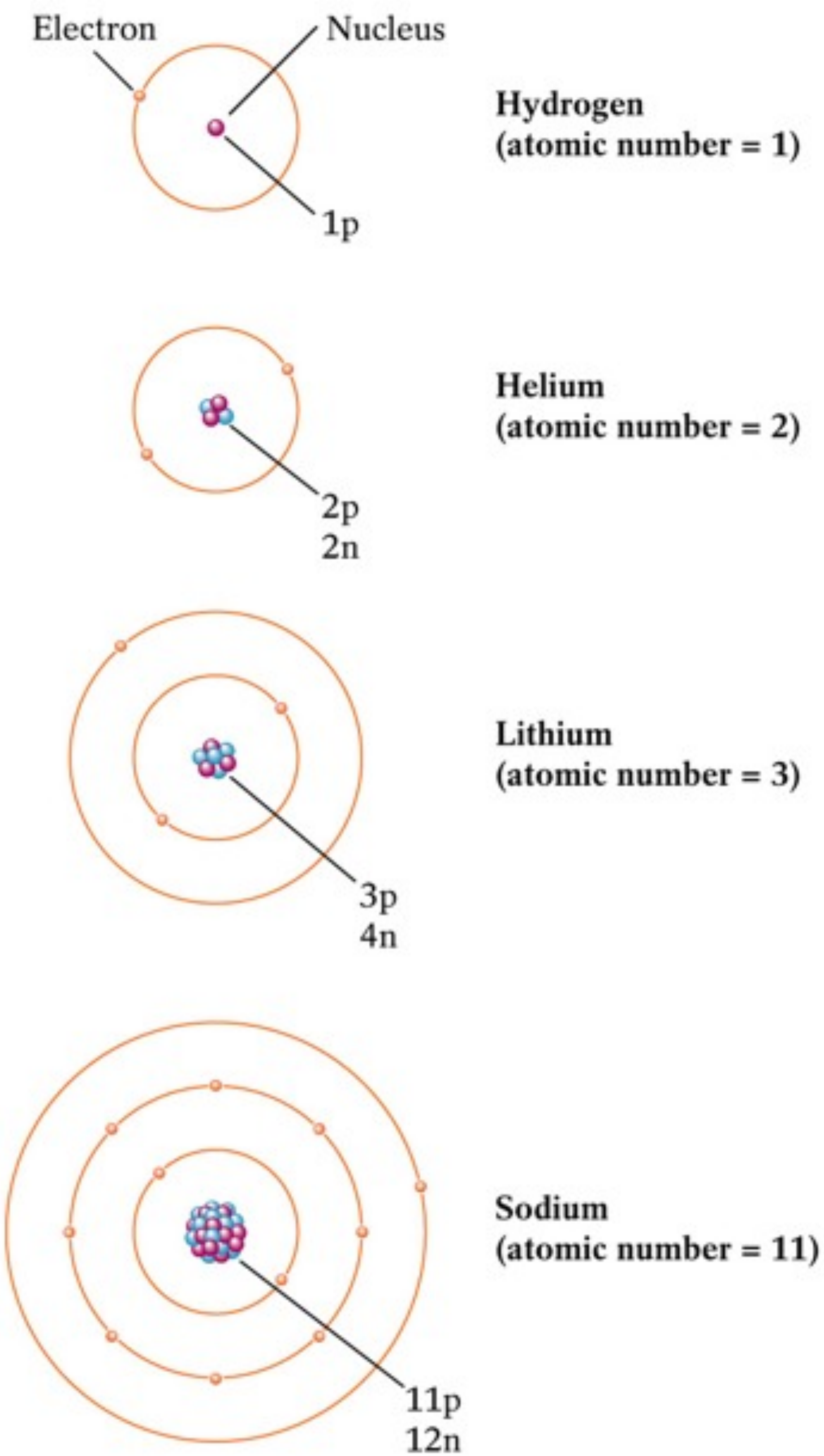
The Atom



Atomic Number

The number of protons in the nucleus

The Atom



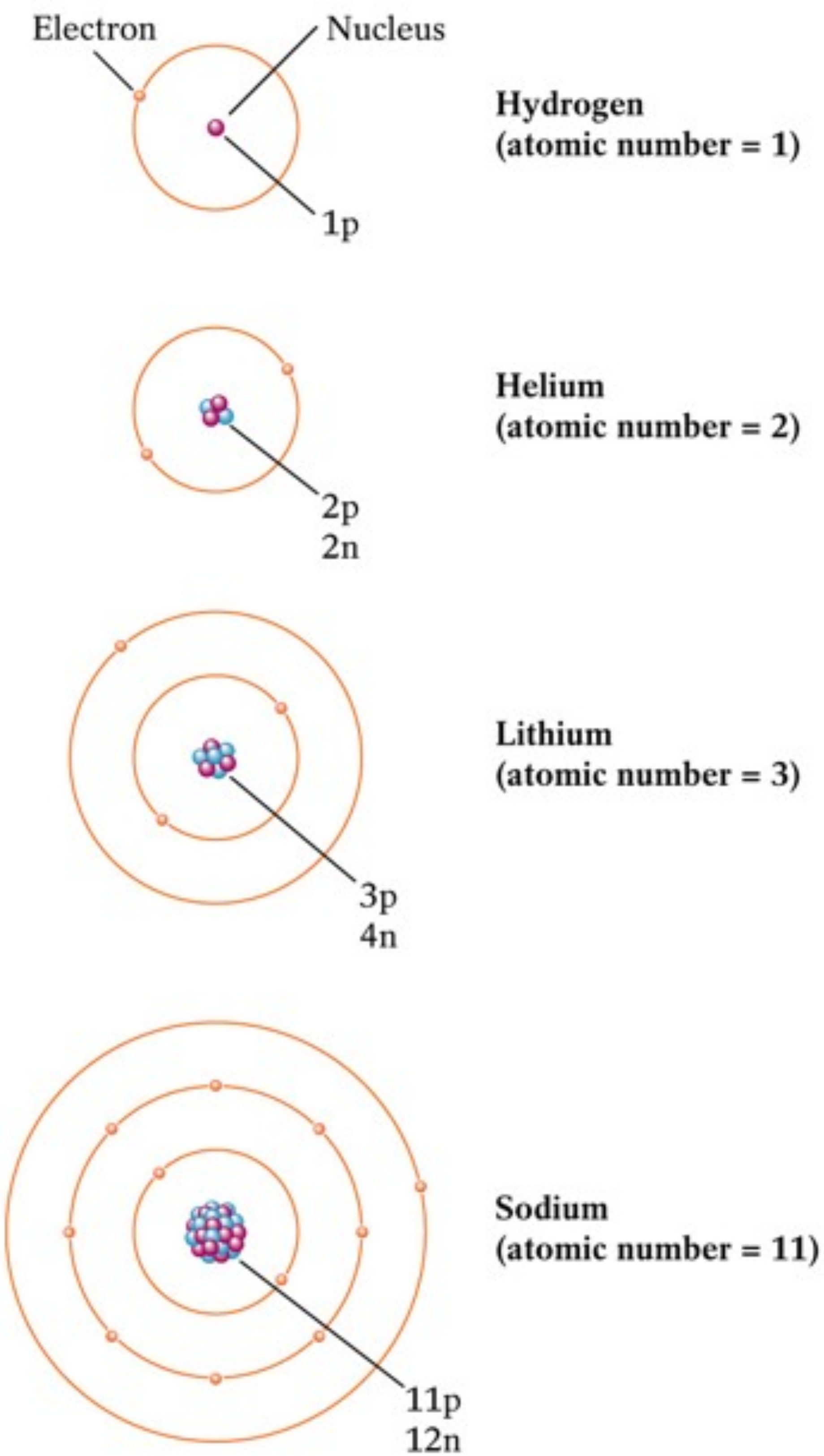
Atomic Number

The number of protons in the nucleus

Atomic Weight

The number of protons and neutrons in the nucleus

The Atom



Atomic Number

The number of protons in the nucleus

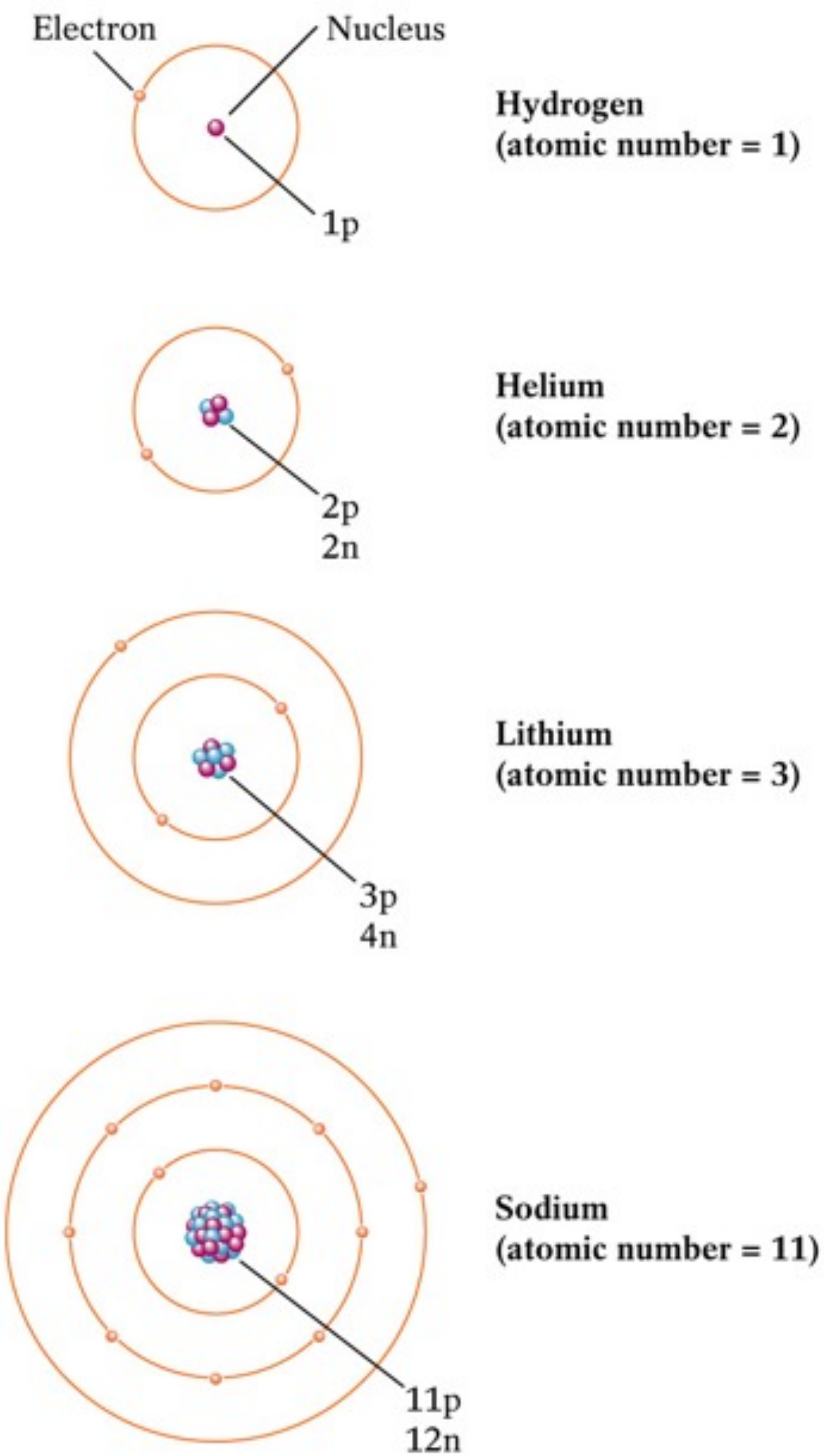
Atomic Weight

The number of protons and neutrons in the nucleus

Isotopes

Atoms of the same element (same # of protons), but with different numbers of neutrons

The Atom



Atomic Number

The number of protons in the nucleus

Atomic Weight

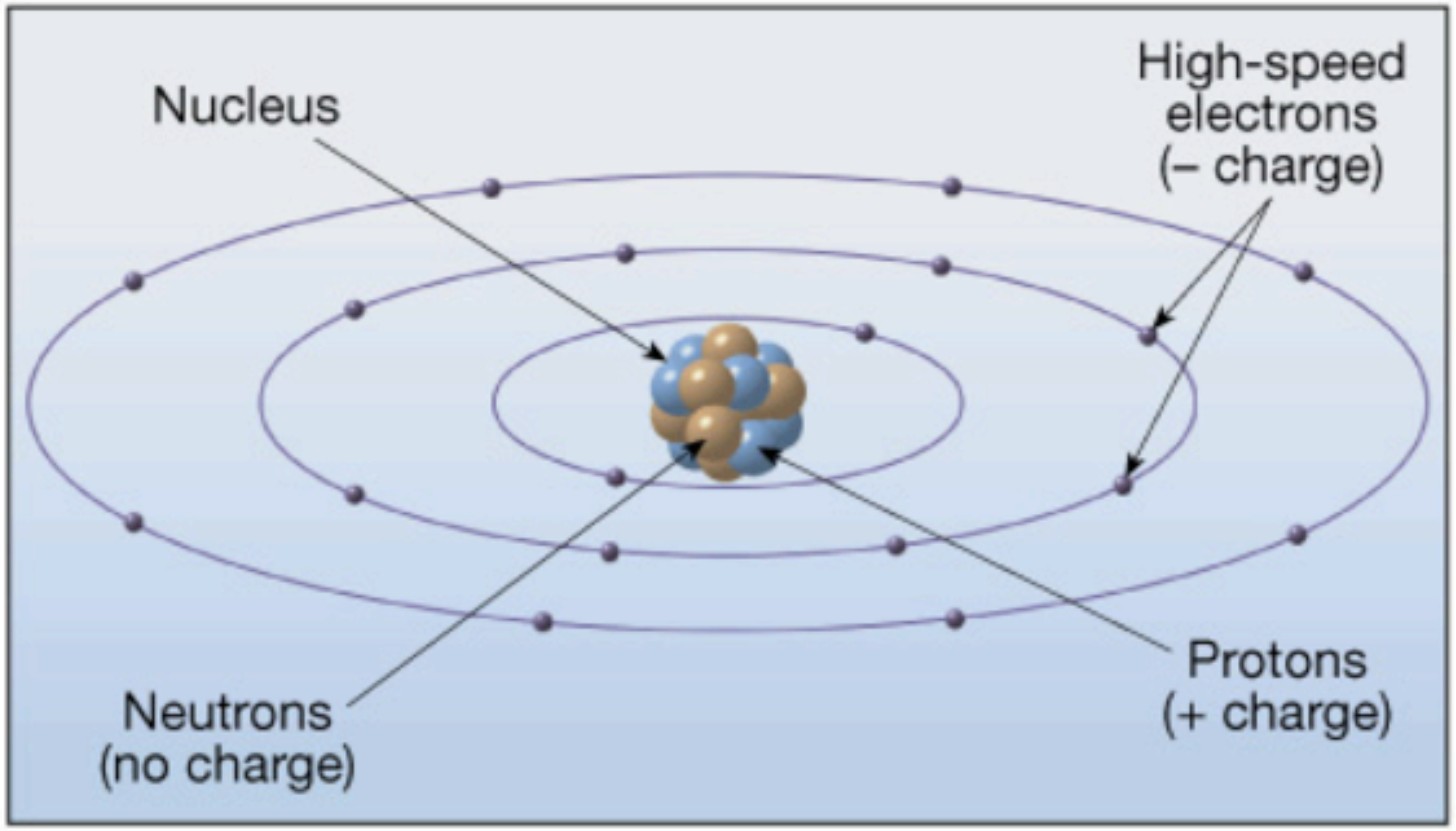
The number of protons and neutrons in the nucleus

Isotopes

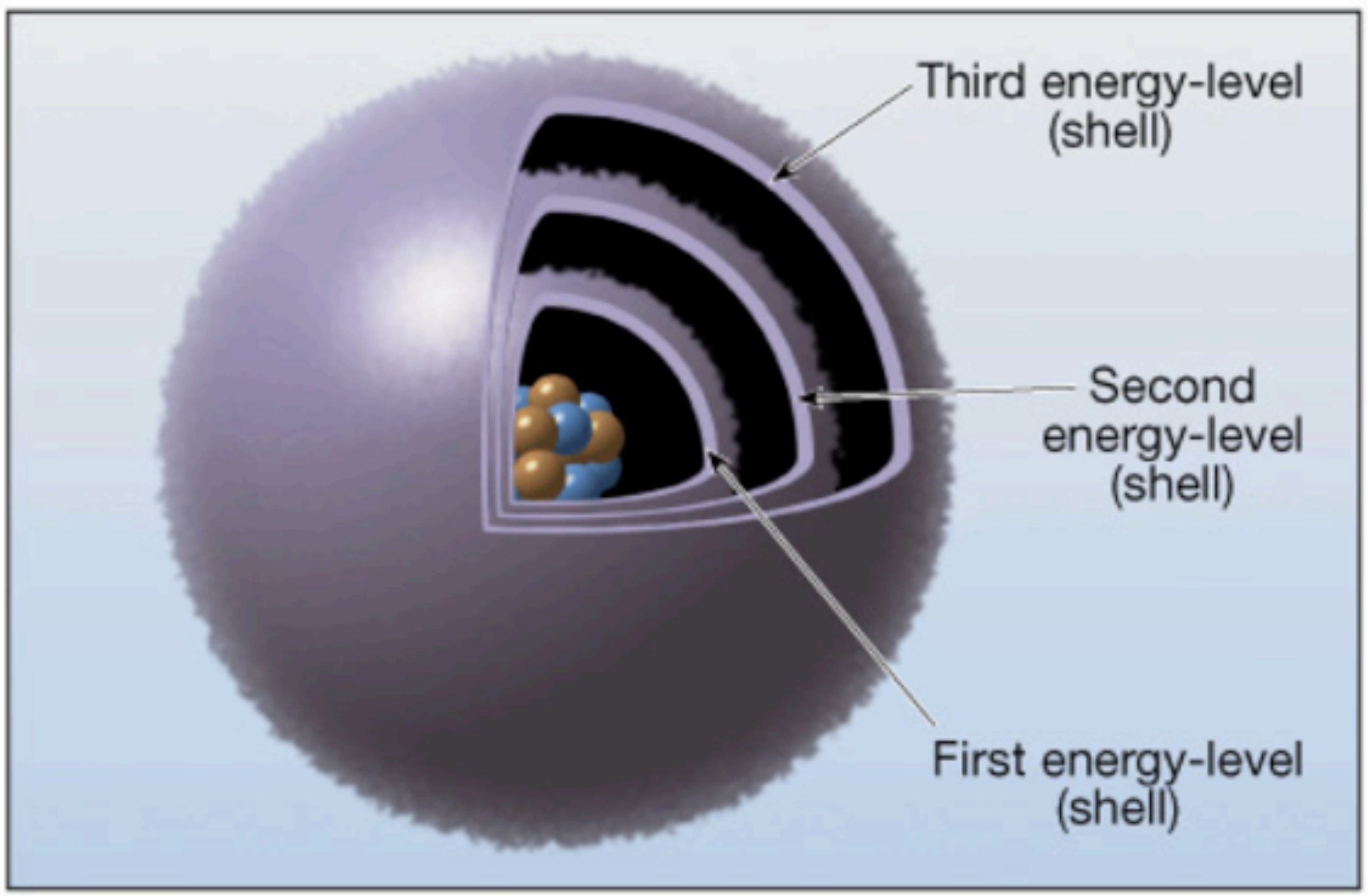
Atoms of the same element (same # of protons), but with different numbers of neutrons

Ions

Atoms of different numbers of electrons. Positive or negatively charged



A.

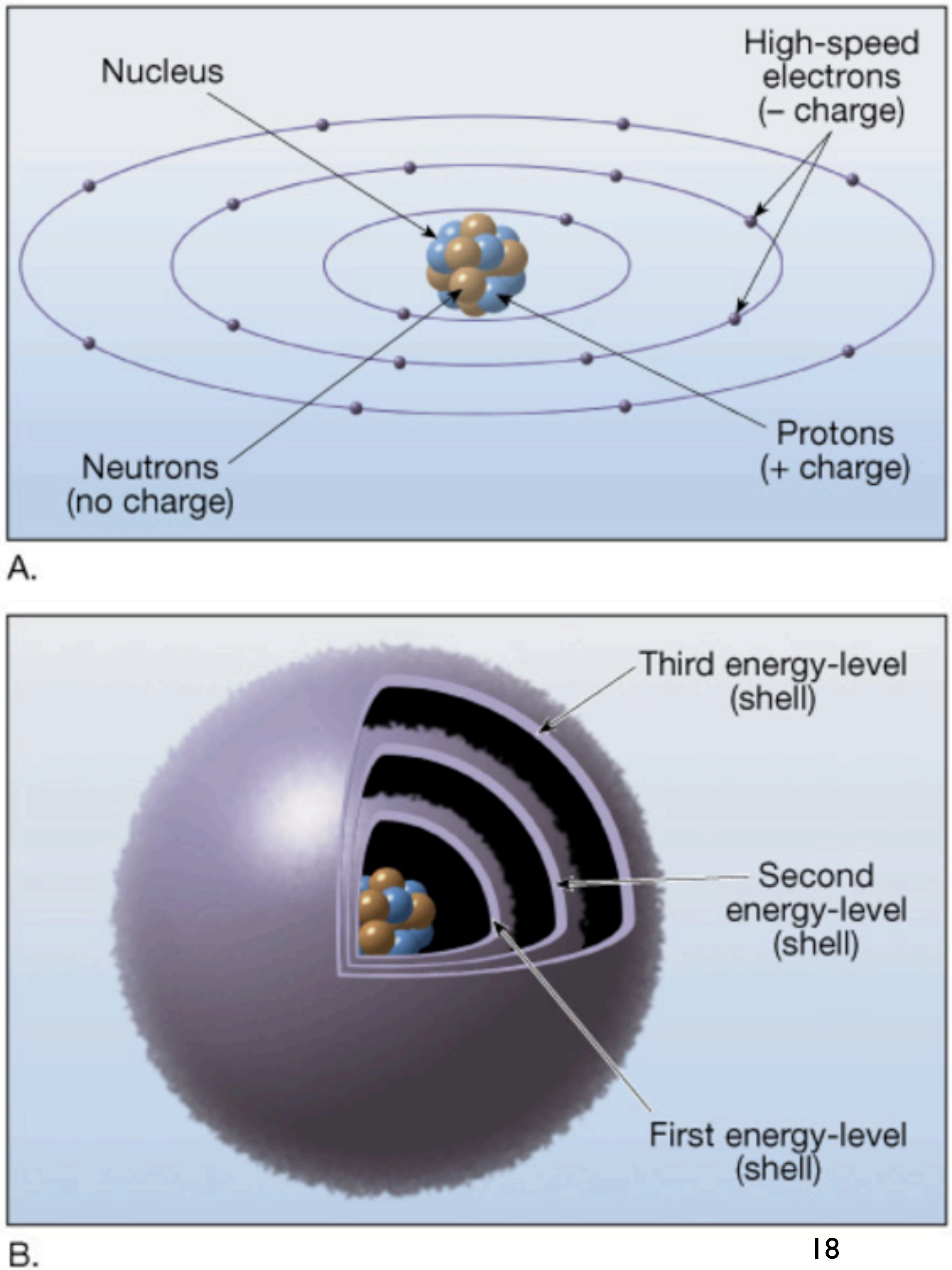


B.

The Atom

Octet rule

1) With the exception of H and He which can hold 2 electrons, the outermost shell of most atoms hold 8 electrons.



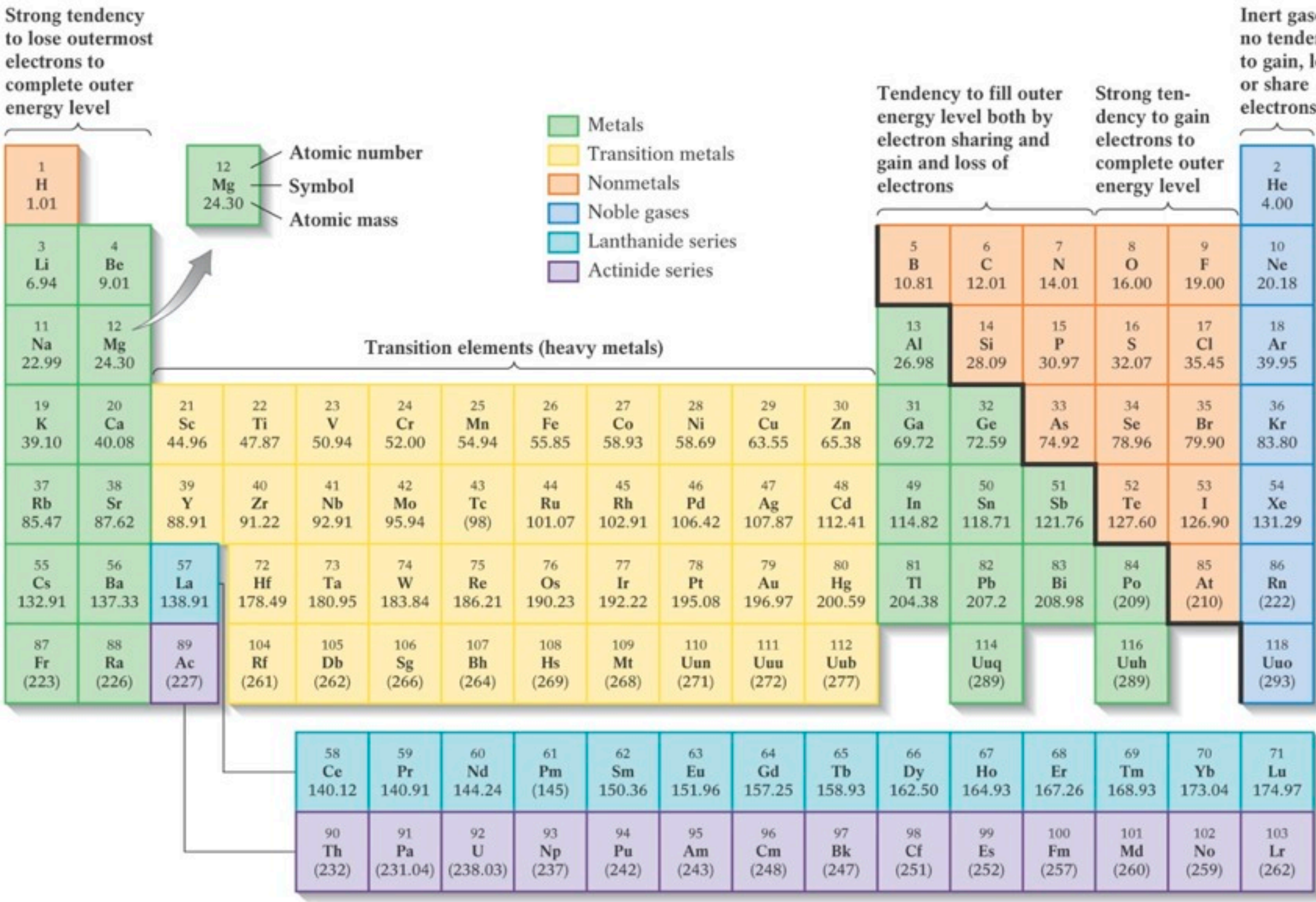
The Atom

Octet rule

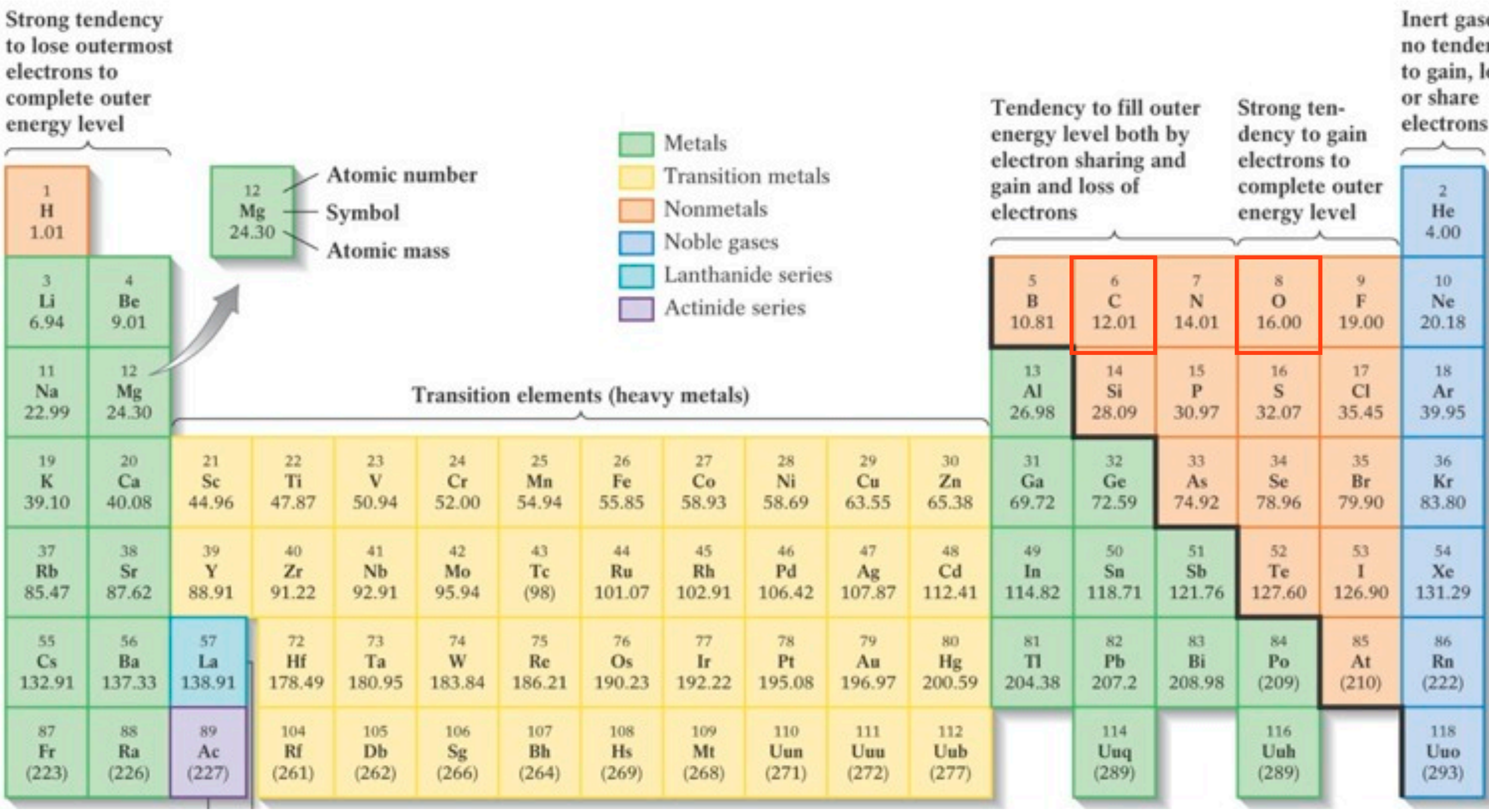
1) With the exception of H and He which can hold 2 electrons, the outermost shell of most atoms hold 8 electrons.

2) Chemical stability requires the outer electron shell of an atom to be full. Therefore most atoms seek to attain 8 electrons
(oct= eight)

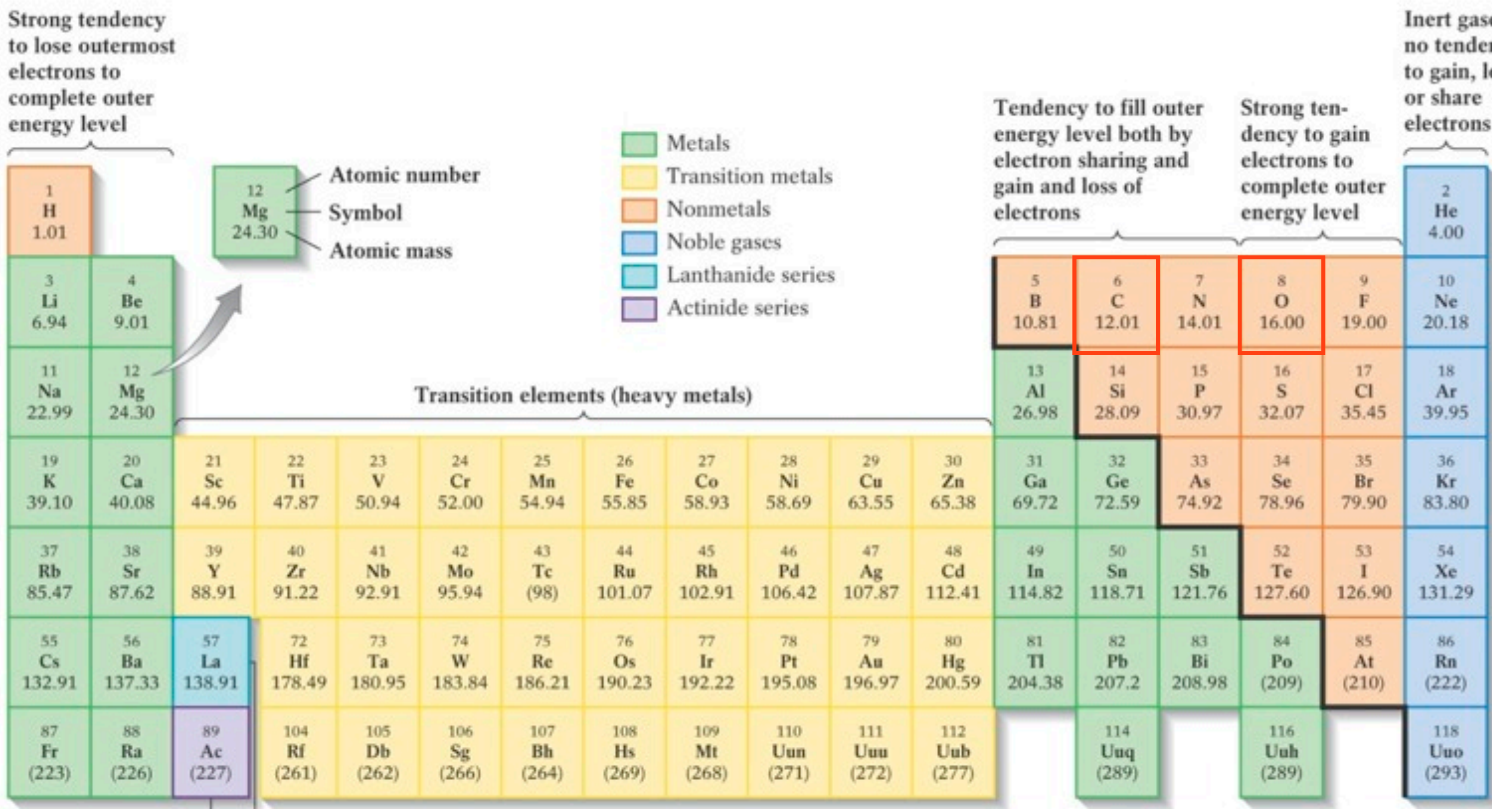
Electron Valence Configuration
Number of electrons in outer shell



Octet Rule for CO2



Octet Rule for CO_2

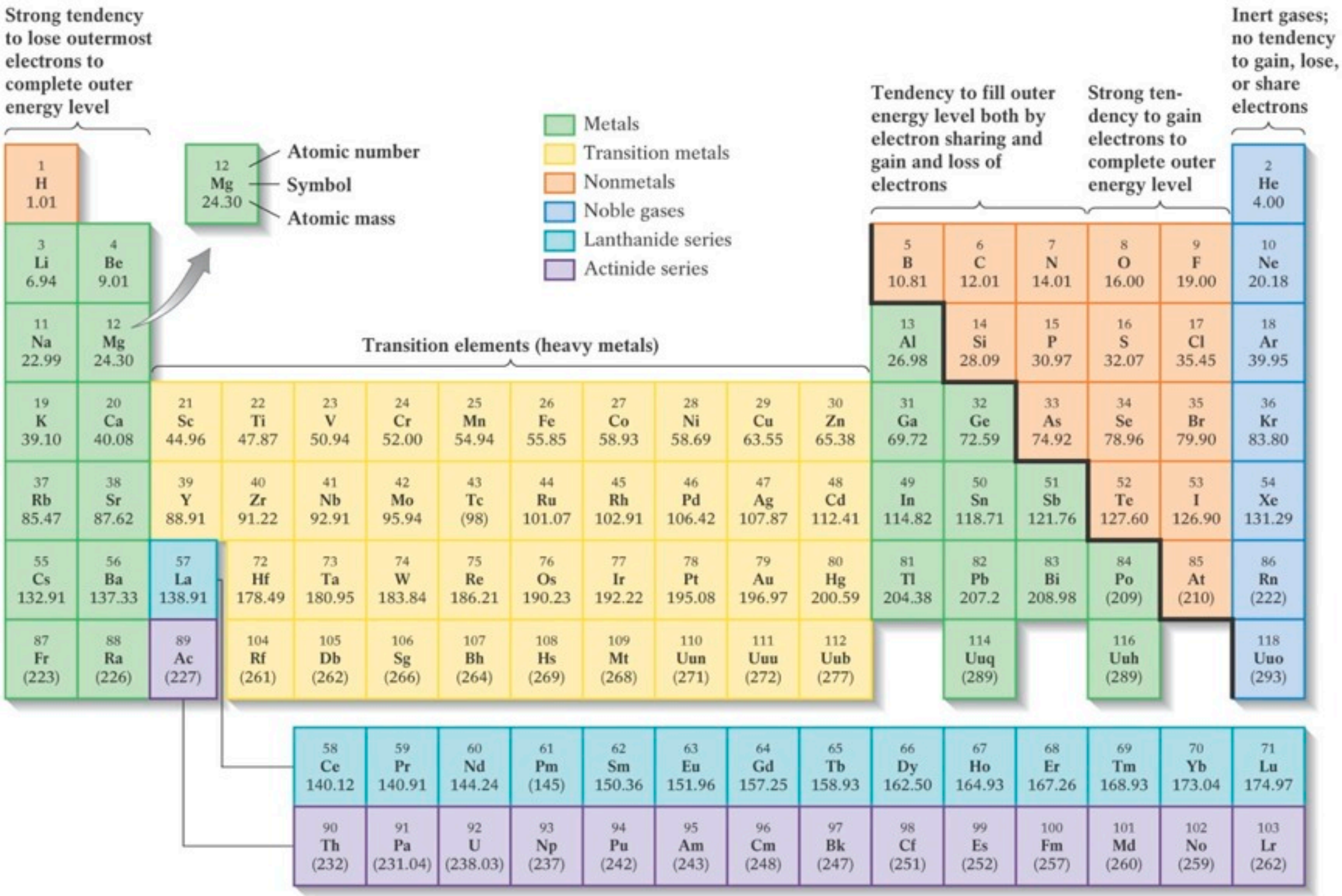


Valence

C = 4e

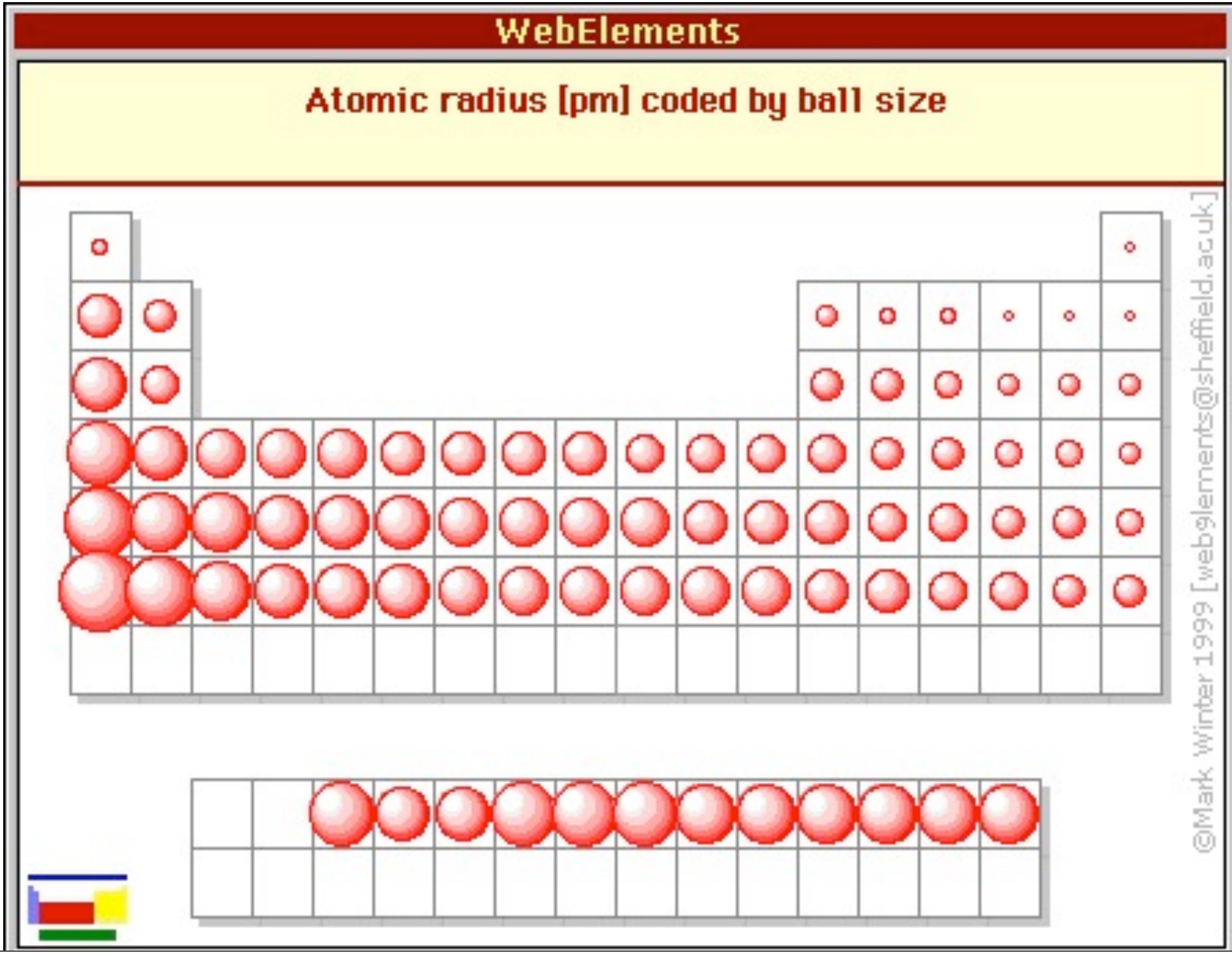
O = 6e

Atom Radii



Strong tendency to lose outermost electrons to complete outer energy level
Atomic number
Symbol
Atomic mass
12 Mg 24.30
Metals
Transition metals
Nonmetals
Noble gases
Lanthanide series
Actinide series
Tendency to fill outer energy level both by electron sharing and gain and loss of electrons
Strong tendency to gain electrons to complete outer energy level
Inert gases; no tendency to gain, lose, or share electrons
Transition elements (heavy metals)
1 H 1.01
2 He 4.00
3 Li 6.94
4 Be 9.01
5 B 10.81
6 C 12.01
7 N 14.01
8 O 16.00
9 F 19.00
10 Ne 20.18
11 Na 22.99
12 Mg 24.30
13 Al 26.98
14 Si 28.09
15 P 30.97
16 S 32.07
17 Cl 35.45
18 Ar 39.95
19 K 39.10
20 Ca 40.08
21 Sc 44.96
22 Ti 47.87
23 V 50.94
24 Cr 52.00
25 Mn 54.94
26 Fe 55.85
27 Co 58.93
28 Ni 58.69
29 Cu 63.55
30 Zn 65.38
31 Ga 69.72
32 Ge 72.59
33 As 74.92
34 Se 78.96
35 Br 79.90
36 Kr 83.80
37 Rb 85.47
38 Sr 87.62
39 Y 88.91
40 Zr 91.22
41 Nb 92.91
42 Mo 95.94
43 Tc (98)
44 Ru 101.07
45 Rh 102.91
46 Pd 106.42
47 Ag 107.87
48 Cd 112.41
49 In 114.82
50 Sn 118.71
51 Sb 121.76
52 Te 127.60
53 I 126.90
54 Xe 131.29
55 Cs 132.91
56 Ba 137.33
57 La 138.91
72 Hf 178.49
73 Ta 180.95
74 W 183.84
75 Re 186.21
76 Os 190.23
77 Ir 192.22
78 Pt 195.08
79 Au 196.97
80 Hg 200.59
81 Tl 204.38
82 Pb 207.2
83 Bi 208.98
84 Po (209)
85 At (210)
86 Rn (222)
87 Fr (223)
88 Ra (226)
89 Ac (227)
104 Rf (261)
105 Db (262)
106 Sg (266)
107 Bh (264)
108 Hs (269)
109 Mt (268)
110 Uun (271)
111 Uuu (272)
112 Uub (277)
114 Uuq (289)
116 Uuh (289)
118 Uuo (293)
58 Ce 140.12
59 Pr 140.91
60 Nd 144.24
61 Pm (145)
62 Sm 150.36
63 Eu 151.96
64 Gd 157.25
65 Tb 158.93
66 Dy 162.50
67 Ho 164.93
68 Er 167.26
69 Tm 168.93
70 Yb 173.04
71 Lu 174.97
90 Th (232)
91 Pa (231.04)
92 U (238.03)
93 Np (237)
94 Pu (242)
95 Am (243)
96 Cm (248)
97 Bk (247)
98 Cf (251)
99 Es (252)
100 Fm (257)
101 Md (260)
102 No (259)
103 Lr (262)

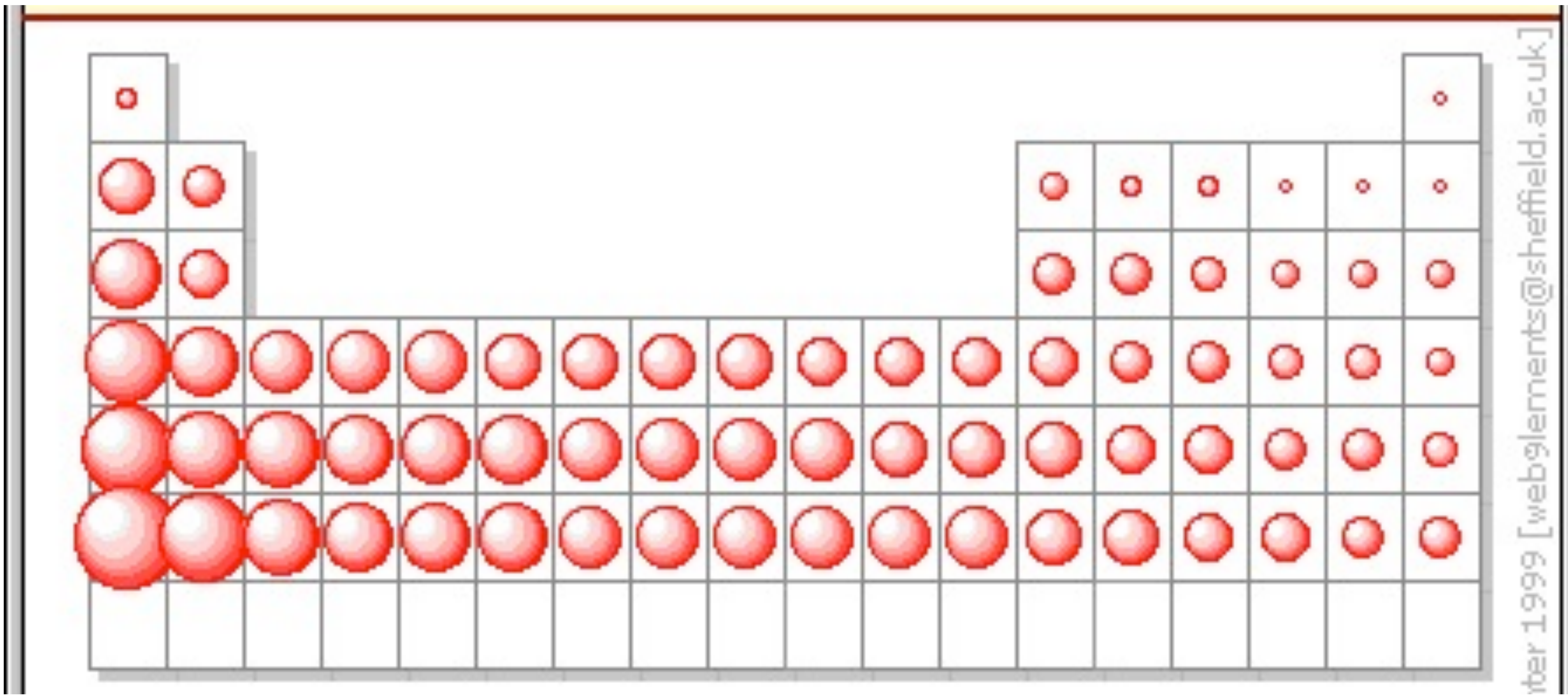
Atom Radii


WebElements
Atomic radius [pm] coded by ball size
©Mark Winter 1999 [webelements@sheffield.ac.uk]

Electronegativity

Weak Electronegativity
Loses electrons

Strong Electronegativity
Holds electrons

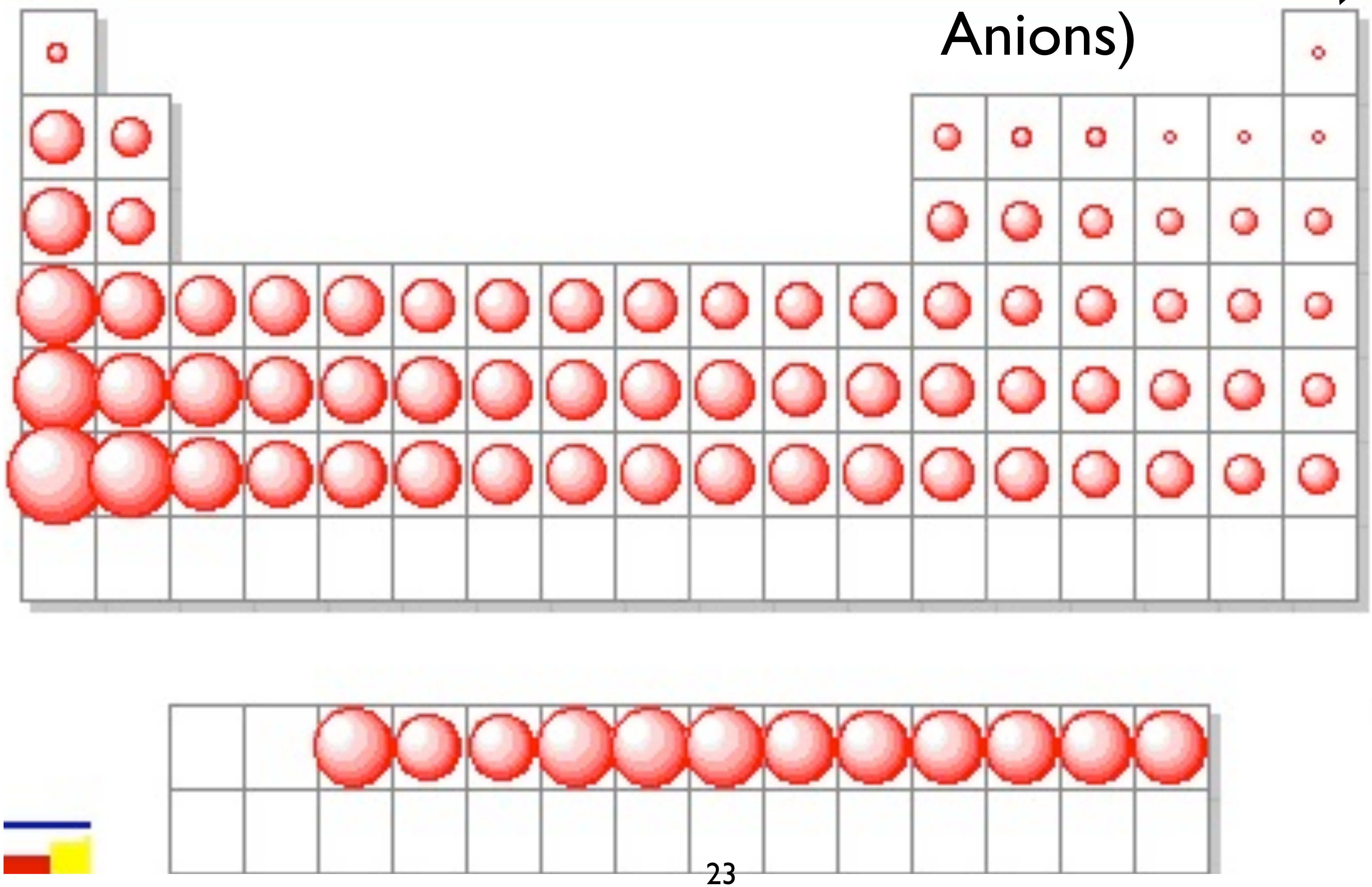


Cations(+) and Anions(-)

Inert gasses

Electron donor (Positively charged Cations)

Electron acceptor (Negatively charged Anions)

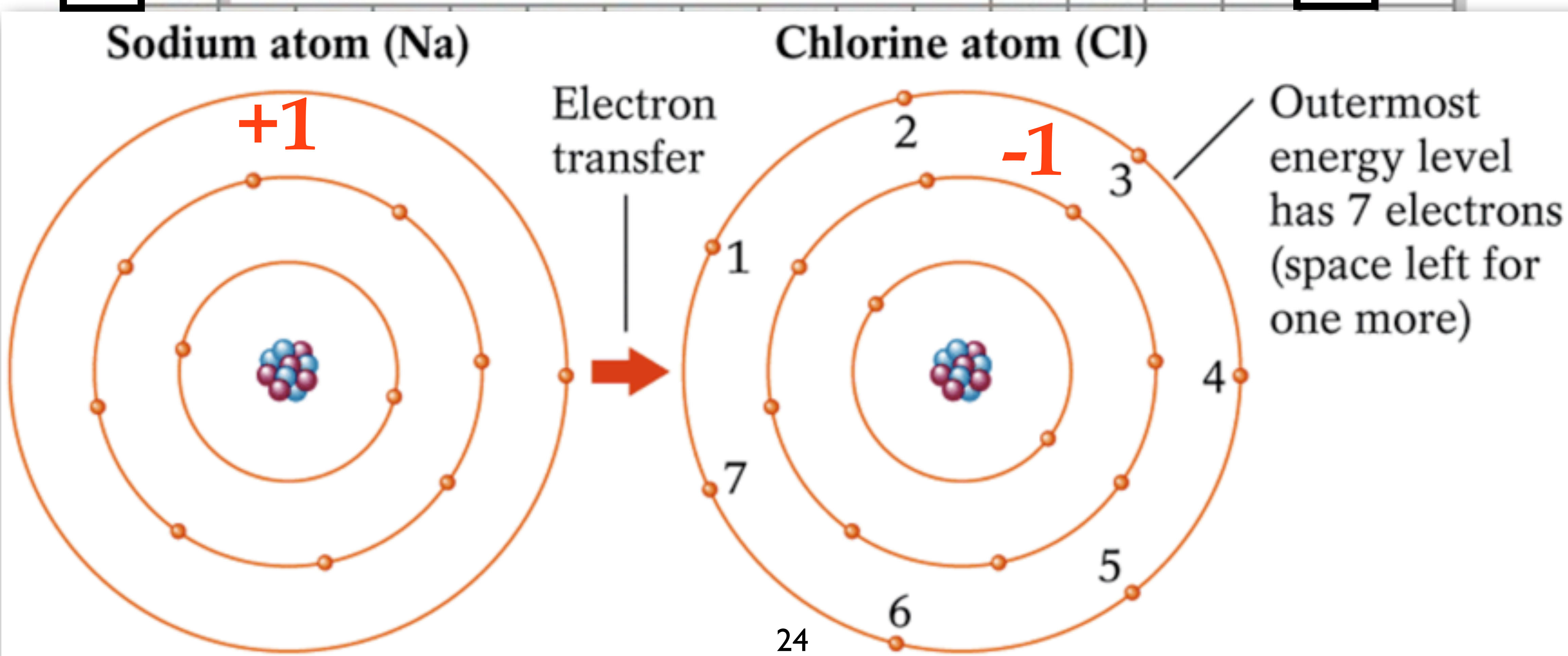


Ions develop due to Electron exchange

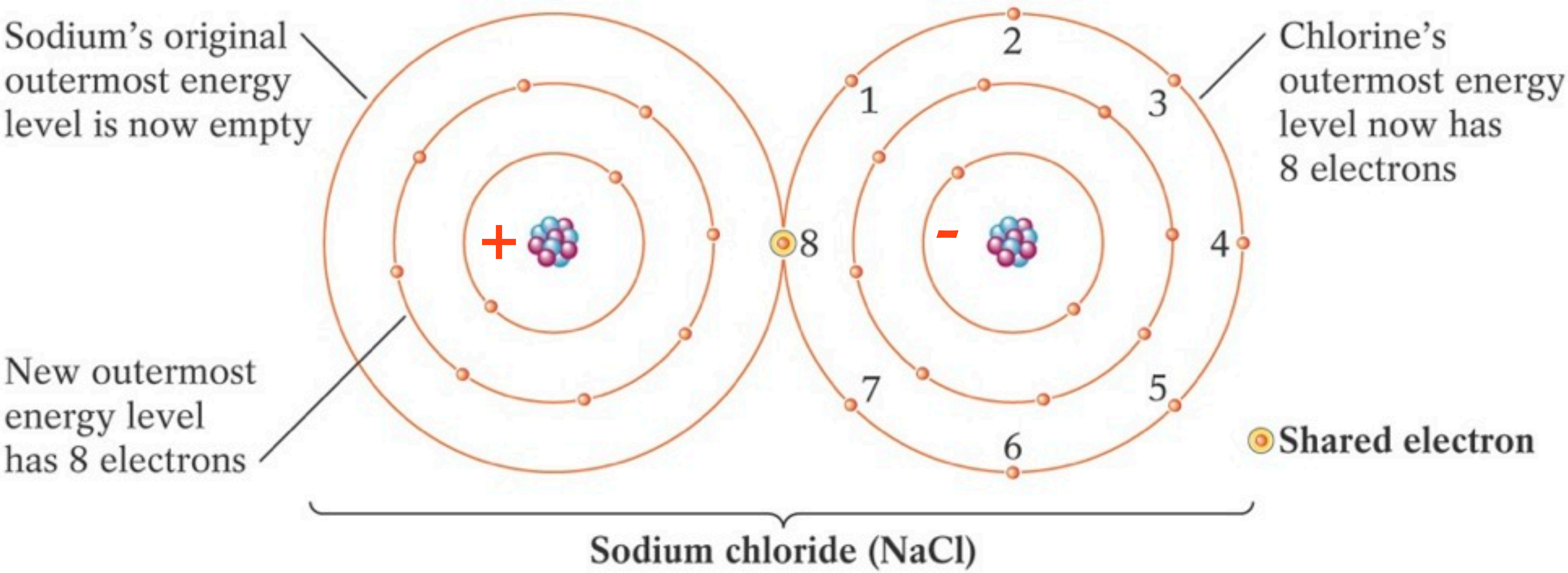
Inert gasses

Electron donor
(Positively charged)

Electron acceptor
(Negatively charged)



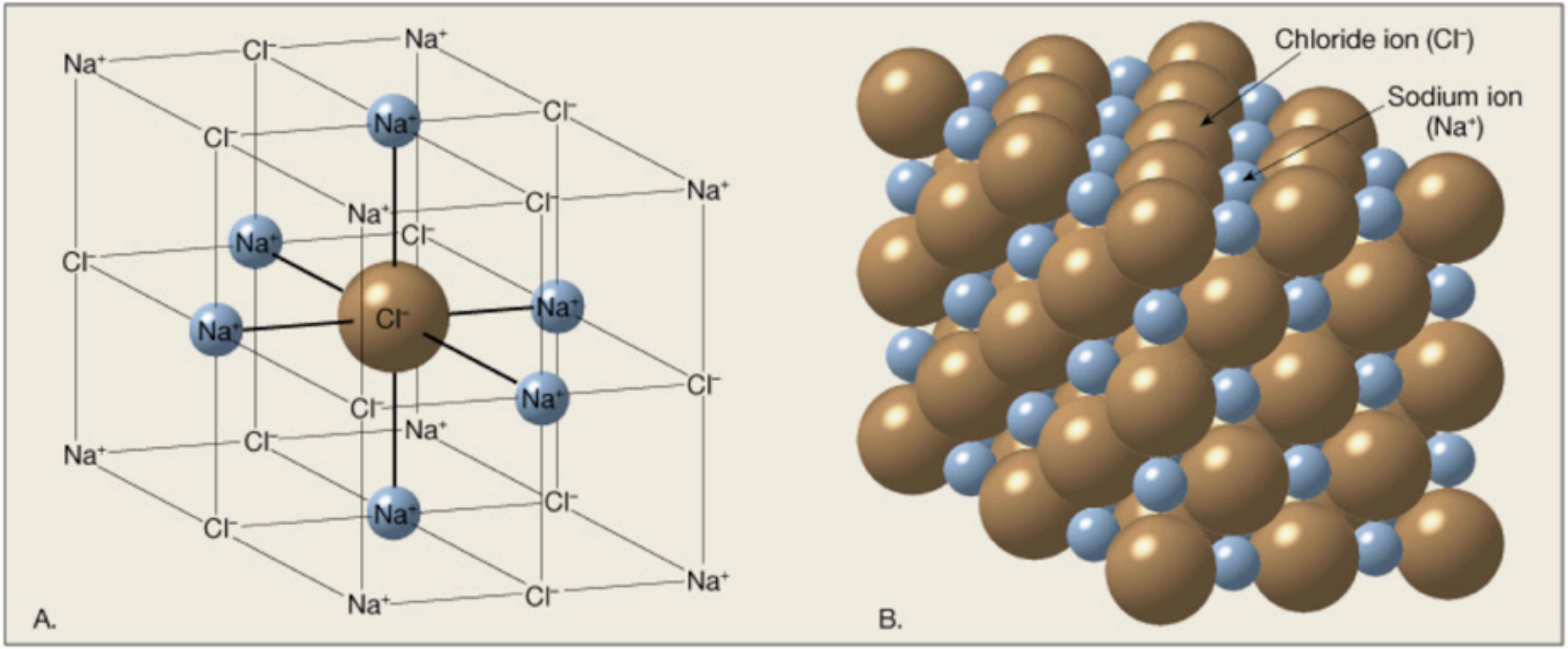
Ionic Bonding (atomic bond)



1) The molecule has no net charge. However the molecule is dipolar having a slight positive charge on the Na side and a slight negative charge on Cl side

2) Weak bond because Na has low electronegativity

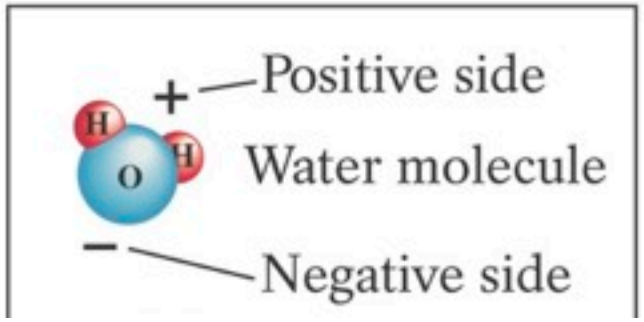
van der Waals Bonding (molecular bond)



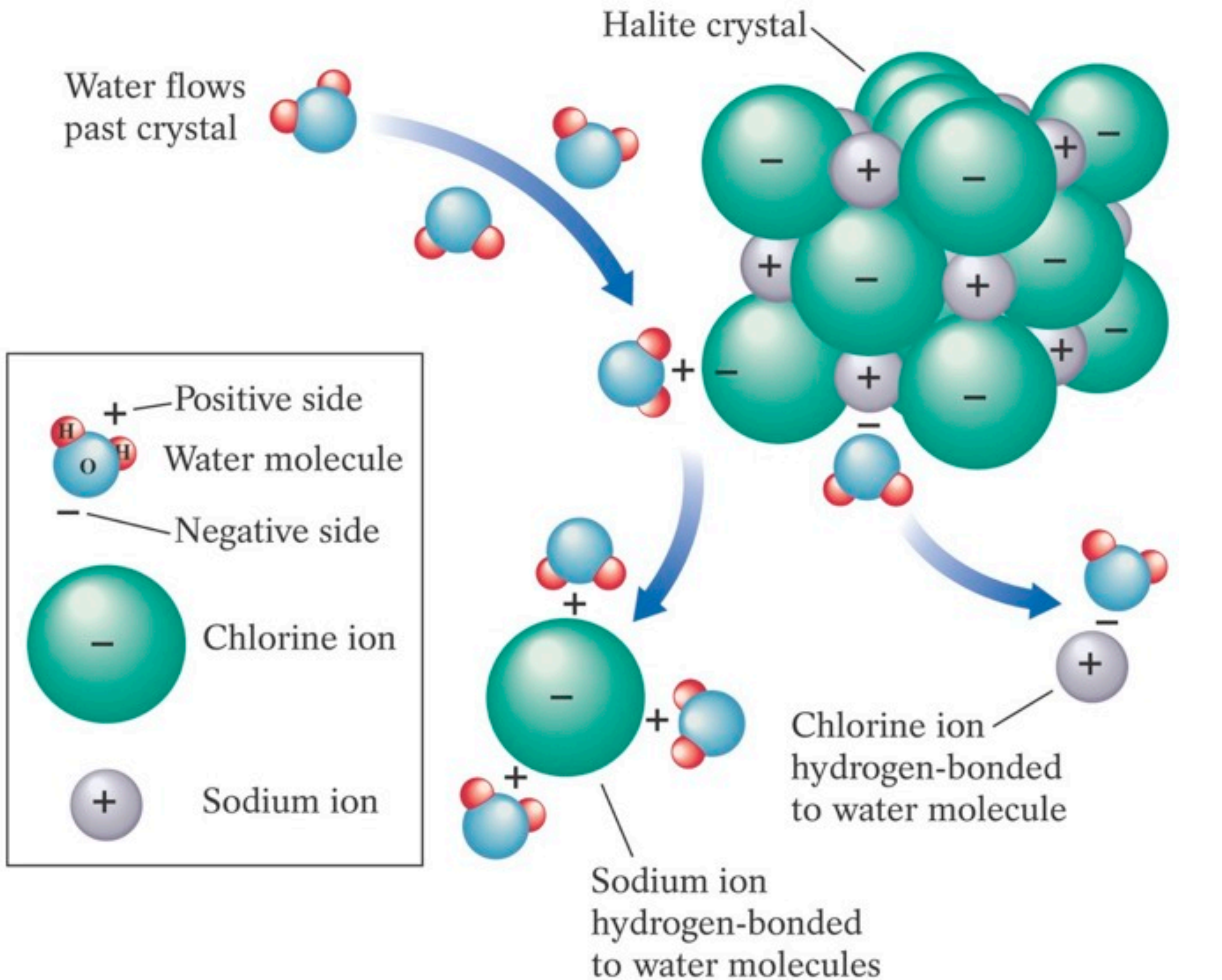
Because **Ionically** bonded NaCl pairs have an electron polarized charge, NaCl pairs stick together in an eight-sided cubic **internal structure**

Van der Wall bonds are very weak

Hydrogen Bonds (molecular bond)



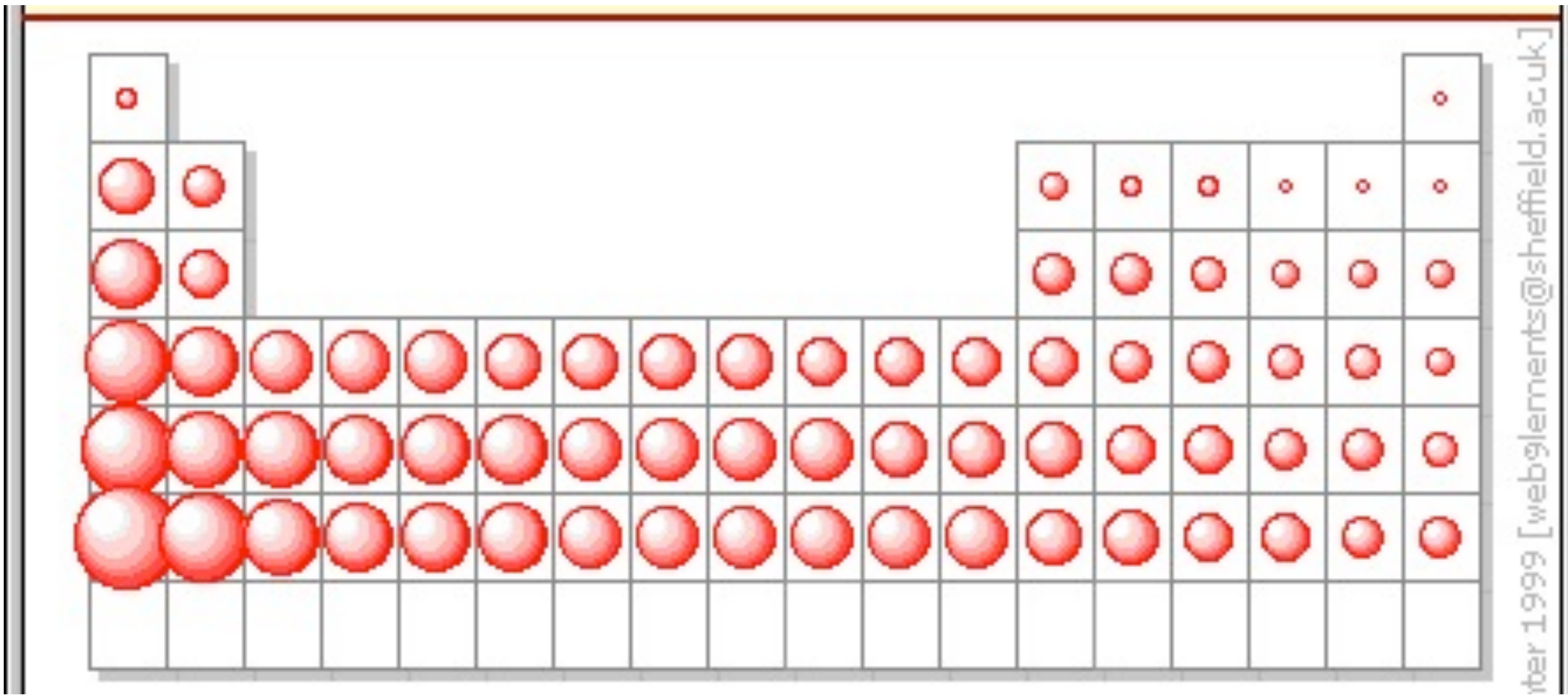
Hydrogen Bonds (molecular bond)



Water- the Universal Solvent

Covalent Bonding (atomic bond)

Shared electrons between strongly electronegativity atoms



Strongest bonds because atoms have good ability to hold onto there own electrons as well as shared electrons

Covalent Bonding (atomic bond)

Shared electrons between strongly electronegativity atoms

Strongest bonds because atoms have good ability to hold onto there own electrons as well as shared electrons

Earth Materials/ Minerals

Chapter 2

As you know, lanes of traffic on the highway are separated by white lines. How long are the lines?

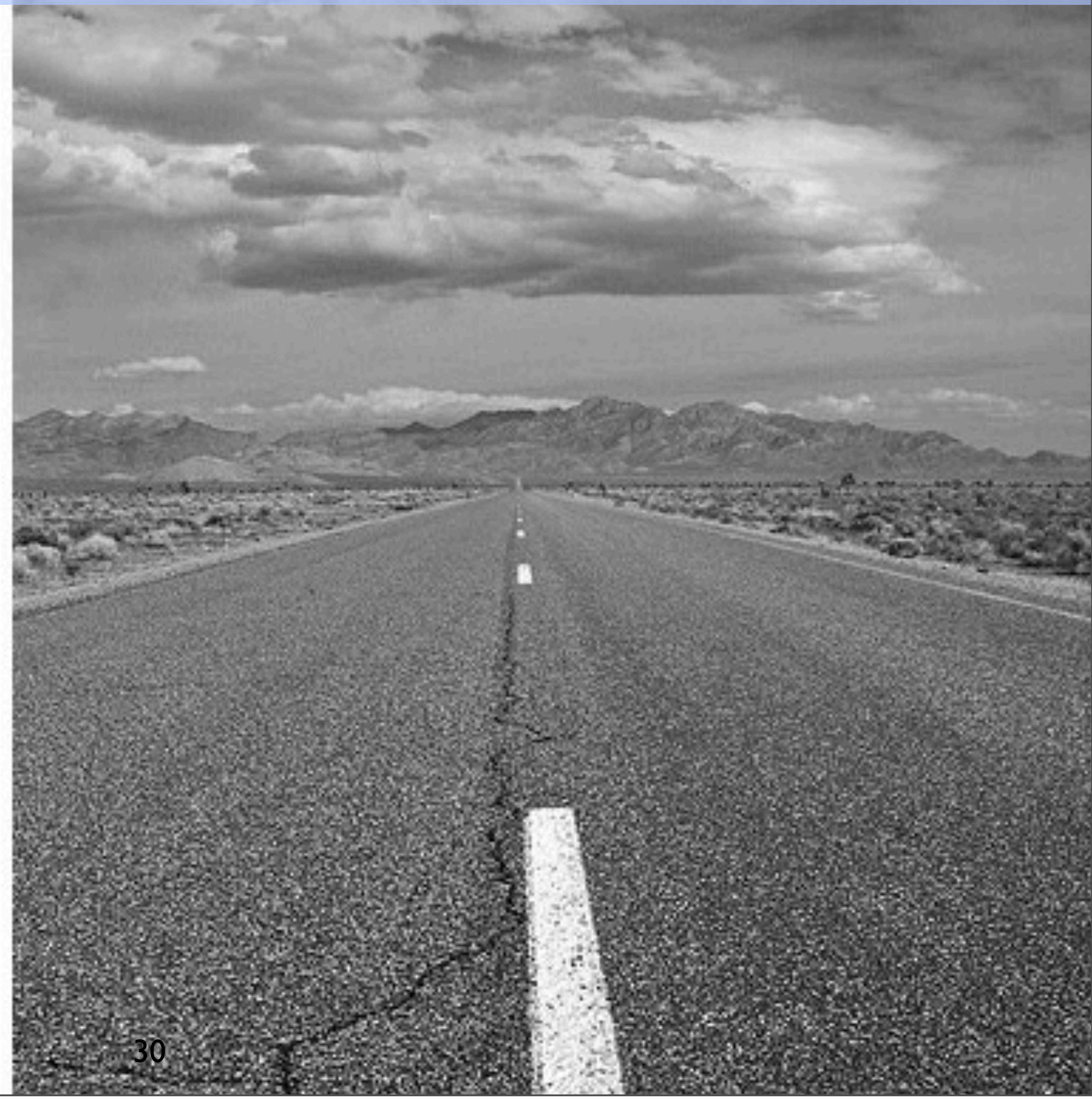
a) 2 ft

b) 4 ft

c) 6 ft

d) 8 ft

e) 10 ft



What is distance between the white lines?

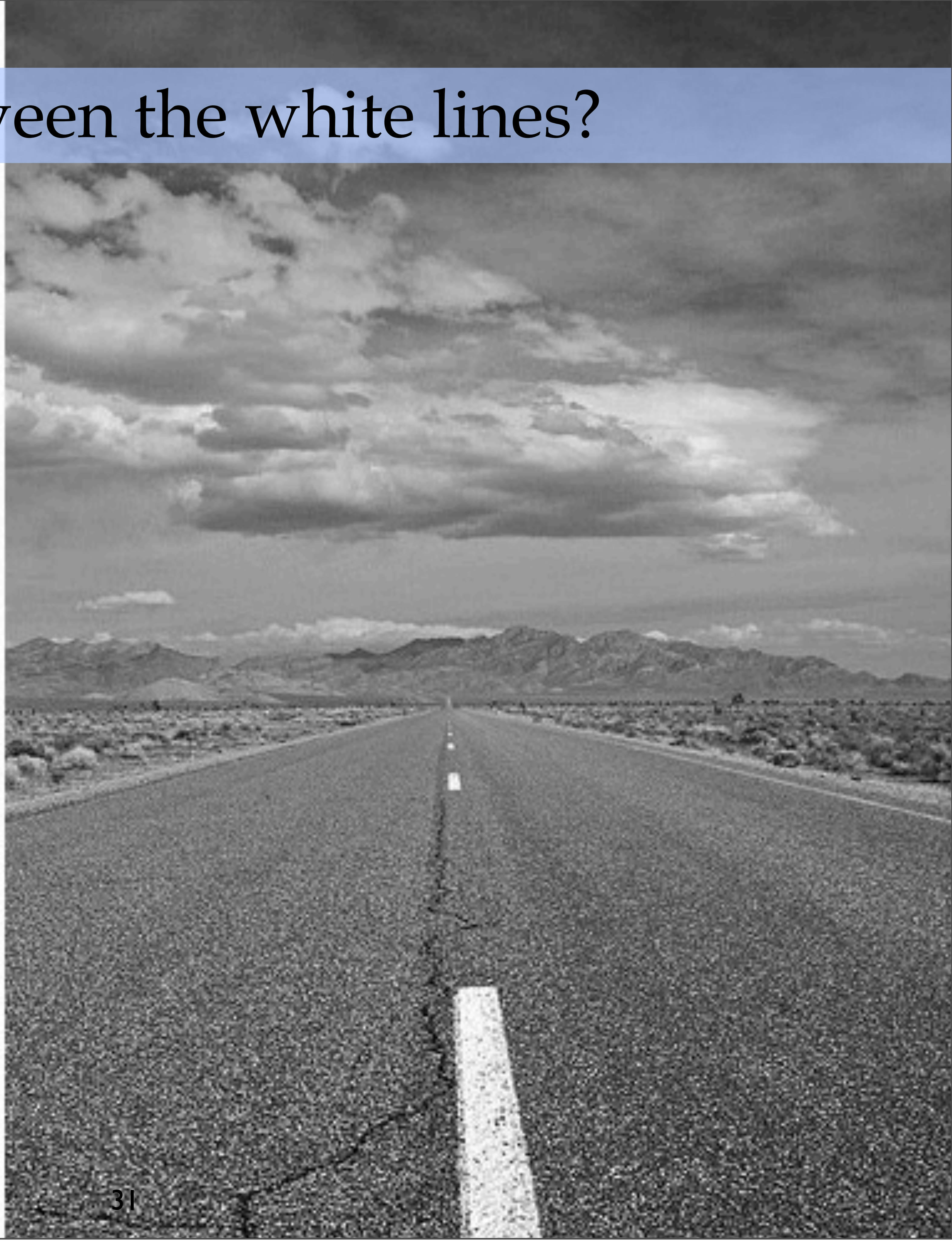
a) 5 ft

b) 15 ft

c) 20 ft

d) 25 ft

e) 30 ft



Length 10ft Spacing 30 ft

Today

1) Exam 1 Evaluation

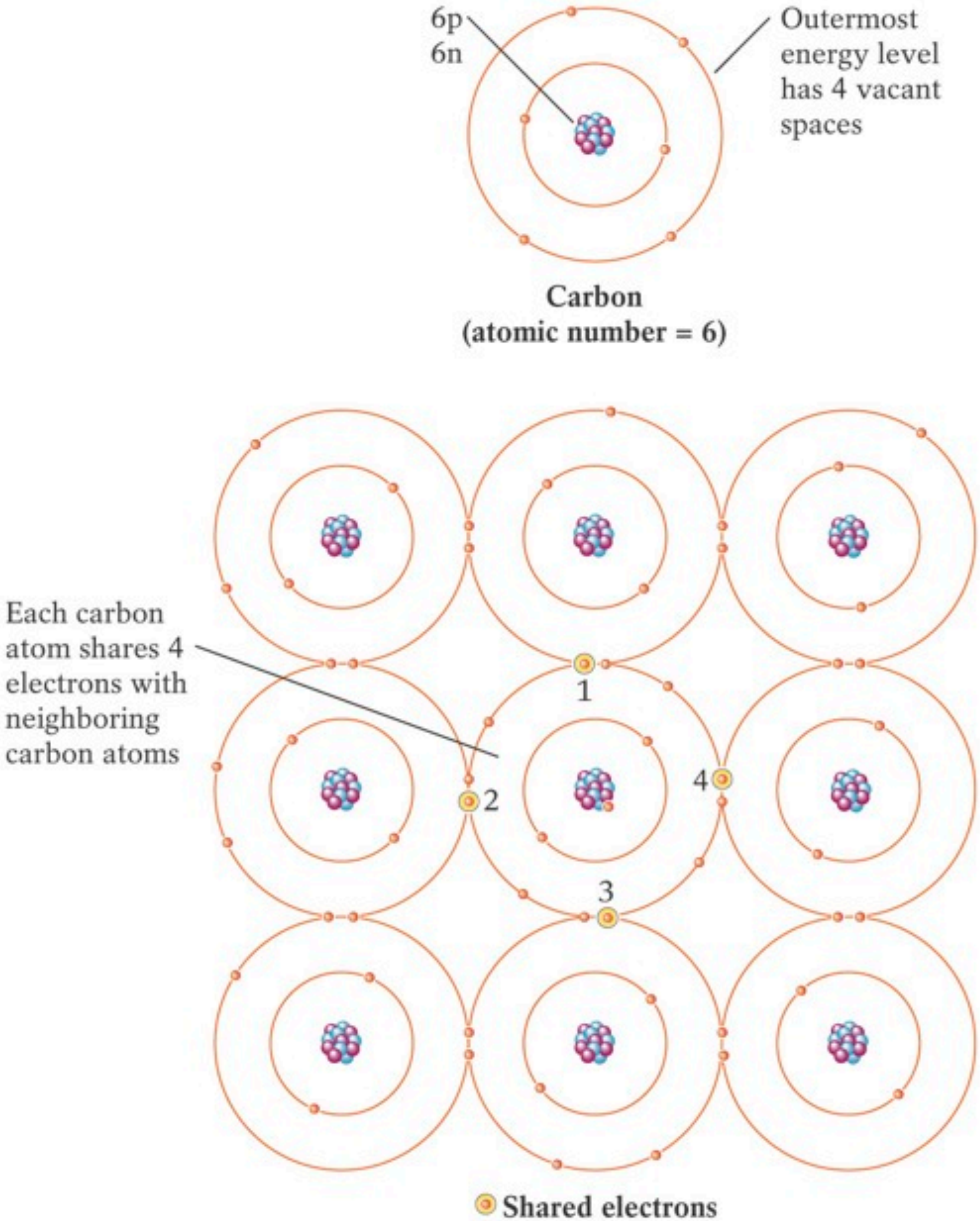
-You will have ~15 minutes or so to go over the exam and talk within your group about what you missed. I may answer a few questions.

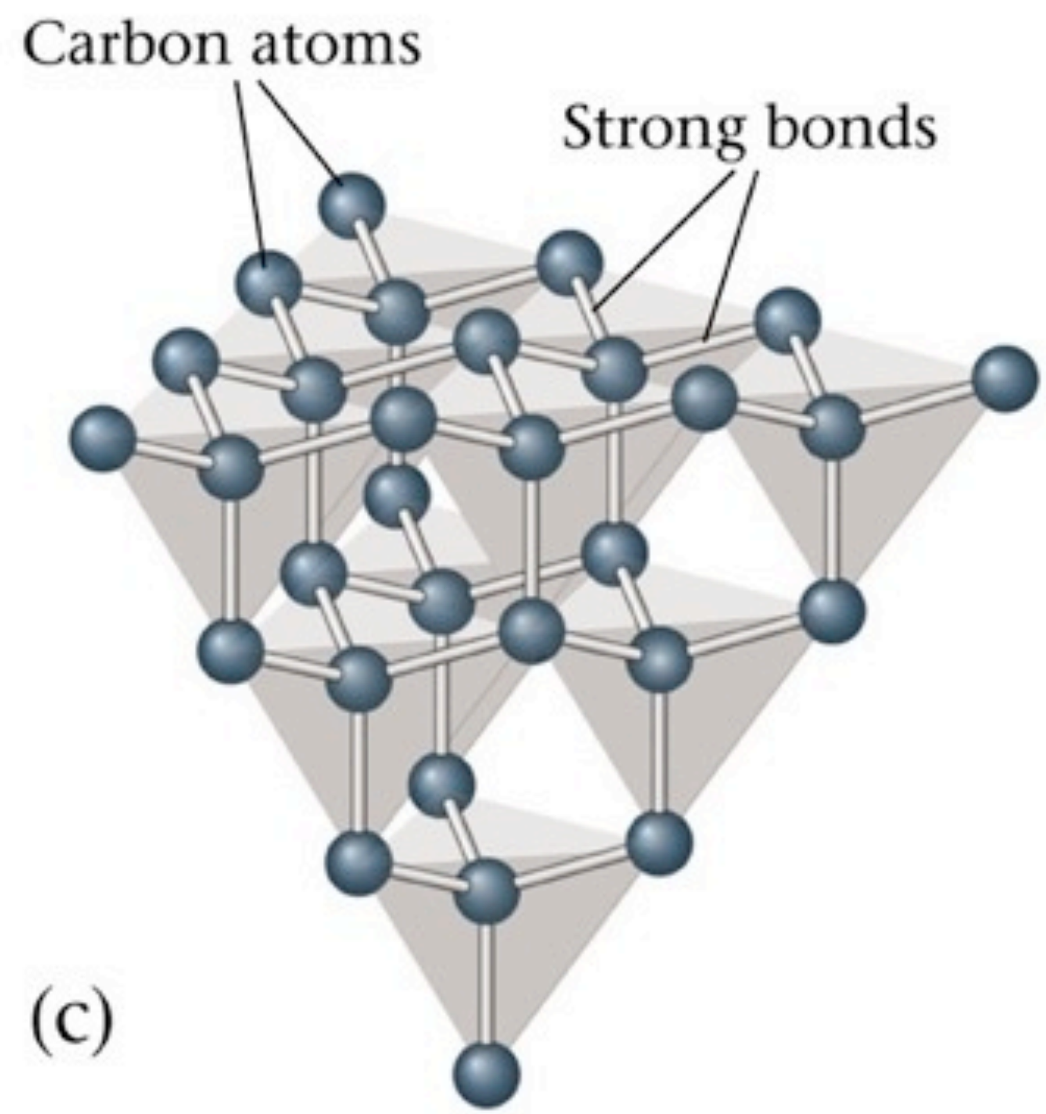
-Then you will return the Better-Than-Pass section to me and keep the Pass Section for yourself. I will hold onto your exams and if you would like more detail on what you did not understand, you will need to meet with me outside of class.

2) Review and Wrap-up Earth Materials (Minerals)

3) In-Class Group Exercise: Mineral Identification (you will need your class handouts)

Covalent Bonding
(atomic bond)

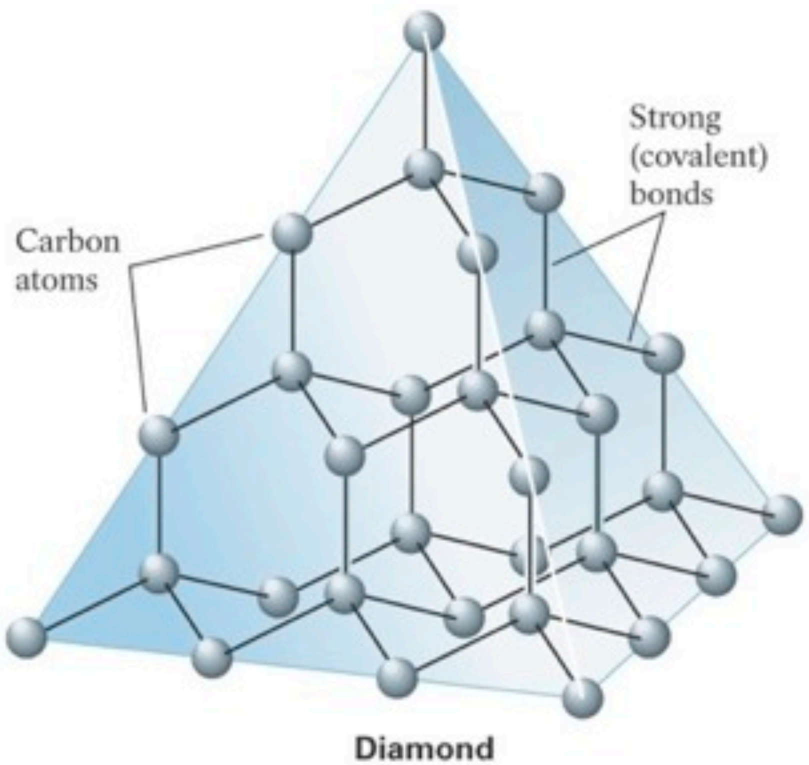




Physical Properties

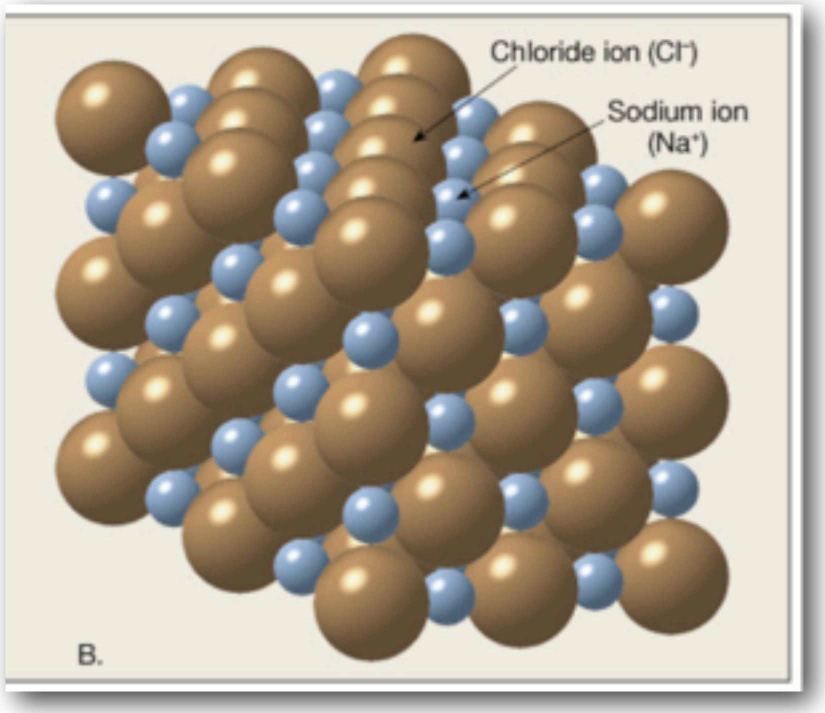
1) Crystal Habit
2) Color
3) Cleavage or fracture
4) Streak
5) Luster
6) Hardness
7) Specific Gravity
8) Special Properties (Effervescence Taste Smell X-Ray diffraction)

Crystal Habit



Double pyramid

Halite (salt) cubic



Mineral Habits and Color

of Silicate Rock Forming Minerals
(90% of the crust)

Olivine

Pyroxene

Hornblende

Biotite

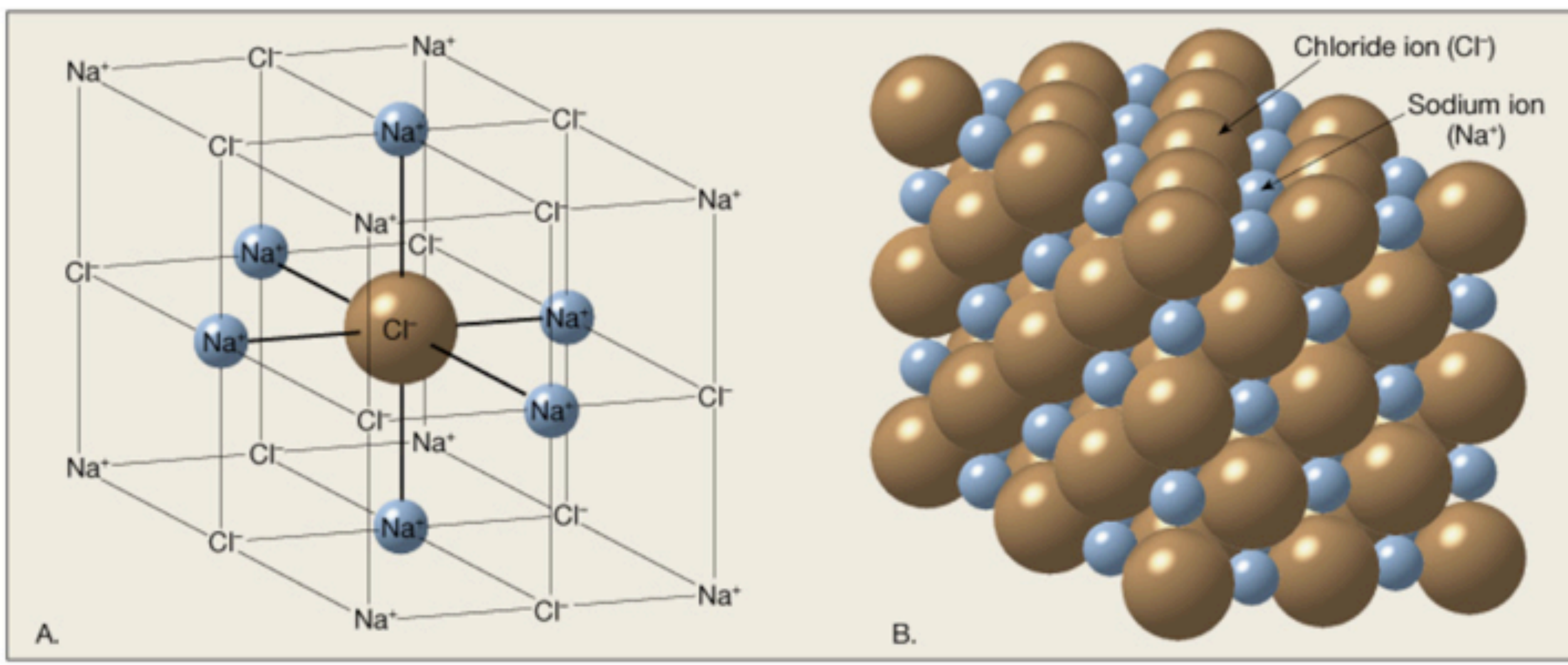
Muscovite

Quartz

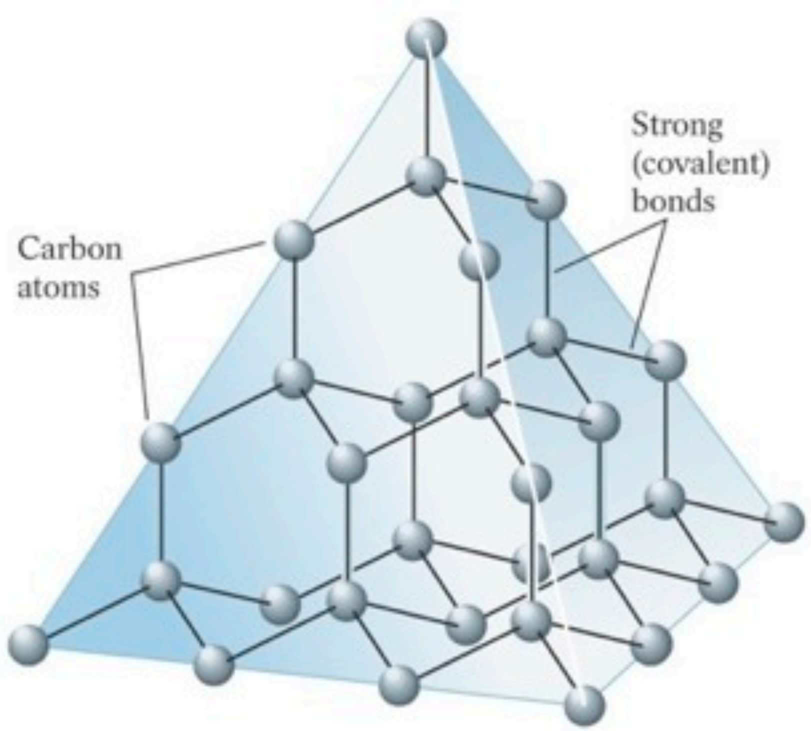
Feldspar group

Cleavage

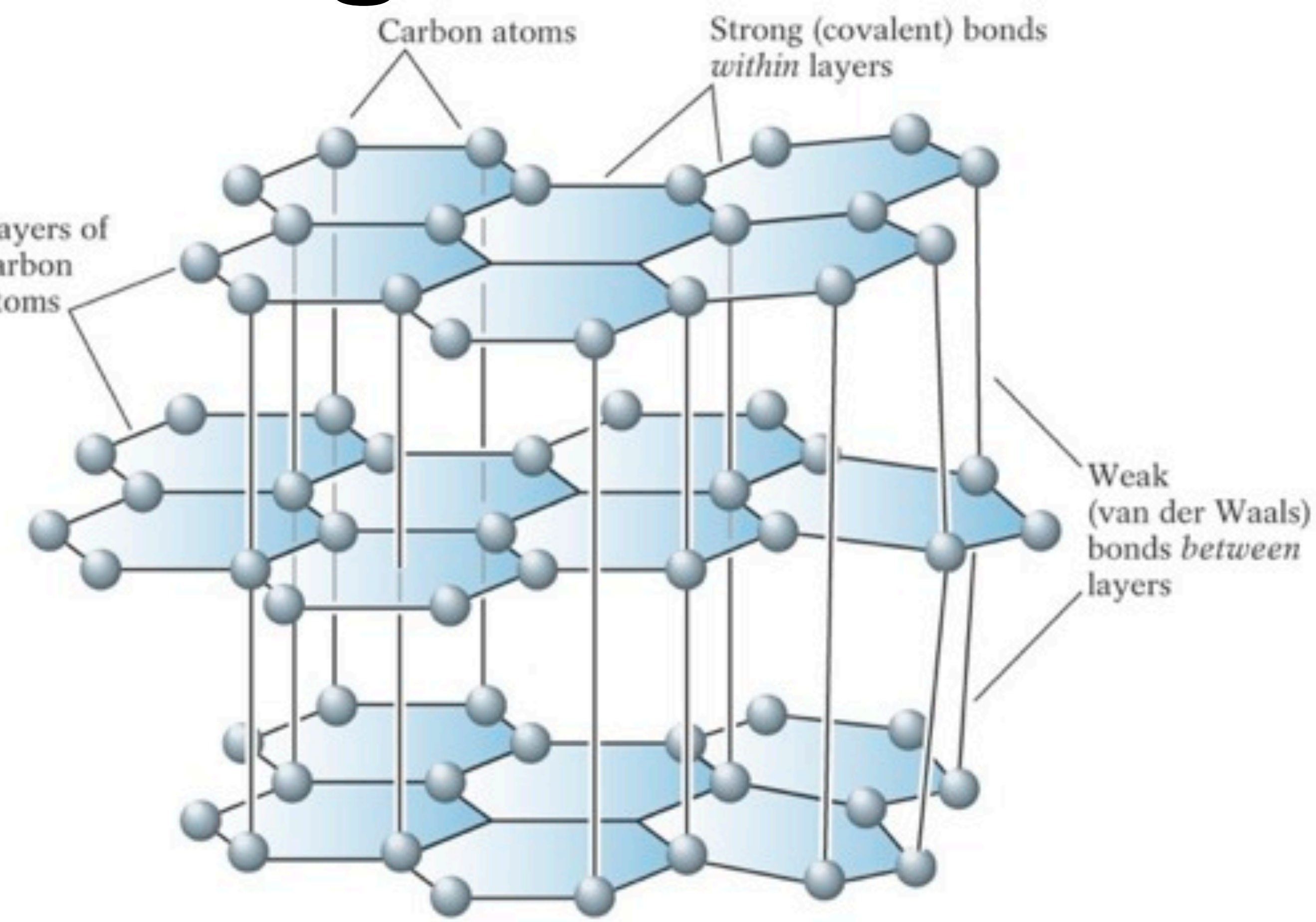
Tendency for a mineral to break along distinct planes of weakness



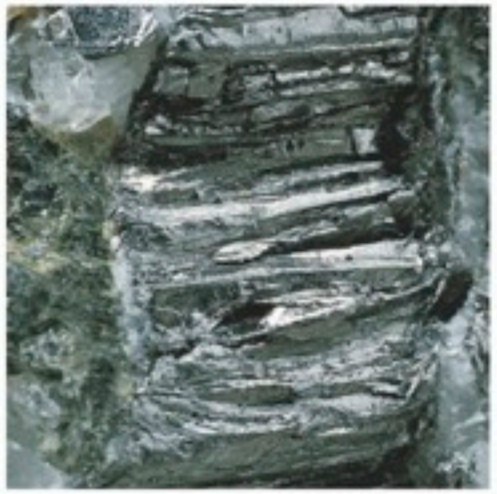
Polymorphs: Diamonds and Graphite Covalent Bonding vs. Van der Walls Bonding



Diamond

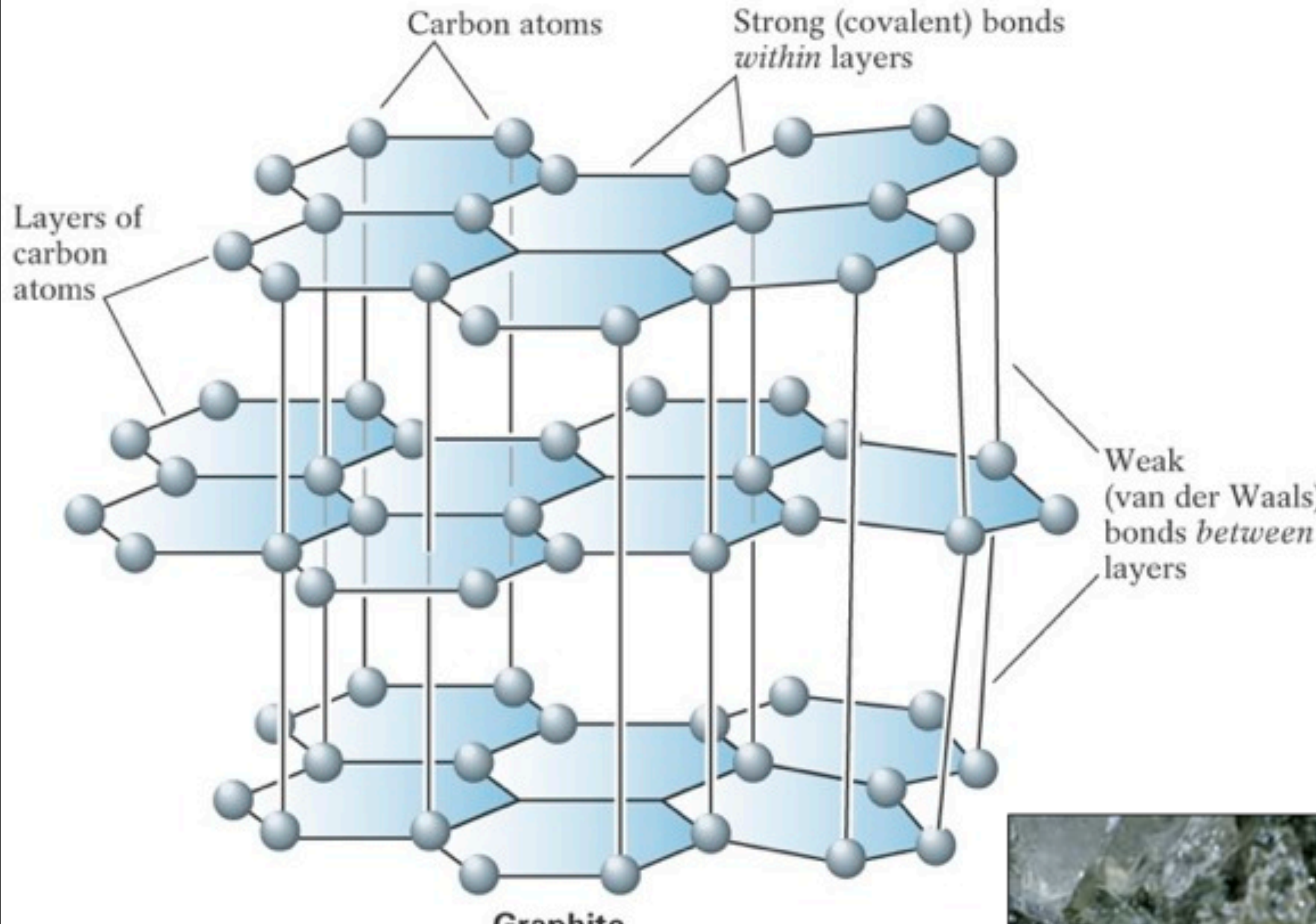


Graphite



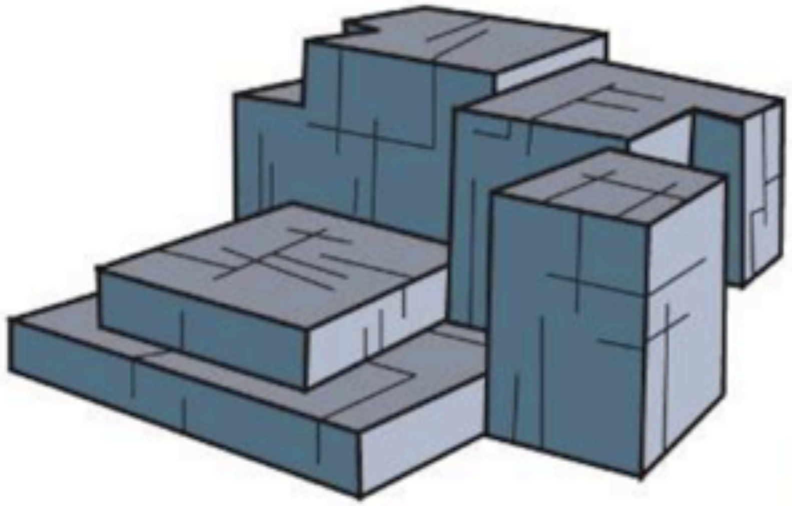
Cleavage

Tendency for a mineral to break along distinct planes of weakness

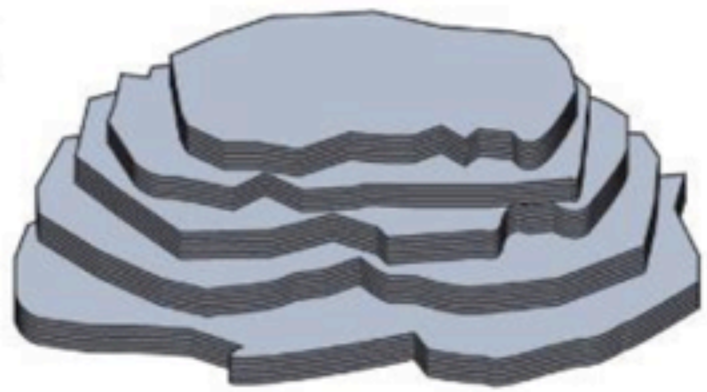


Identifying Cleavage

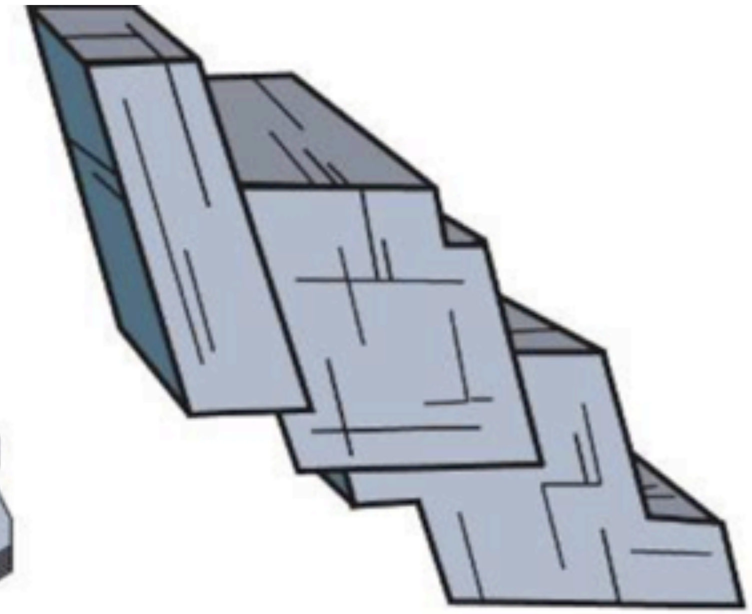
Look for repeated parallel and intersecting planes



(a)



(b)



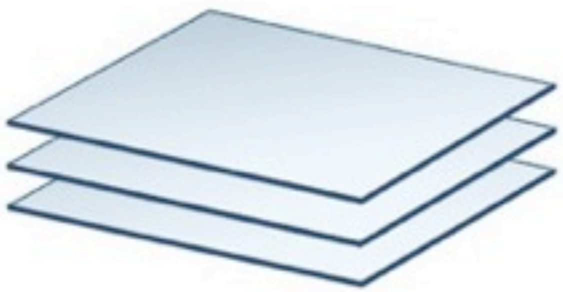
(c)

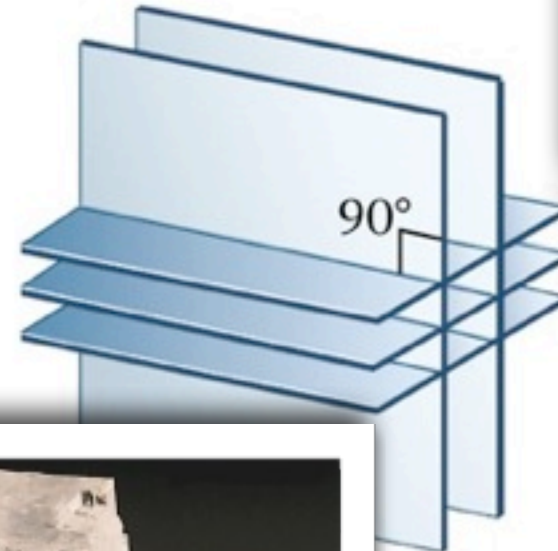
(a)

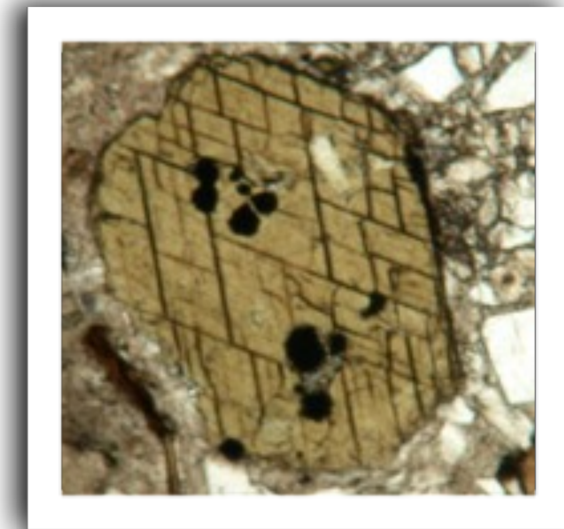
(b)

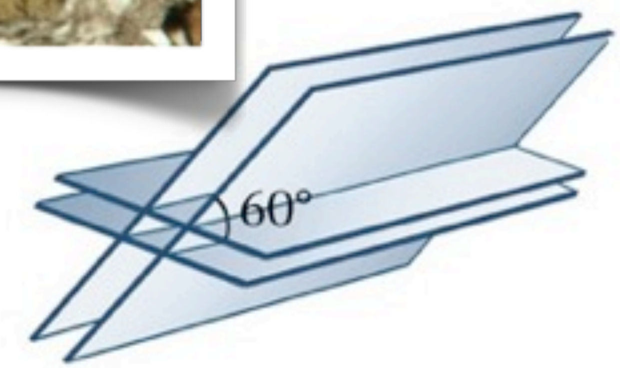
(c)

Cleavage

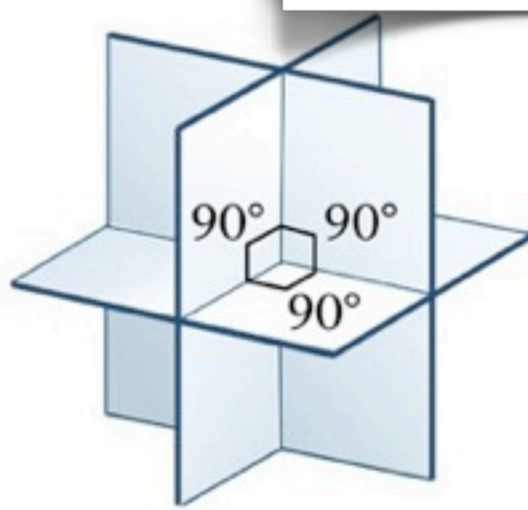




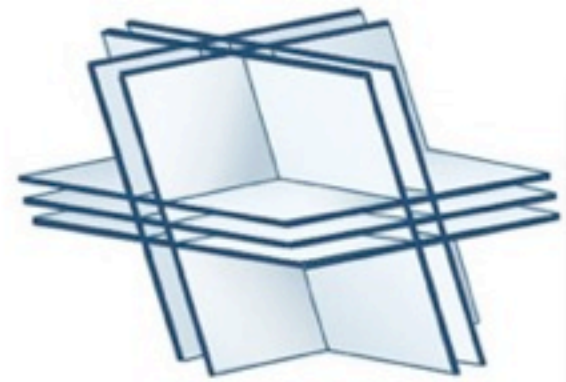




(c)

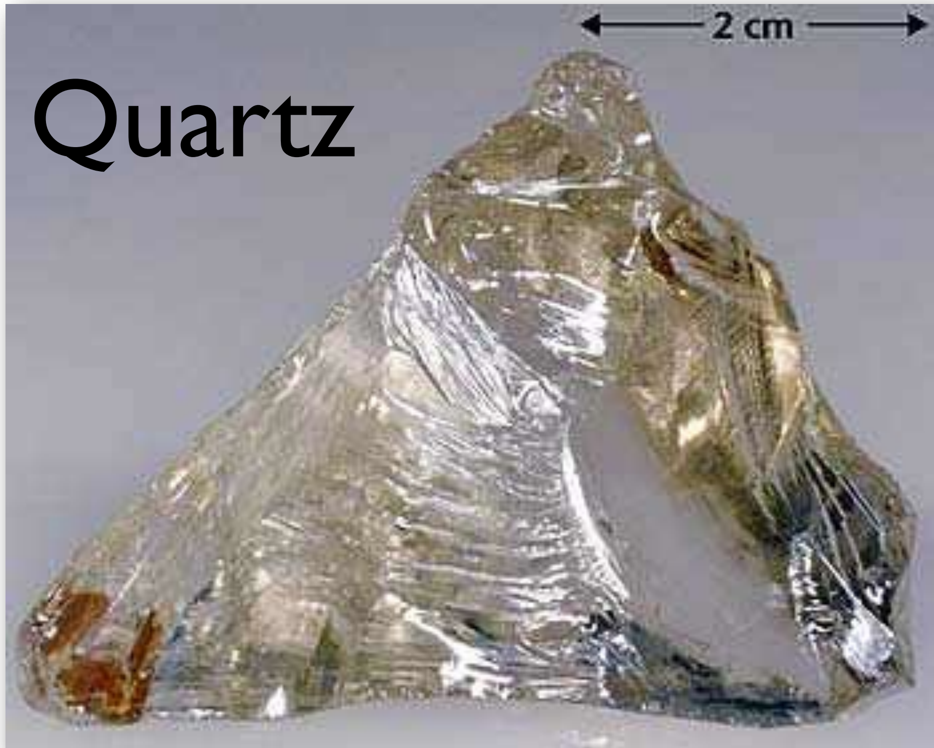


(d)



(e)

Conchoidal Fracture



Quartz
(glass)

Obsidian (volcanic glass)

Streak

When powdered minerals have certain color that may be different from the unpowdered form

Luster

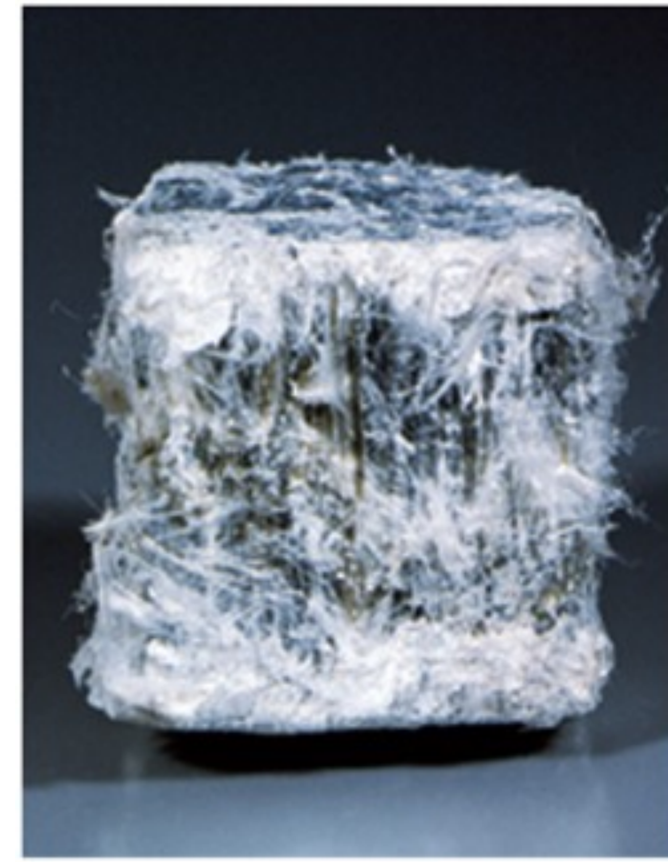
(a)

Pearly

Earthy

(b)

Silky



(c)

Vitreous

(d)

Metallic

Adamantine

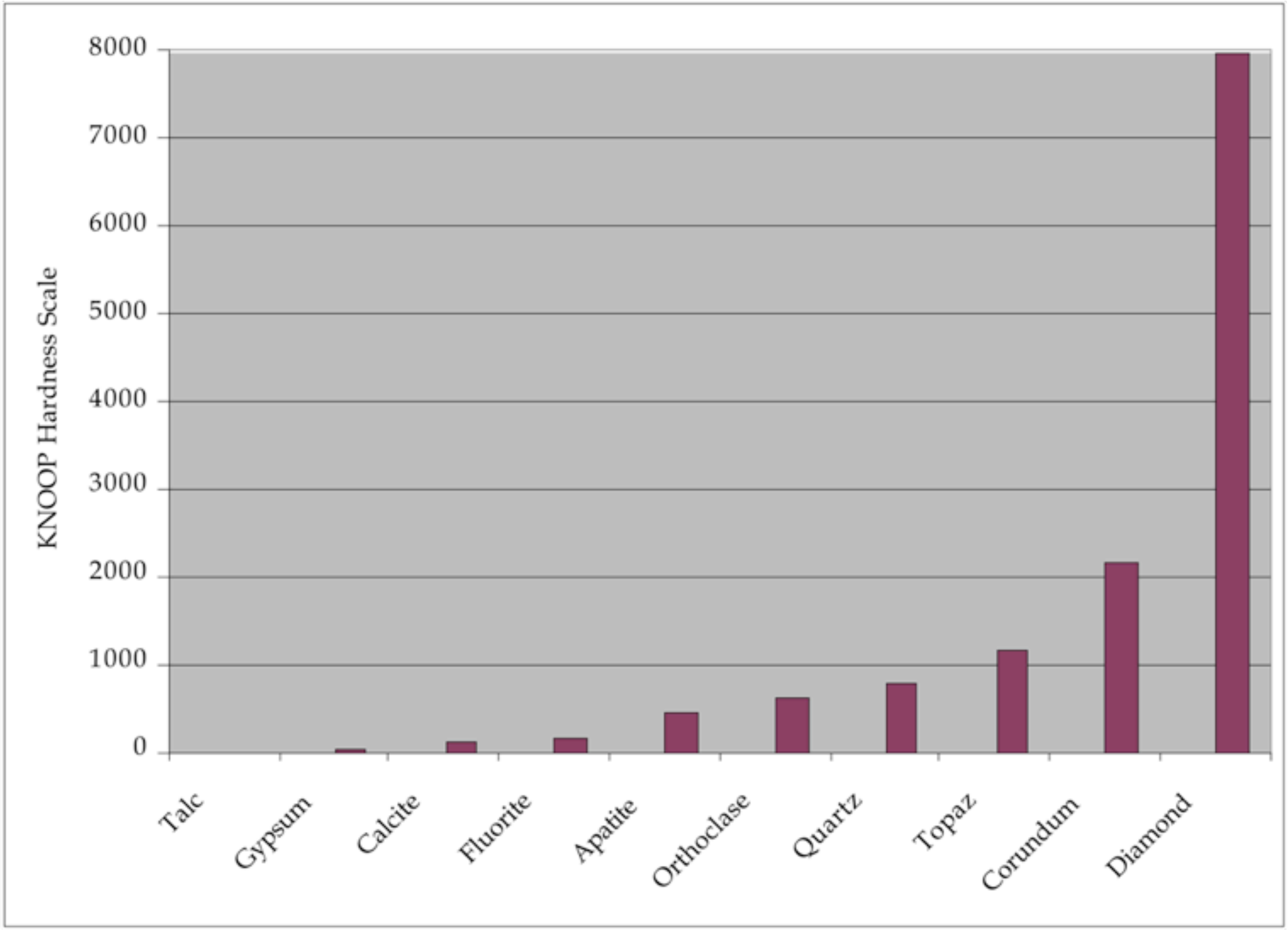
(e)

Relative Hardness

Mineral	Hardness	Hardness of Some Common Objects
Talc	1	
Gypsum	2	
		Human fingernail (2.5)
Calcite	3	
		Copper penny (3.5)
Fluorite	4	
Apatite	5	
		Glass (5–6), Pocketknife blade (5–6)
Orthoclase (potassium feldspar)	6	
		Steel file (6.5)
Quartz	7	
Topaz	8	
Corundum	9	
Diamond	10	

Moh's
Hardness scale

Absolute Hardness



Measure of pressure. Units are mass per area (e.g., g/mm2)

Special Properties

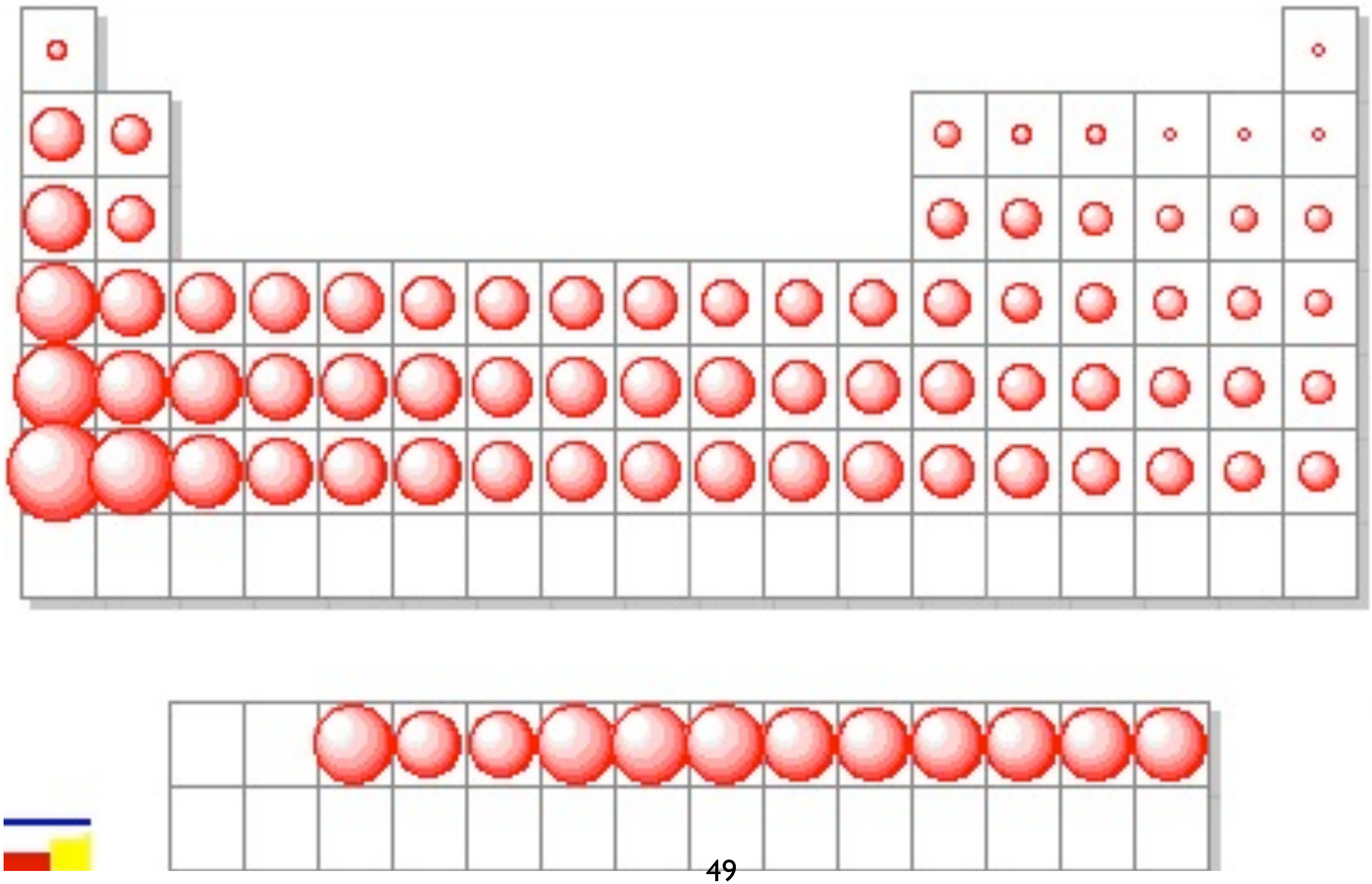
(Effervescence Taste Smell X-Ray diffraction)

Read in the text page 51-55

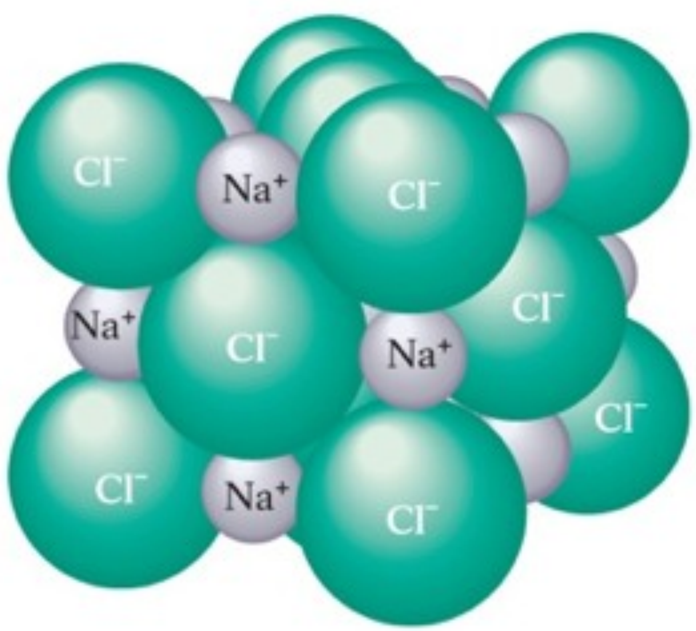
Cation Exchange
Size and Charge Count

Electron donor (Positively charged Cations)

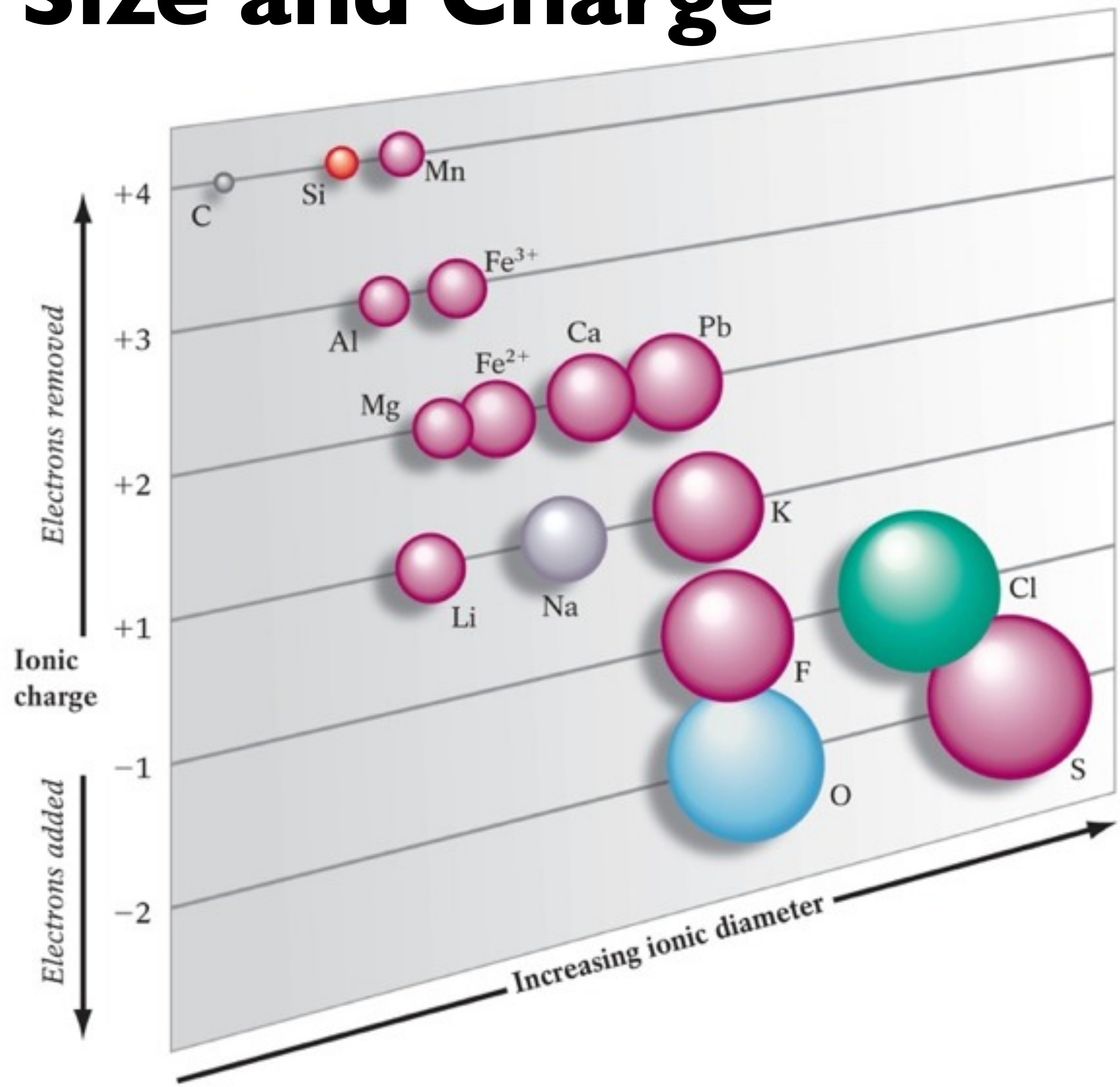
Electron acceptor (Negatively charged Anions)



Cations and Anions
Atom Size and Charge



(a) Crystalline structure of NaCl



Cation Exchange

Cation Exchange

Pure Quartz

Amethyst Quartz(Fe)

Rose Quartz (Ti)

Chemical Compositions

of Silicate Rock Forming Minerals
(90% of the crust)

Olivine $(Mg,Fe)_2 SiO_4$

Pyroxene $(Mg,Fe, Ca)_2 Si_2O_6$

Hornblende $(Ca,Na)_2 (Mg,Fe,Al)_5 Si_6 (Si,Al)_2 O_{22} (OH)_2$

Biotite $K(Mg,Fe)_3 (Al Si_3 O_{10})(OH)_2$

Muscovite $KAl_2 (Al Si_3 O_{10}) (OH)_2$

Quartz SiO_2

Feldspar group ($CaAl_2Si_2O_8$ $KAlSi_3O_8$ $NaAlSi_3O_8$)

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of Silicate Rock Forming Minerals
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Olivine $(Mg,Fe)_2 SiO_4$

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Quartz SiO_2

Feldspar group ($CaAl_2Si_2O_8$ $KAlSi_3O_8$ $NaAlSi_3O_8$)

Temperature, Pressure, & Composition of the melt

Chemical Compositions

of Silicate Rock Forming Minerals
(90% of the crust)

Olivine	$(Mg,Fe)_2\ SiO_4$
Pyroxene	$(Mg,Fe,\ Ca)_2\ Si_2O_6$
Hornblende	$(Ca,Na)_2\ (Mg,Fe,Al)_5\ Si_6\ (Si,Al)_2\ O_{22}\ (OH)_2$
Biotite	$K(Mg,Fe)_3\ (Al\ Si_3\ O_{10})(OH)_2$
Muscovite	$KAl_2\ (Al\ Si_3\ O_{10})\ (OH)_2$
Quartz	SiO_2
Feldspar group	$(CaAl_2Si_2O_8$ $KAlSi_3O_8$ $NaAlSi_3O_8)$

Chemical Compositions

of Silicate Rock Forming Minerals
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Olivine	$(Mg,Fe)_2\ SiO_4$
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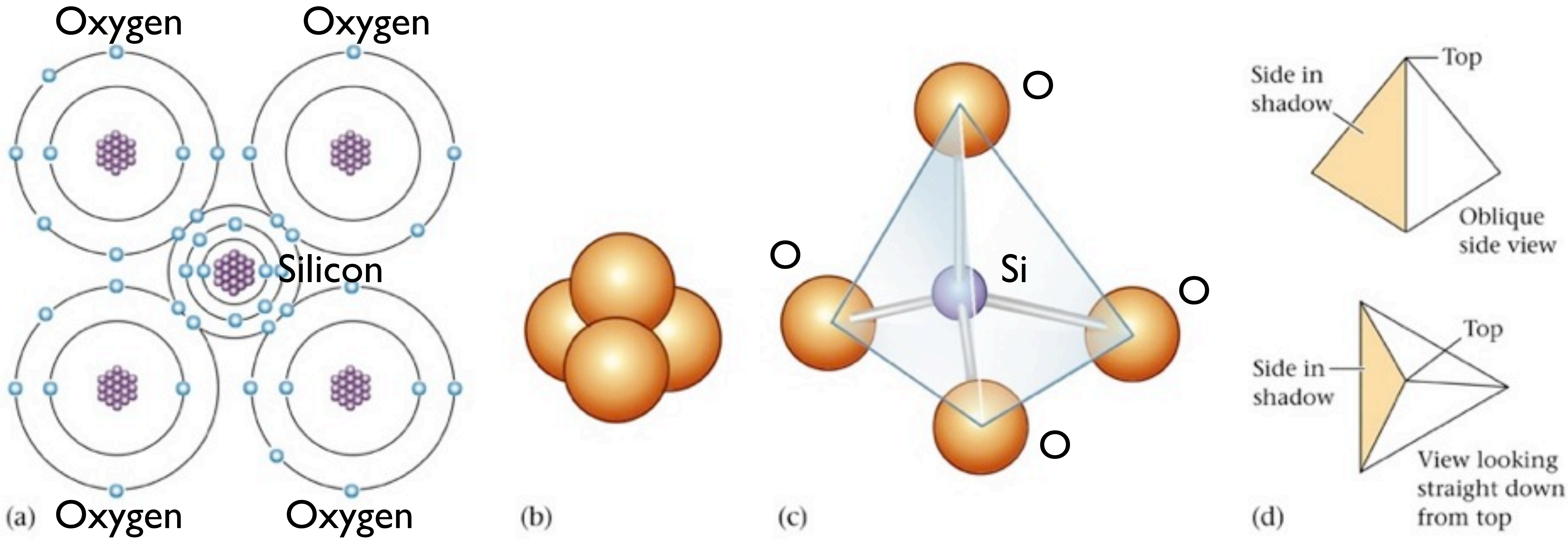
Feldspar group	$(CaAl_2Si_2O_8$ $KAlSi_3O_8$ $NaAlSi_3O_8)$

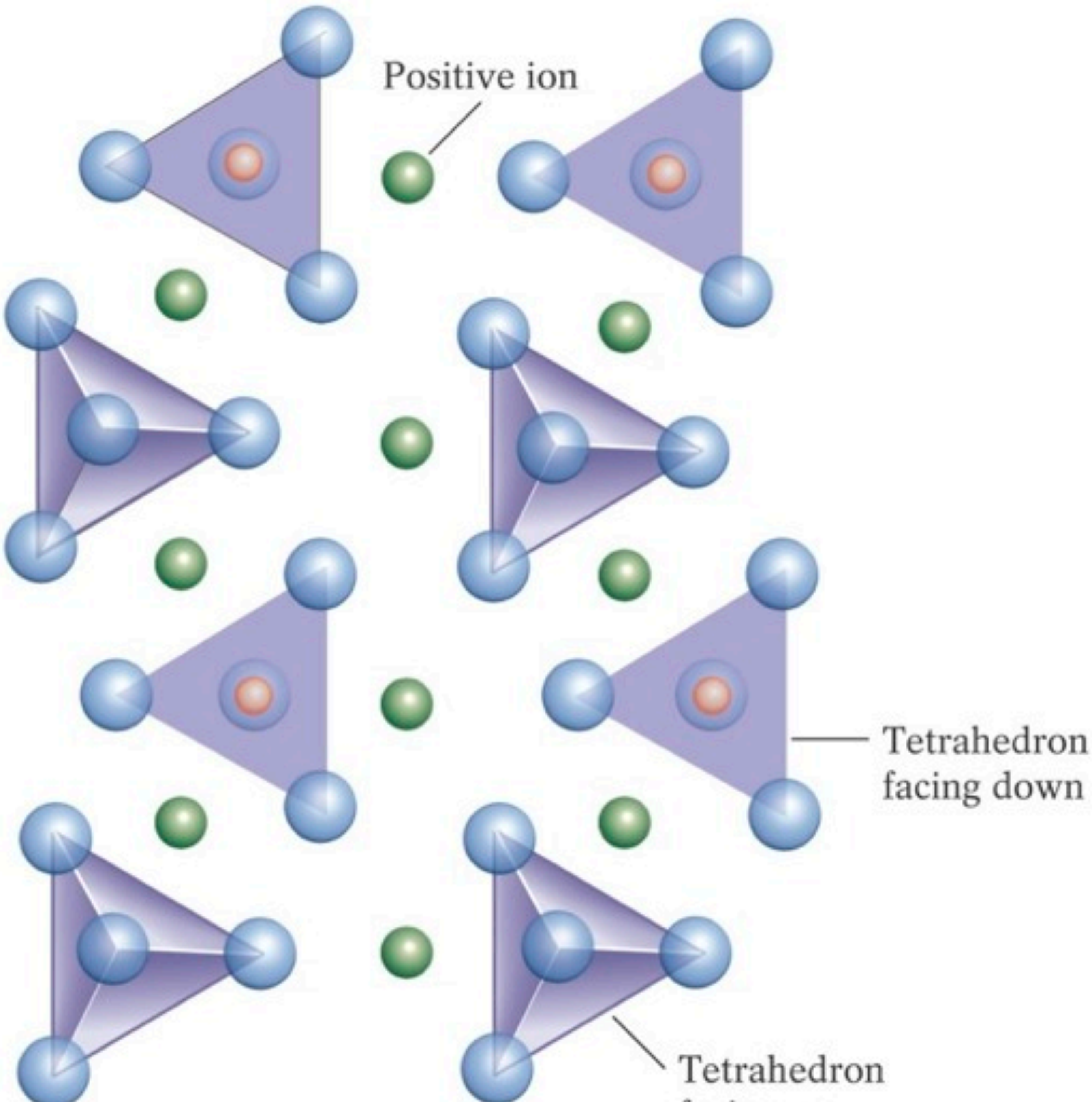
Temperature, Pressure, & Composition of the melt

SiO_4 Silica Tetrahedron

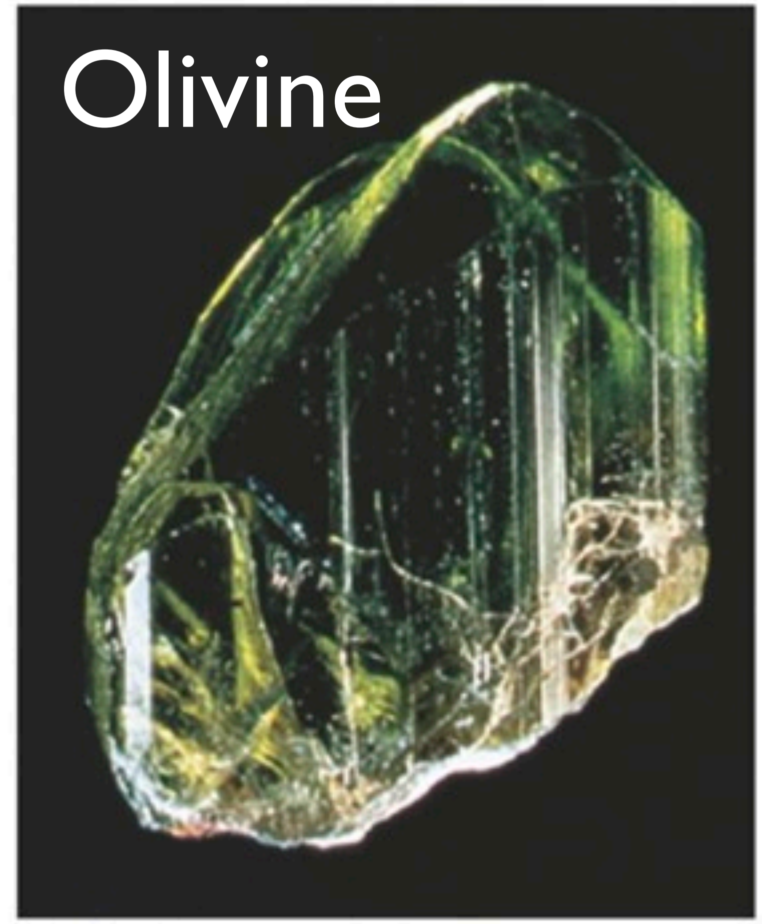


Covalently bonded: The silica tetrahedron is the fundamental building block of silicate minerals which compose 90% of Earth's crust

Isolated Silica Tetrahedron

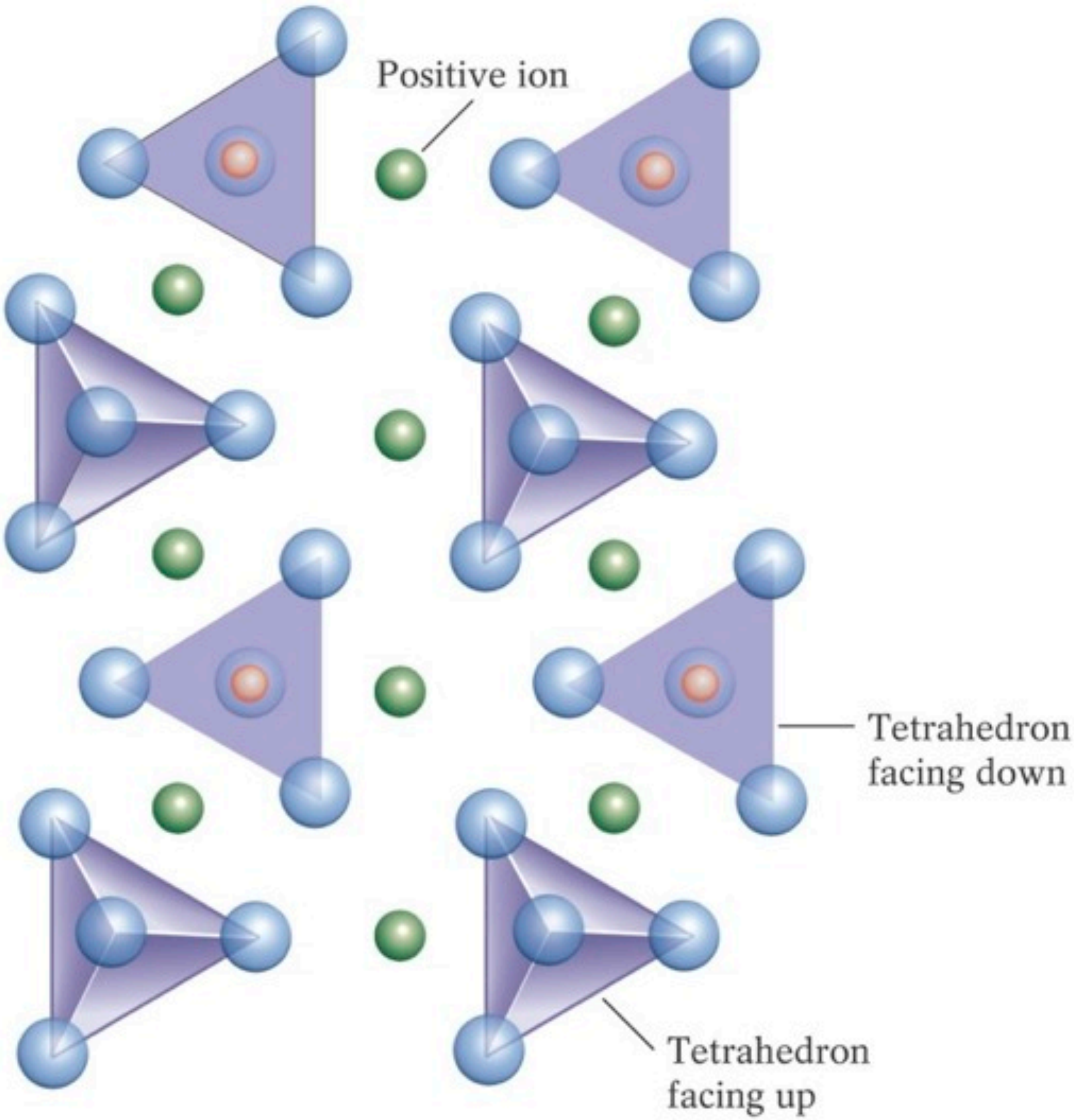


SiO_4 Independent tetrahedra **1:4**

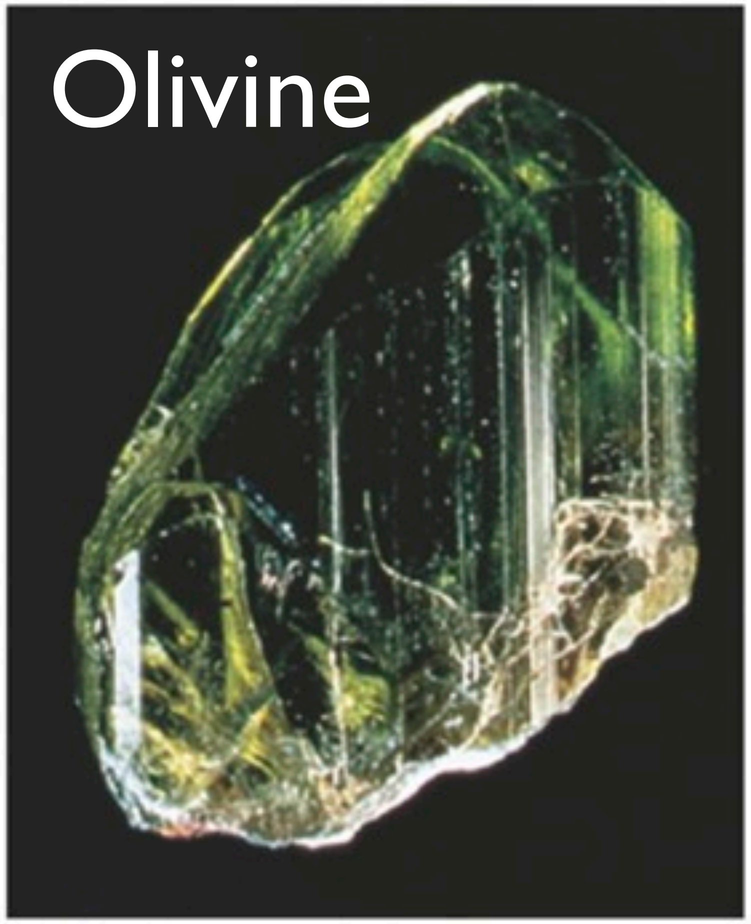


Each -4 charged tetrahedron bonded to two +2 positively charged cations.

Isolated Silica Tetrahedron



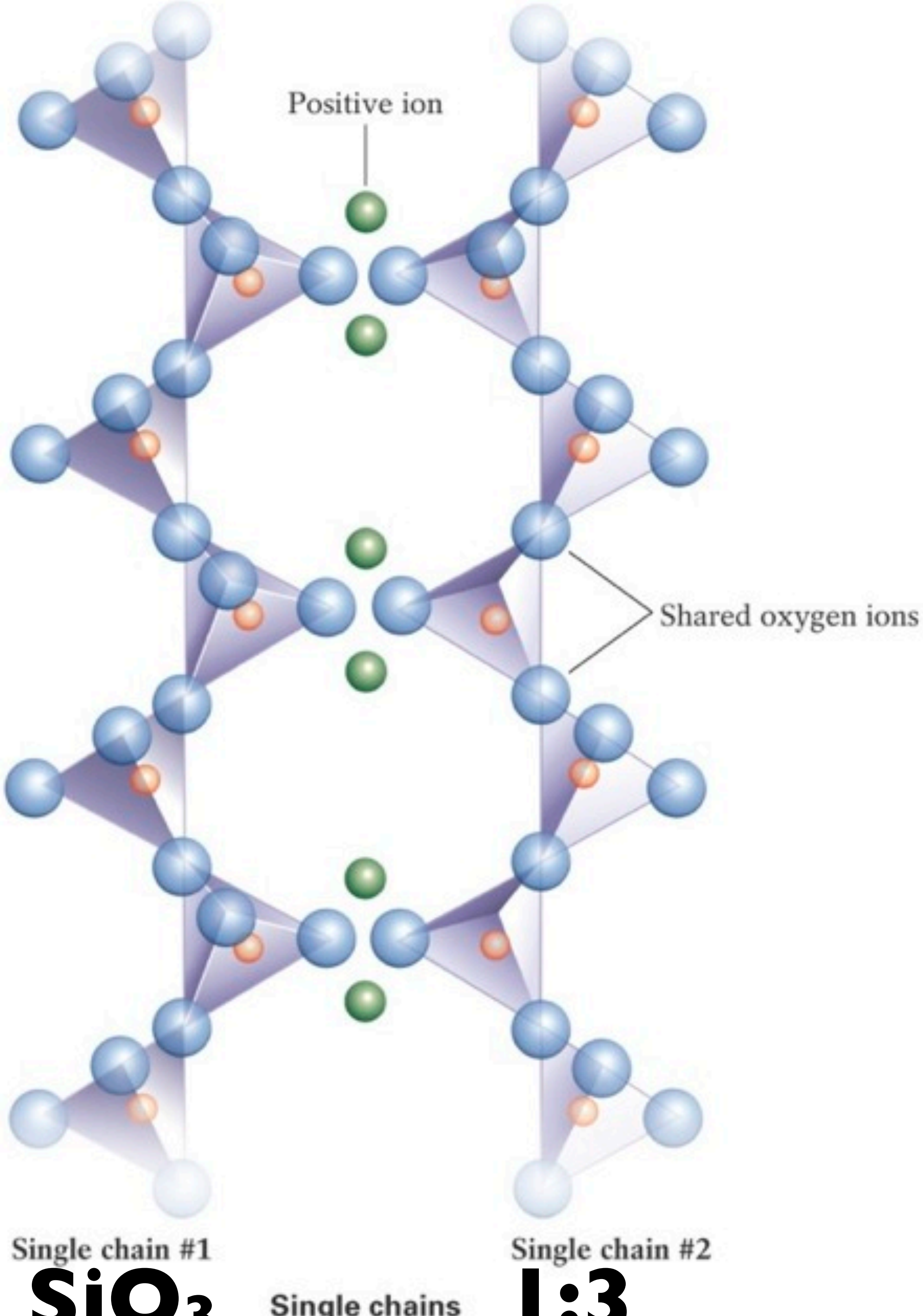
SiO_4 Independent tetrahedra **1:4**



Each -4 charged tetrahedron bonded to two +2 positively charged cations.

Because Tetrahedrons are not organized there is no plane of weakness

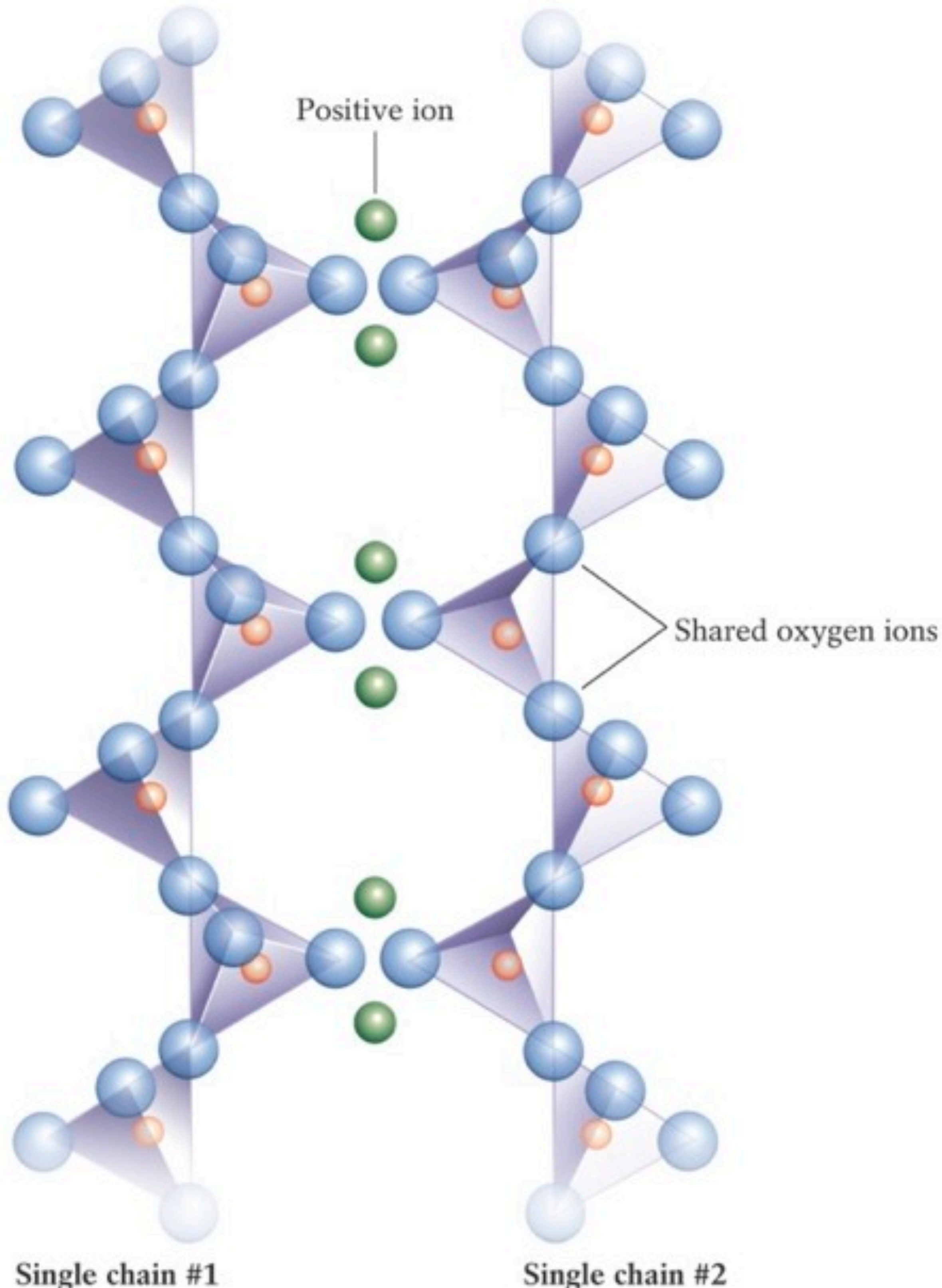
Single Chain Silicate



SiO_3 **1:3**

Each tetrahedron shares two corner Oxygen atoms. Each tetrahedron still has -4 charge Ionic bonds occur between chains.

Single Chain Silicate

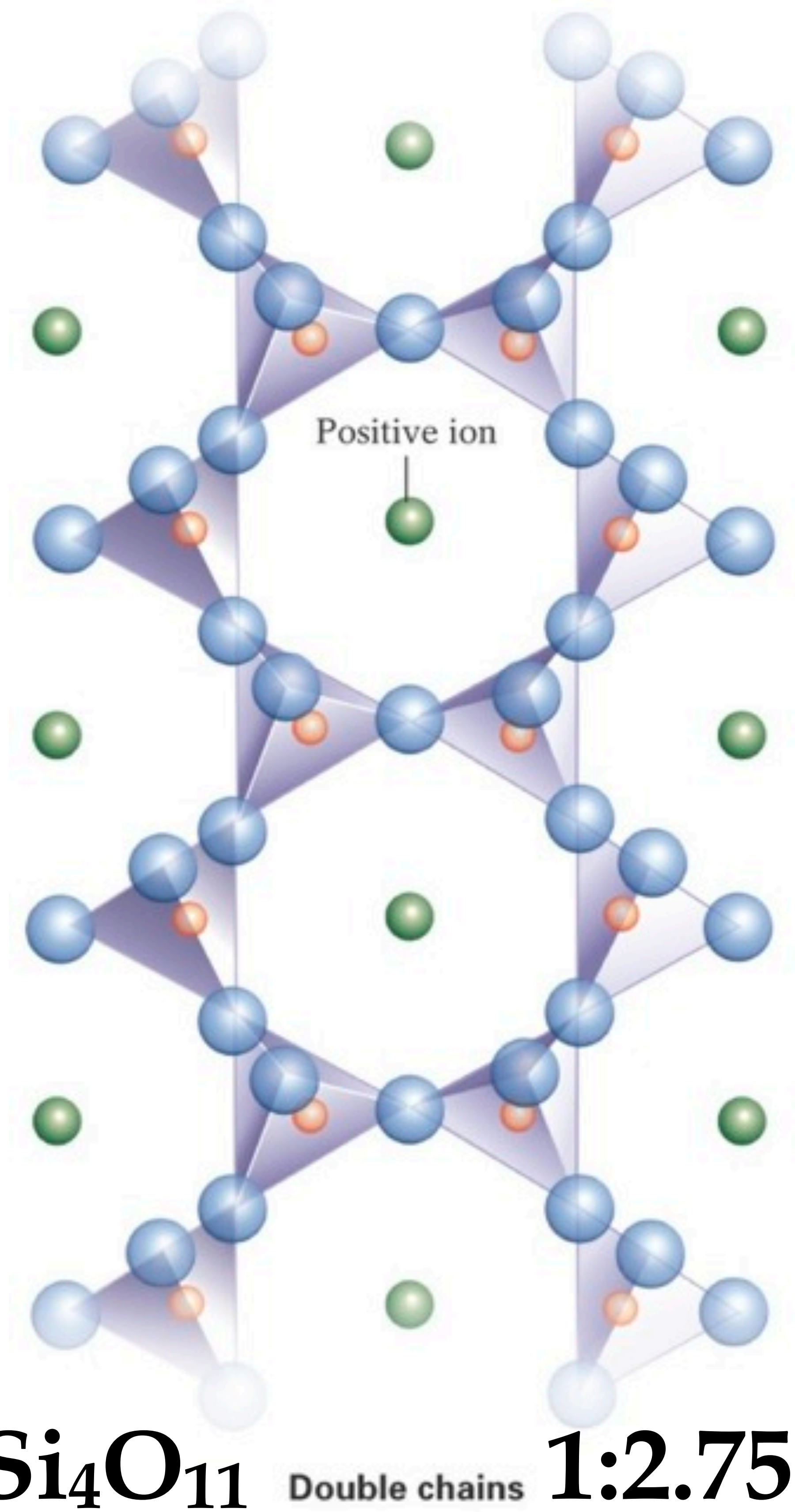


SiO_3 **1:3**

Each tetrahedron shares two corner Oxygen atoms. Each tetrahedron still has -4 charge Ionic bonds occur between chains.

Because Tetrahedrons chain is single and symmetrical there are two planes of weakness at right anlges to each other

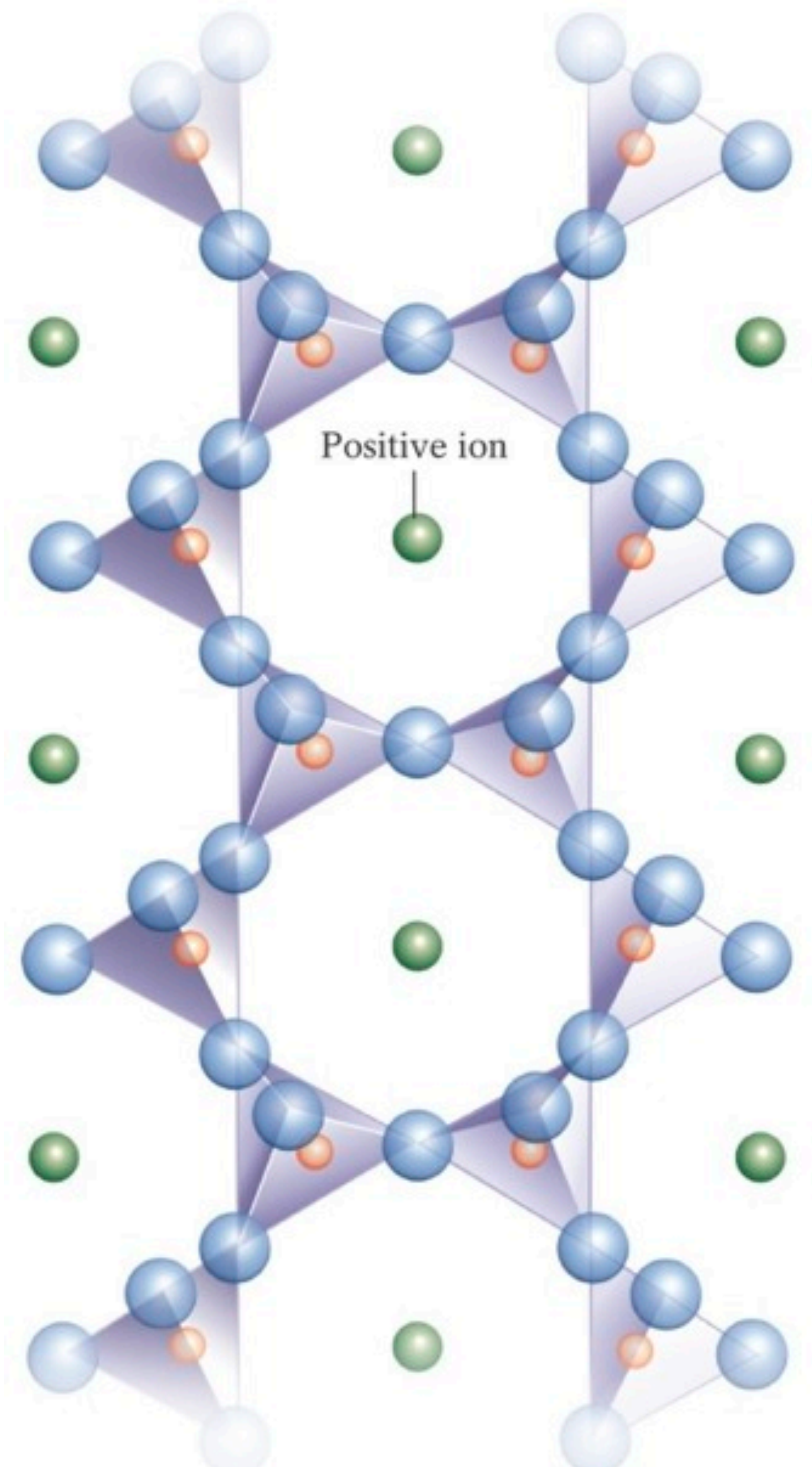
Double Chain Silicate



Si_4O_{11} 1:2.75

Each tetrahedron shares two corner Oxygen atoms and some share three Oxygen atoms.
Cations are interspersed within and between the chains

Double Chain Silicate

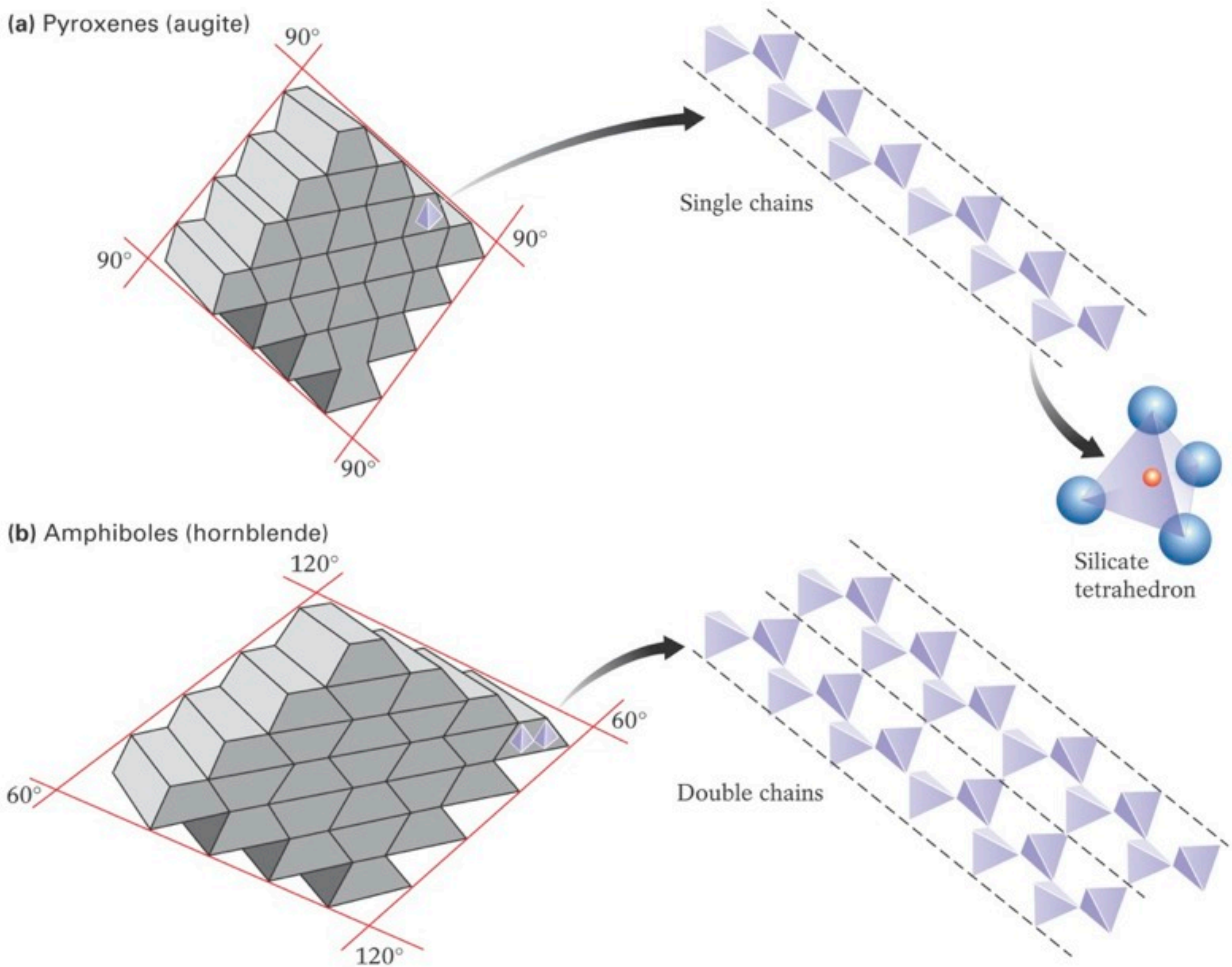


Si_4O_{11} 1:2.75

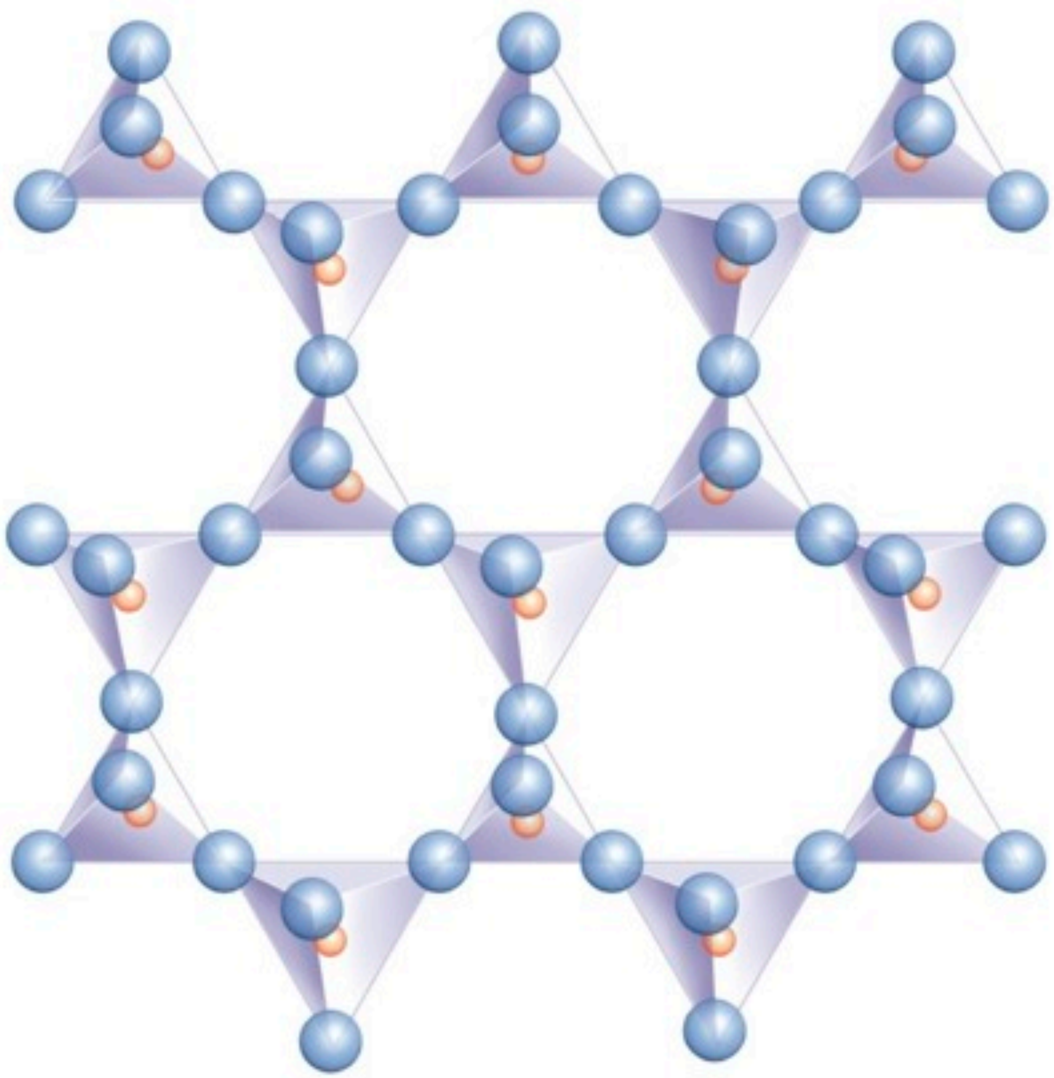
Each tetrahedron shares two corner Oxygen atoms and some share three Oxygen atoms.
Cations are interspersed within and between the chains

Because Tetrahedrons double chain is asymmetrical there are two planes of weakness at oblique angles to each other.

Cleavage Angles for Chain Silicates



Sheet Silicate

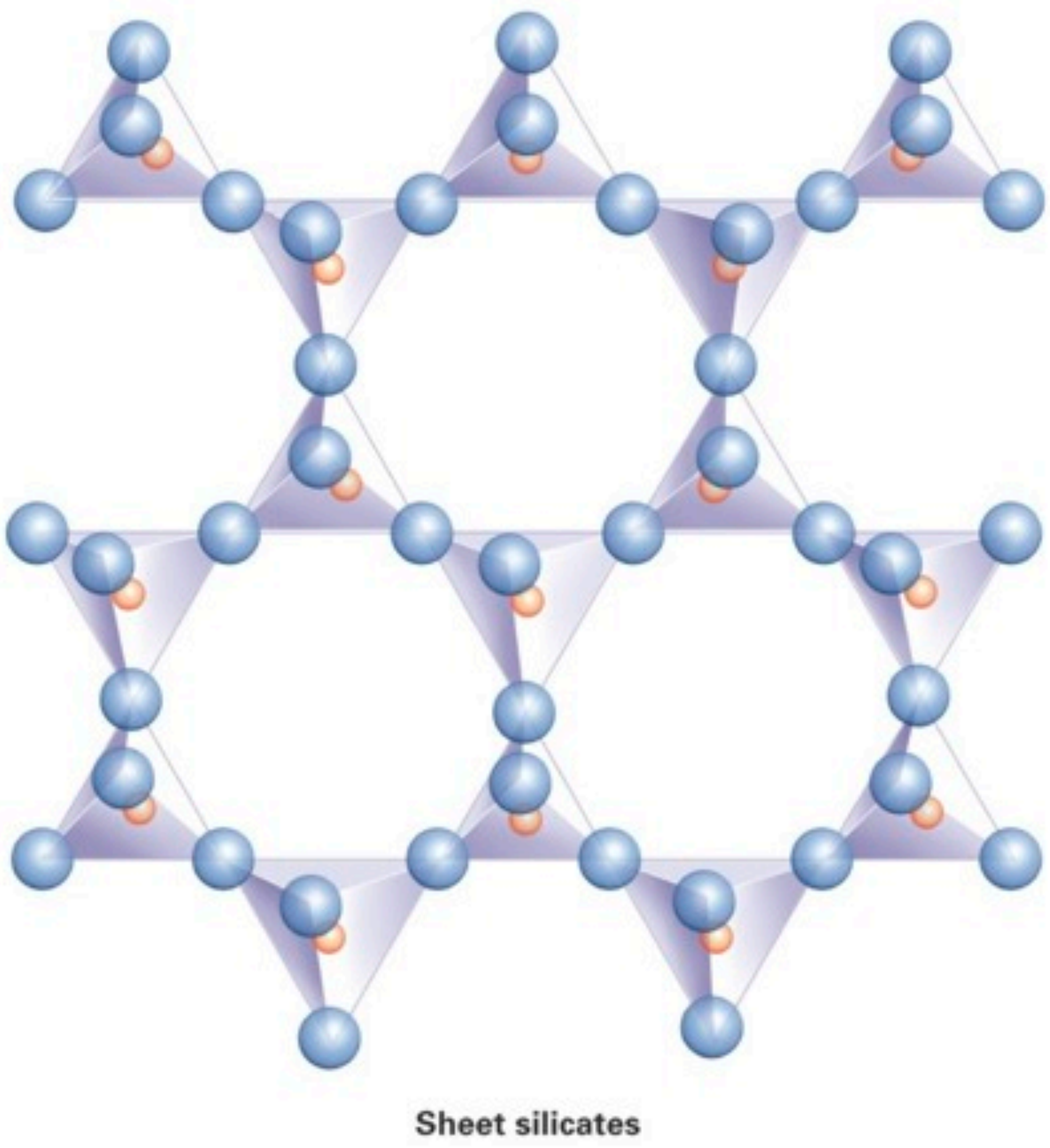


Sheet silicates

Si_2O_5 1:2.5

Each tetrahedron shares three Oxygen atoms forming a two dimensional sheet . Cations interspersed within the sheet in addition to holding the sheet together.

Sheet Silicate

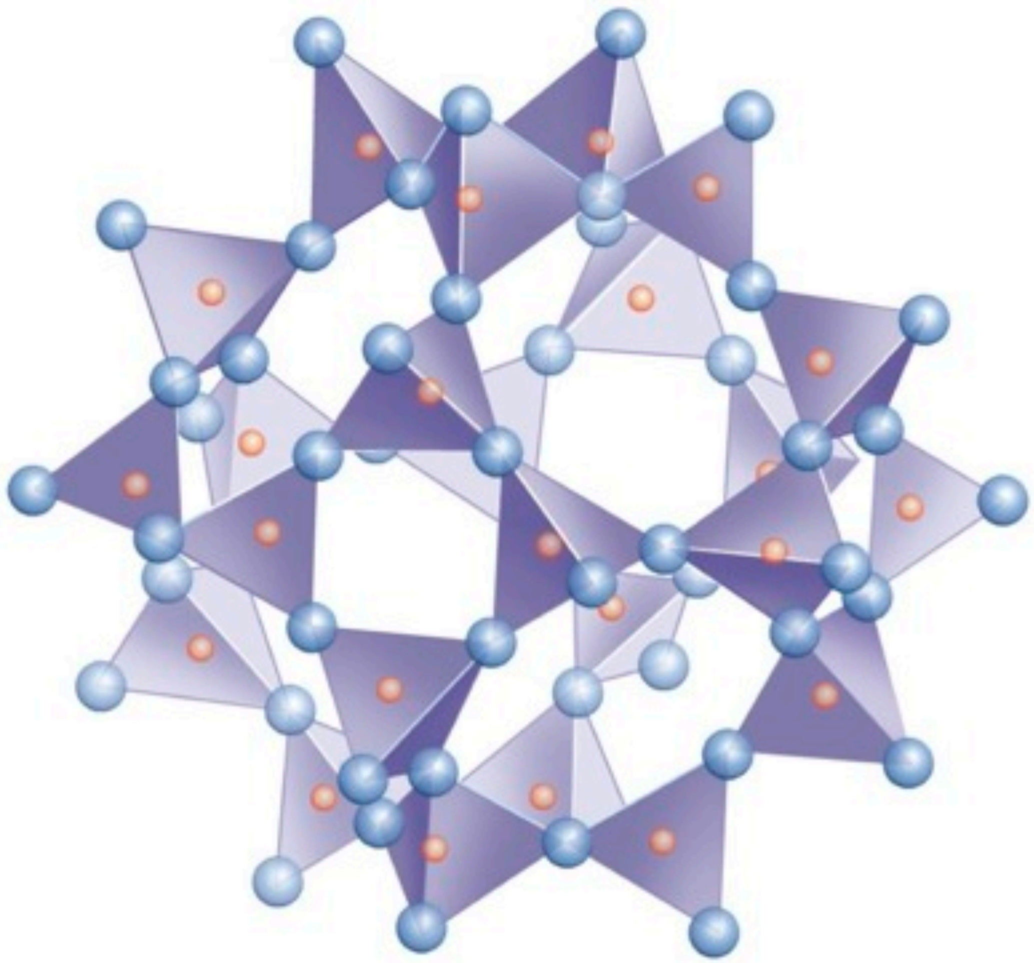


Si_2O_5 **1:2.5**

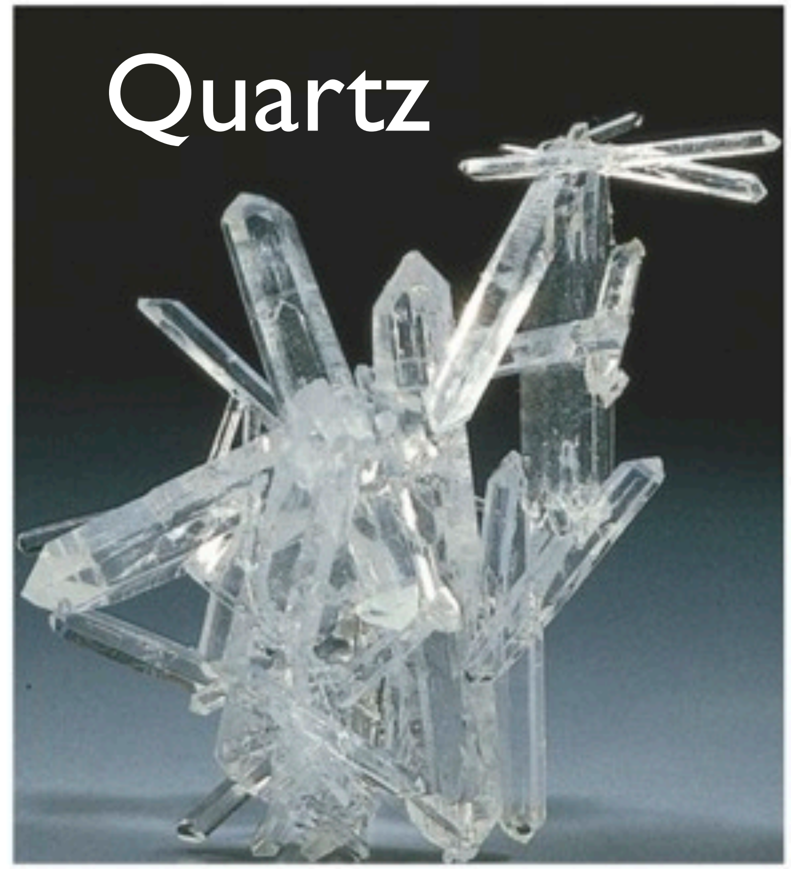
Each tetrahedron shares three Oxygen atoms forming a two dimensional sheet . Cations interspersed within the sheet in addition to holding the sheet together.

Weak ionic bonding between the sheets gives one good direction of cleavage.

3D Framework Silicate



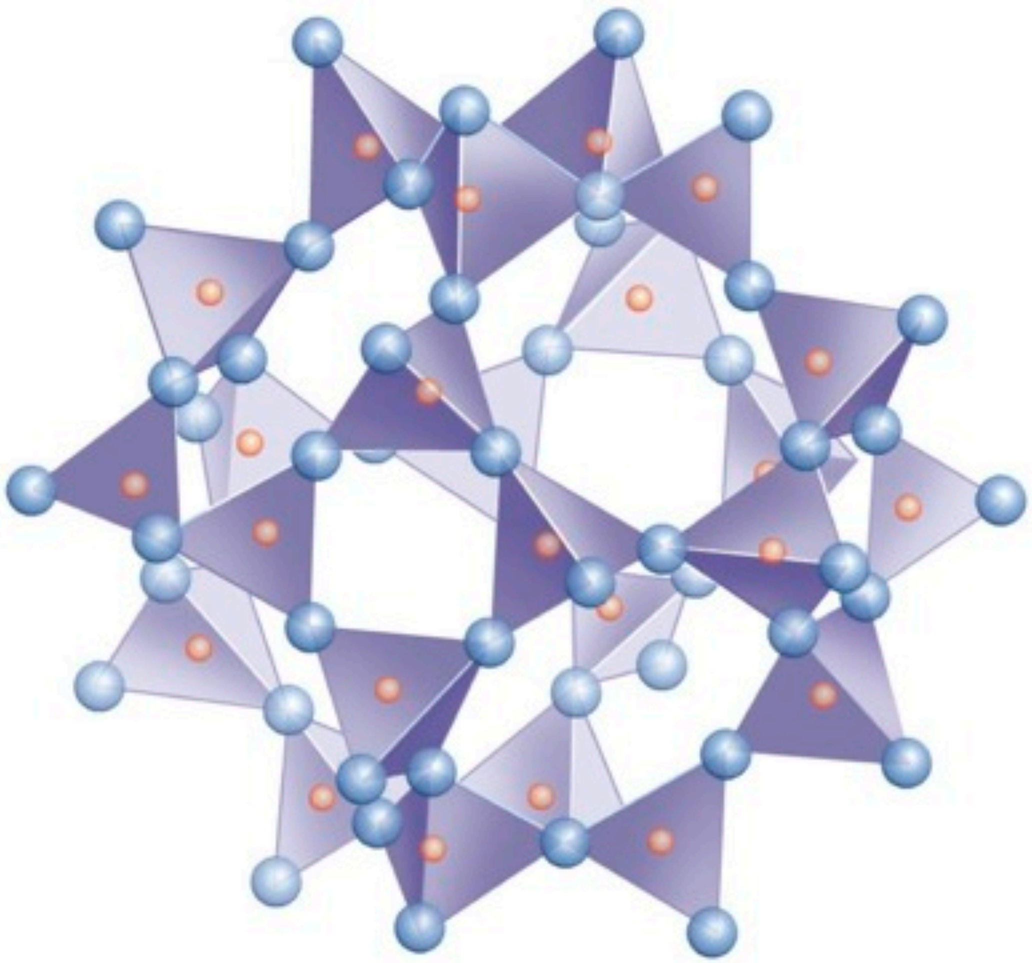
Framework silicates



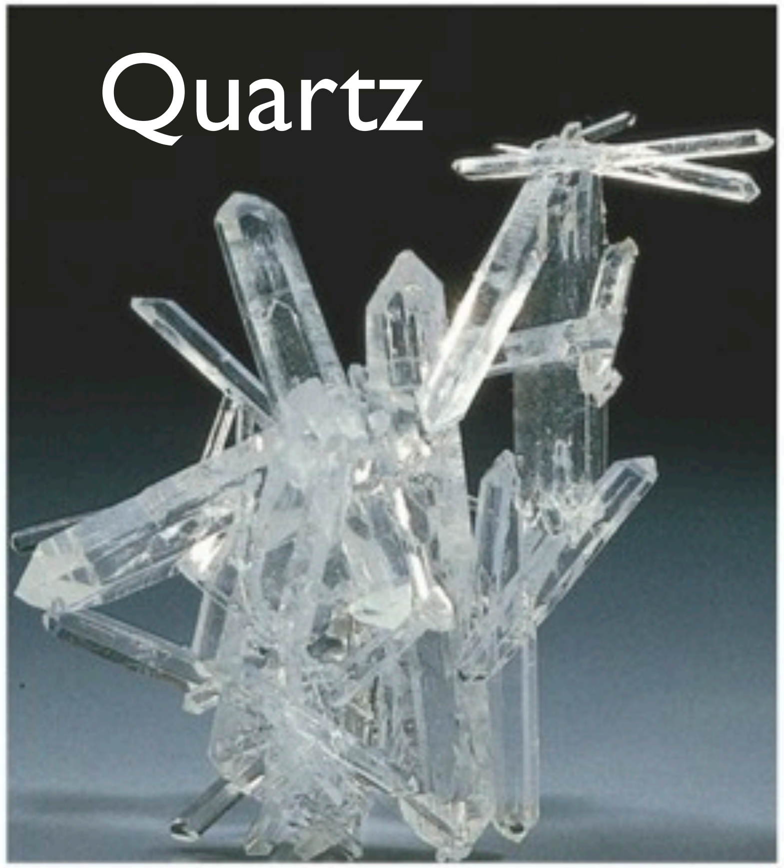
SiO_2 **1:2**

Each tetrahedron shares all four Oxygen atoms forming a 3D framework.
No net charge no cations are needed and no weakness exist

3D Framework Silicate



Framework silicates



Each tetrahedron shares all four Oxygen atoms forming a 3D framework.
No net charge no cations are needed and no weakness exist

SiO_2 **1:2**

Because there is no net charge on the framework, no cations are needed and no weakness exist. No cleavage

Non-silicate Minerals

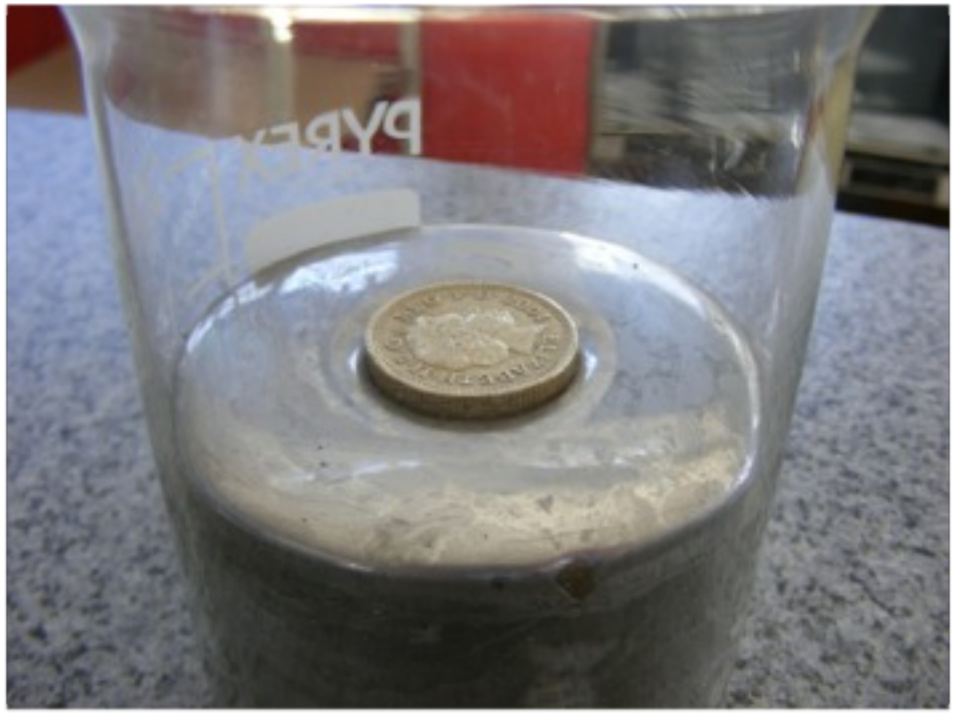
See text Pages 60- 61

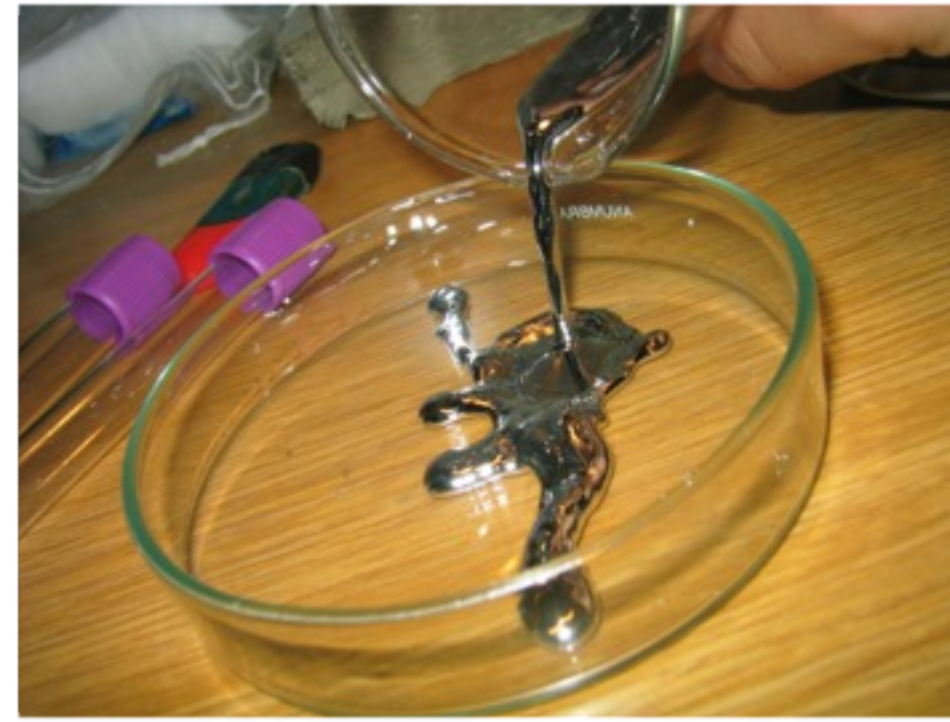
<u>**Carbonates**</u> **CO_3^{-2} (Carbon and Oxygen)**
e.g. $CaCO_3$ is the formula for the mineral calcite

<u>**Oxides**</u> **When negatively charged Oxygen (O^{-2}) bonds to metallic ions.**
e.g. Fe_3O_4 is the formula for the mineral magnetite

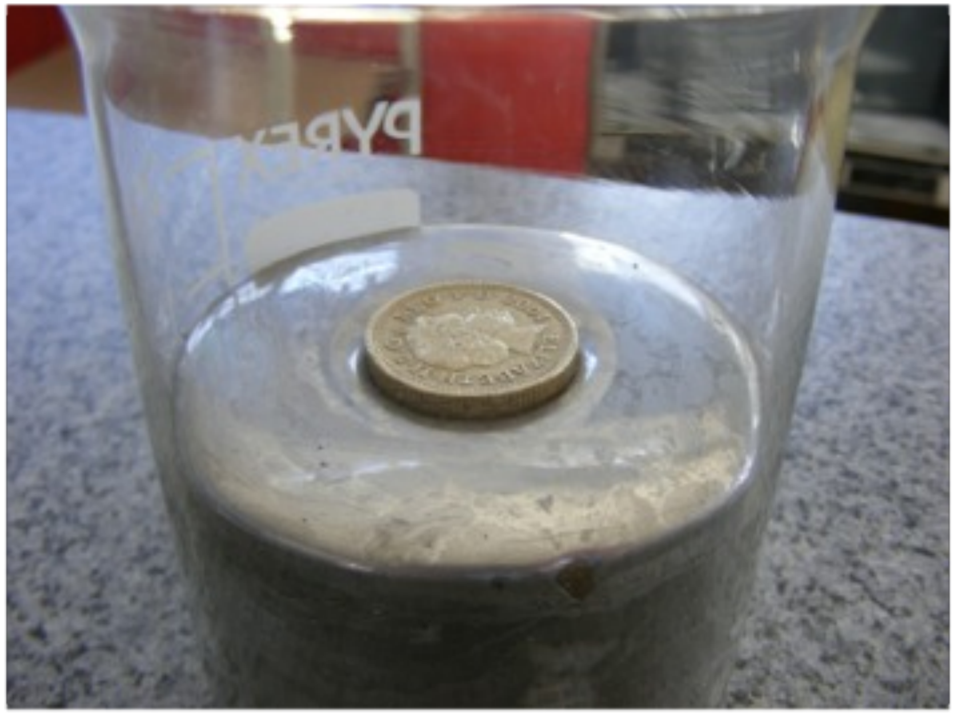
<u>**Sulfides**</u> **e.g. PbS-Galena FeS_2 -Pyrite**

Mercury (Hg)

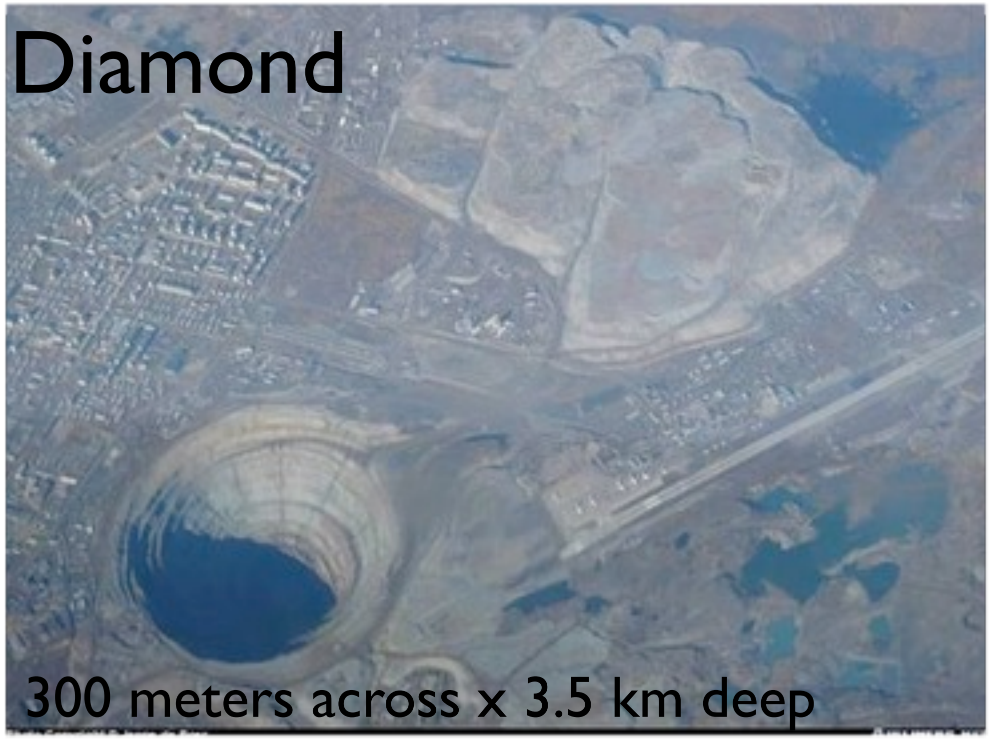




Mercury (Hg)



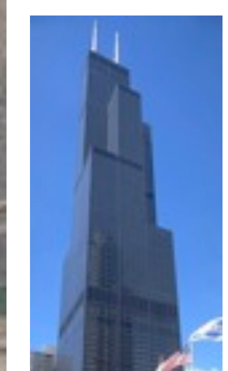
How are they similar? How are they different?



Copper Mine (Cu)

Electrical conductor

- second only to silver



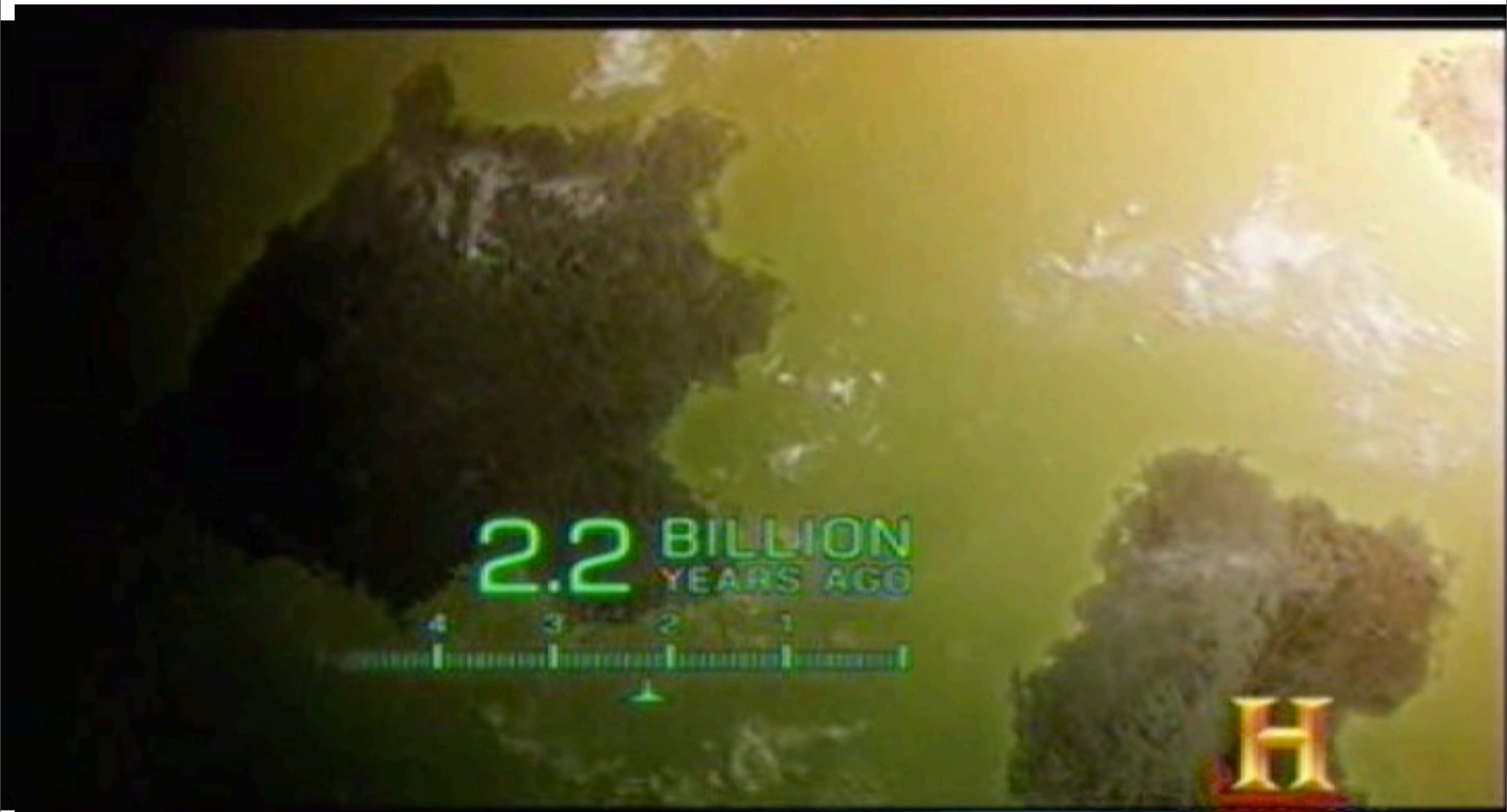
Bingham Canyon Mine, Salt Lake City, UT

Diamond Mine (C)

Kimberly, South Africa

Canada

Earth



Earth

Iron Mine (Fe)

Hull-Rust Mine, Minnesota

1) Next Quiz: Chapter 2 Review/
Chapter 3 Vocabulary