



Module 3

Brad Ashburn, PhD
BIOC 141

Element Names and Chemical Symbols

1A 1																	8A 18
1 H Hydrogen 1.00794																	2 He Helium 4.00260
2A 2												3A 13	4A 14	5A 15	6A 16	7A 17	
3 Li Lithium 6.941	4 Be Beryllium 9.01218											5 B Boron 10.811	6 C Carbon 12.011	7 N Nitrogen 14.0067	8 O Oxygen 15.9994	9 F Fluorine 18.998403	10 Ne Neon 20.1797
11 Na Sodium 22.98977	12 Mg Magnesium 24.305	3B 3	4B 4	5B 5	6B 6	7B 7	8B 8 9 10			1B 11	2B 12	13 Al Aluminum 26.98154	14 Si Silicon 28.0855	15 P Phosphorus 30.97376	16 S Sulfur 32.066	17 Cl Chlorine 35.4527	18 Ar Argon 39.948
19 K Potassium 39.0983	20 Ca Calcium 40.078	21 Sc Scandium 44.9559	22 Ti Titanium 47.88	23 V Vanadium 50.9415	24 Cr Chromium 51.9961	25 Mn Manganese 54.9380	26 Fe Iron 55.847	27 Co Cobalt 58.9332	28 Ni Nickel 58.6934	29 Cu Copper 63.546	30 Zn Zinc 65.39	31 Ga Gallium 69.723	32 Ge Germanium 72.61	33 As Arsenic 74.9216	34 Se Selenium 78.96	35 Br Bromine 79.904	36 Kr Krypton 83.80
37 Rb Rubidium 85.4678	38 Sr Strontium 87.62	39 Y Yttrium 88.9059	40 Zr Zirconium 91.224	41 Nb Niobium 92.9064	42 Mo Molybdenum 95.94	43 Tc Technetium (98)	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.9055	46 Pd Palladium 106.42	47 Ag Silver 107.8682	48 Cd Cadmium 112.411	49 In Indium 114.82	50 Sn Tin 118.710	51 Sb Antimony 121.757	52 Te Tellurium 127.60	53 I Iodine 126.9045	54 Xe Xenon 131.29
55 Cs Cesium 132.9054	56 Ba Barium 137.327	57 *La Lanthanum 138.9055	72 Hf Hafnium 178.49	73 Ta Tantalum 180.9479	74 W Tungsten 183.85	75 Re Rhenium 186.207	76 Os Osmium 190.2	77 Ir Iridium 192.22	78 Pt Platinum 195.08	79 Au Gold 196.9665	80 Hg Mercury 200.59	81 Tl Thallium 204.3833	82 Pb Lead 207.2	83 Bi Bismuth 208.9804	84 Po Polonium (209)	85 At Astatine (210)	86 Rn Radon (222)
87 Fr Francium (223)	88 Ra Radium 226.0254	89 †Ac Actinium 227.0278	104 Rf Rutherfordium (261)	105 Db Dubnium (262)	106 Sg Seaborgium (263)	107 Bh Bohrium (262)	108 Hs Hassium (265)	109 Mt Meitnerium (268)	110 (269)	111 (272)	112 (277)						

*Lanthanide Series	58 Ce Cerium 140.115	59 Pr Praseodymium 140.9077	60 Nd Neodymium 144.24	61 Pm Promethium (145)	62 Sm Samarium 150.36	63 Eu Europium 151.965	64 Gd Gadolinium 157.25	65 Tb Terbium 158.9254	66 Dy Dysprosium 162.50	67 Ho Holmium 164.9303	68 Er Erbium 167.26	69 Tm Thulium 168.9342	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.967
† Actinide Series	90 Th Thorium 232.0381	91 Pa Protactinium 231.0359	92 U Uranium 238.0289	93 Np Neptunium 237.048	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 (258)	102 No Nobelium (259)	103 Lr Lawrencium (260)

Odd Chemical Symbols

Element	Symbol	Latin Name
Antimony	Sb	Stibium
Copper	Cu	Cuprum
Gold	Au	Aurum
Iron	Fe	Ferrum
Lead	Pb	Plumbum
Mercury	Hg	Hydragyrum
Potassium	K	Kalium
Silver	Ag	Argentum
Sodium	Na	Natrium
Tin	Sn	Stannum
Tungsten	W	Wolfram











The Human Body

Element	Percentage by Mass
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Elemental Composition



Concept Review (Section 2.1)

CONCEPT REVIEW EXERCISES

1. What is an element?
2. Give some examples of how the abundance of elements varies.
3. Why are chemical symbols so useful? What is the source of the letter(s) for a chemical symbol?

Practice Problems: 1-8 in Section 2.1

Modern Atomic Theory (Section 2.2)

All elements are composed of atoms.

Diatomic Molecules

hydrogen (H_2)

oxygen (O_2)

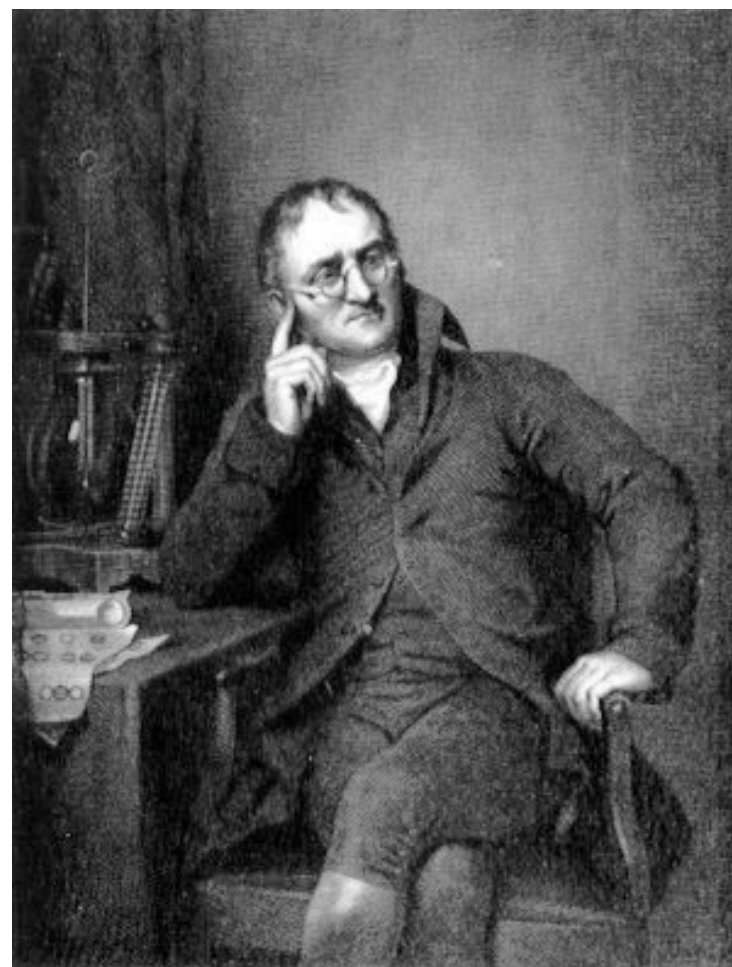
nitrogen (N_2)

fluorine (F_2)

chlorine (Cl_2)

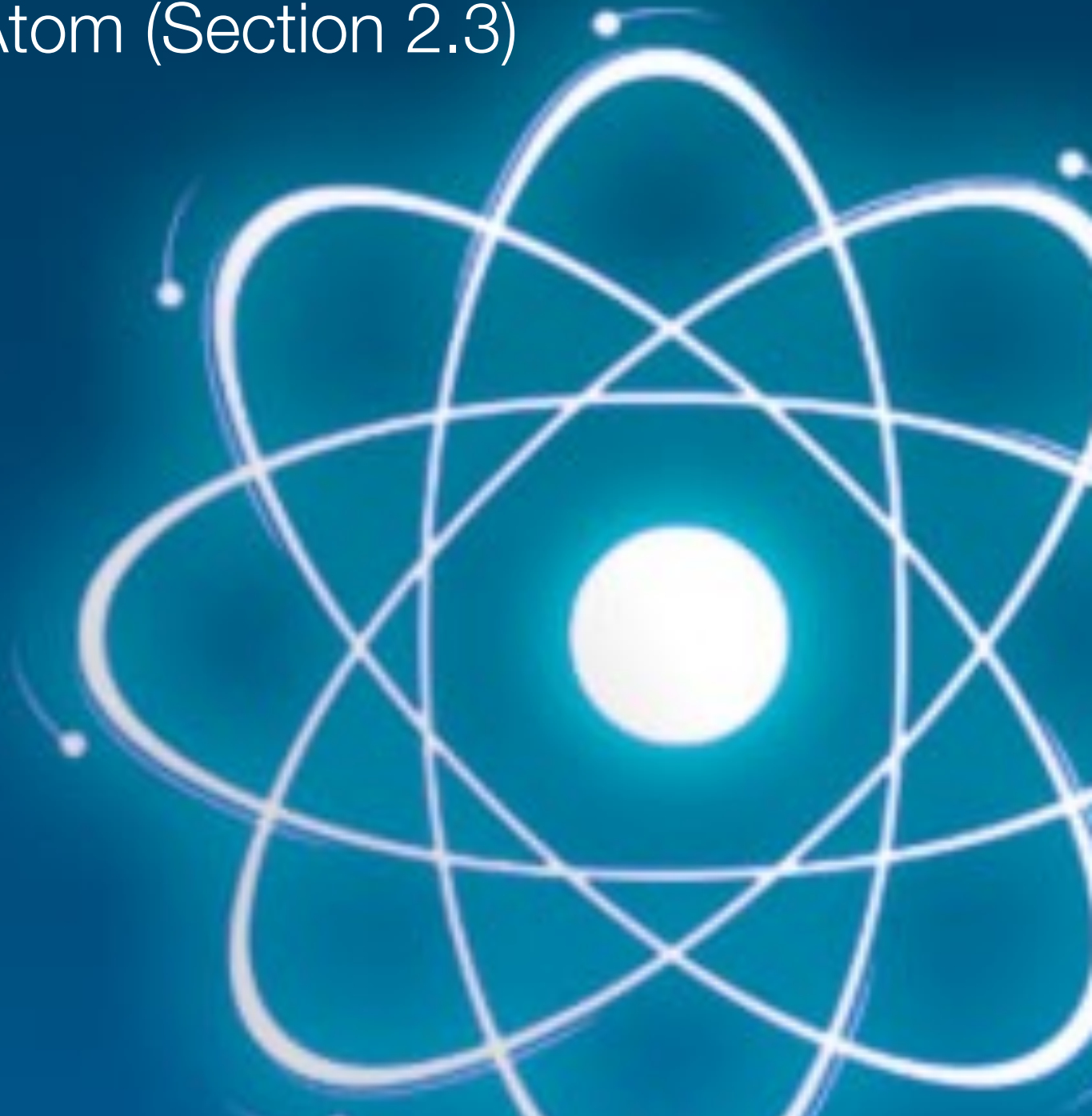
bromine (Br_2)

iodine (I_2)

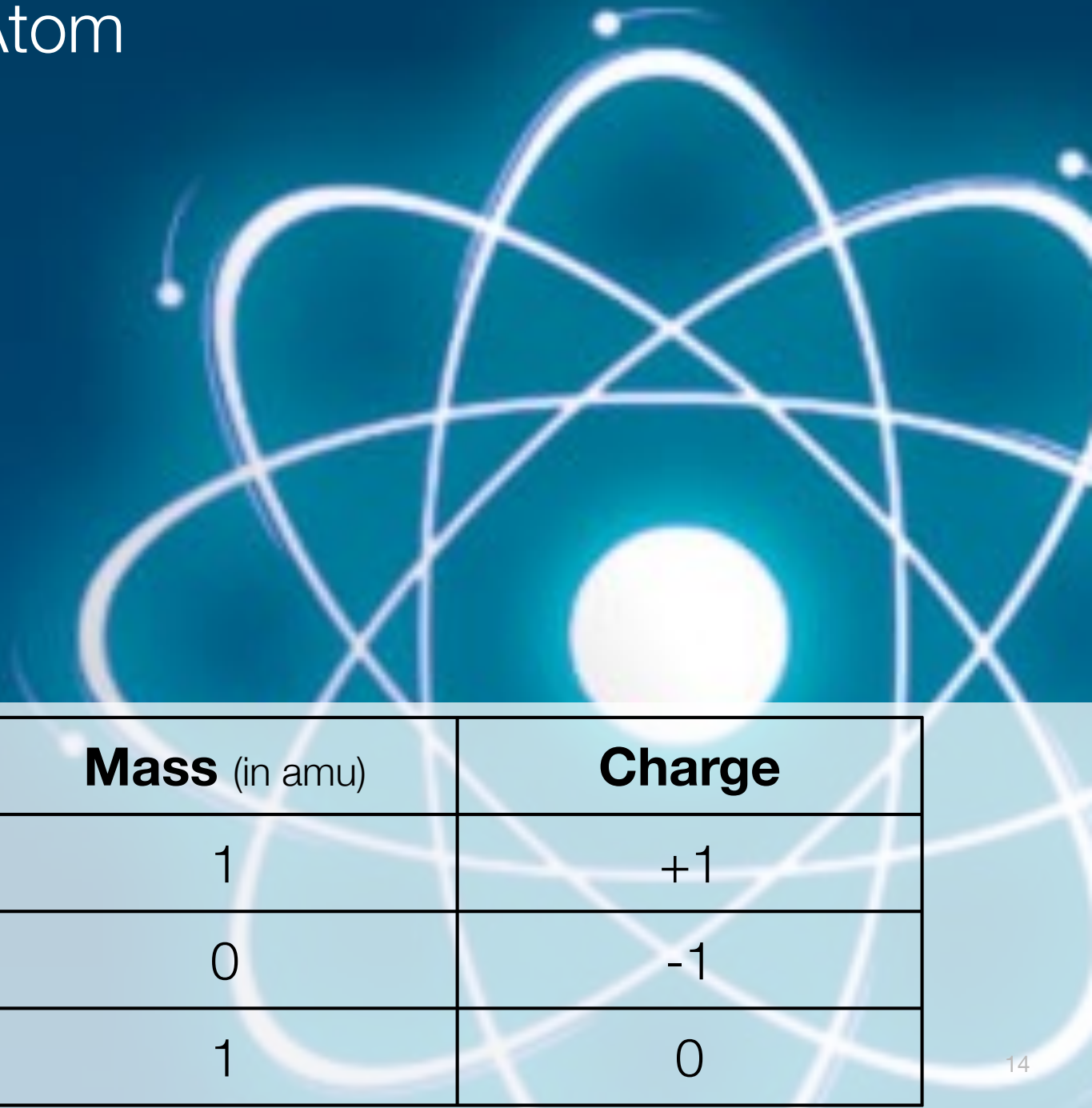


Practice Problems: 1-4 in Section 2.2

Structure of the Atom (Section 2.3)

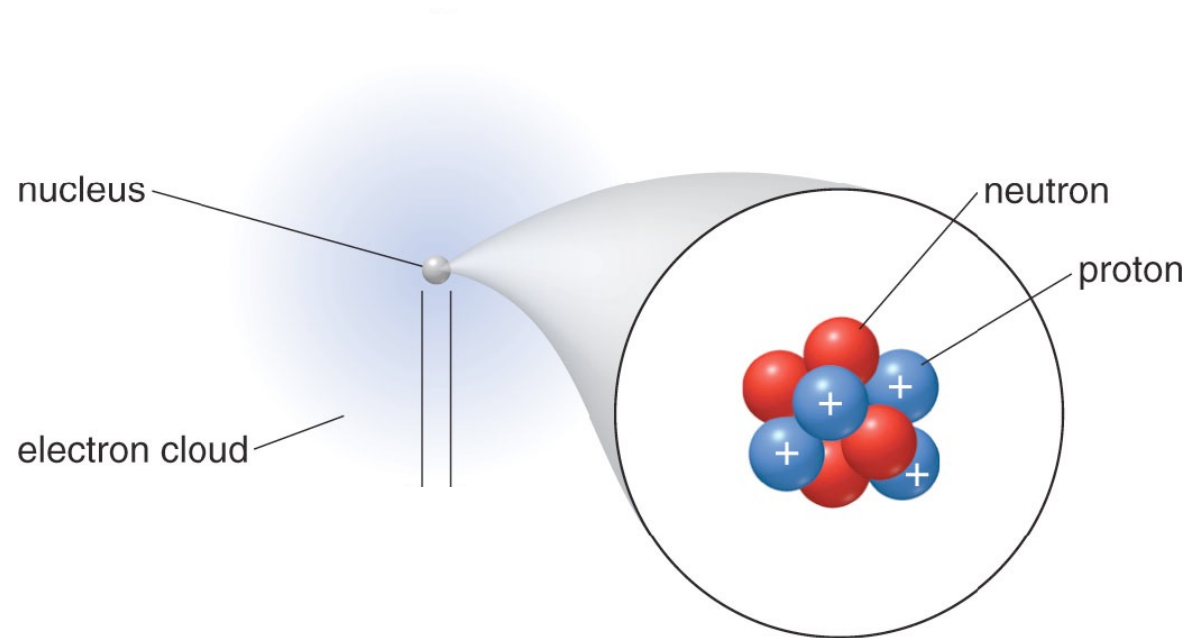


Structure of the Atom



	Mass (in amu)	Charge
Proton	1	+1
Electron	0	-1
Neutron	1	0

Structure of the Atom



Nucleus: Location of protons & neutrons.

Electron Cloud: Location of electrons.

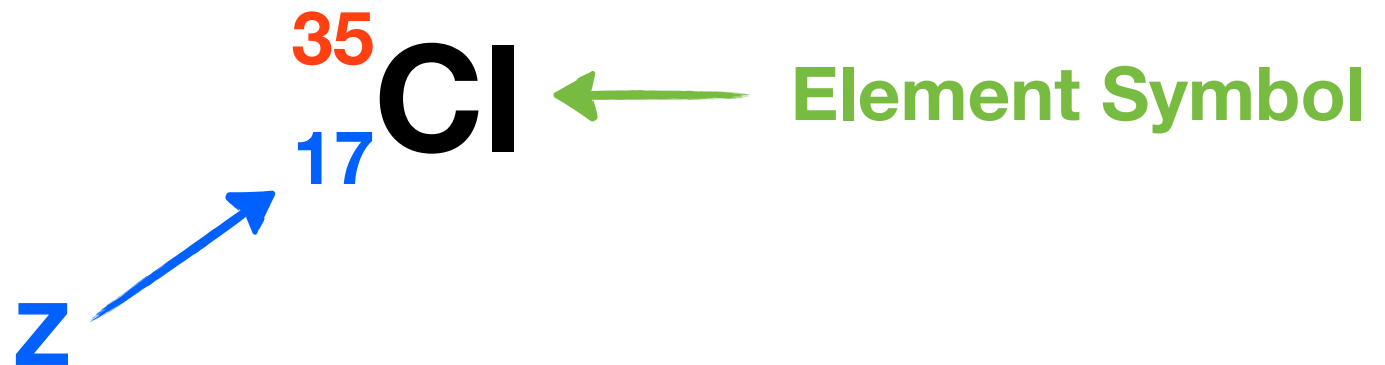
Concept Review (Section 2.3)

CONCEPT REVIEW EXERCISES

1. What are the charges and the relative masses of the three subatomic particles?
2. Describe the structure of an atom in terms of its protons, neutrons, and electrons.

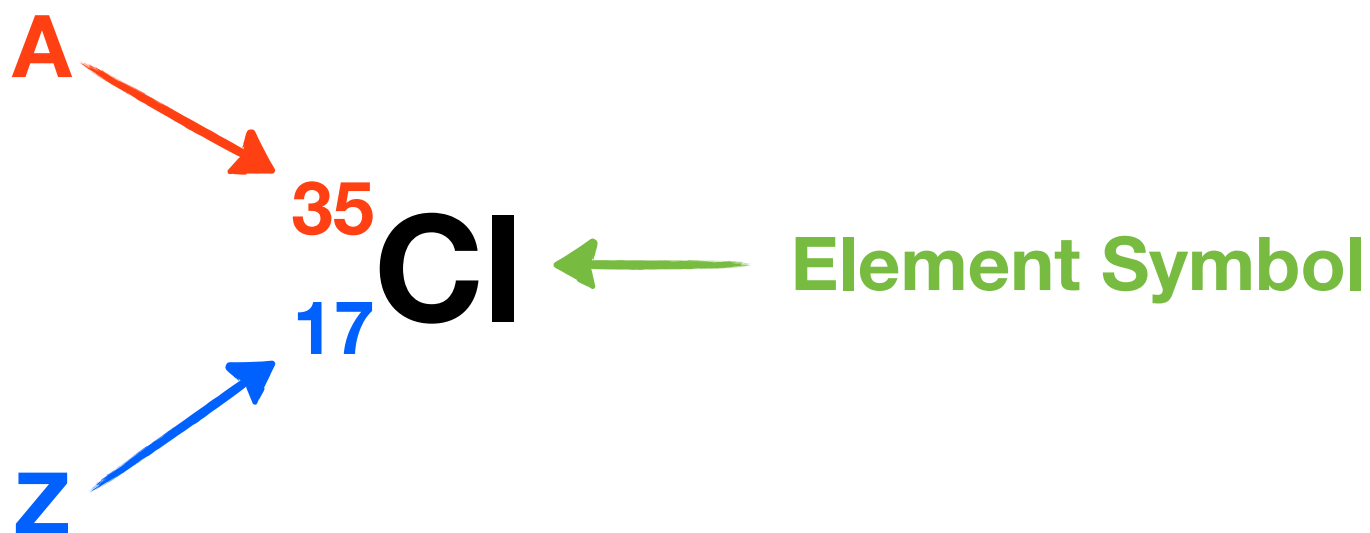
Practice Problems: 1-10 in Section 2.3

The Nuclei of Atoms (Sections 2.4 and 2.5)



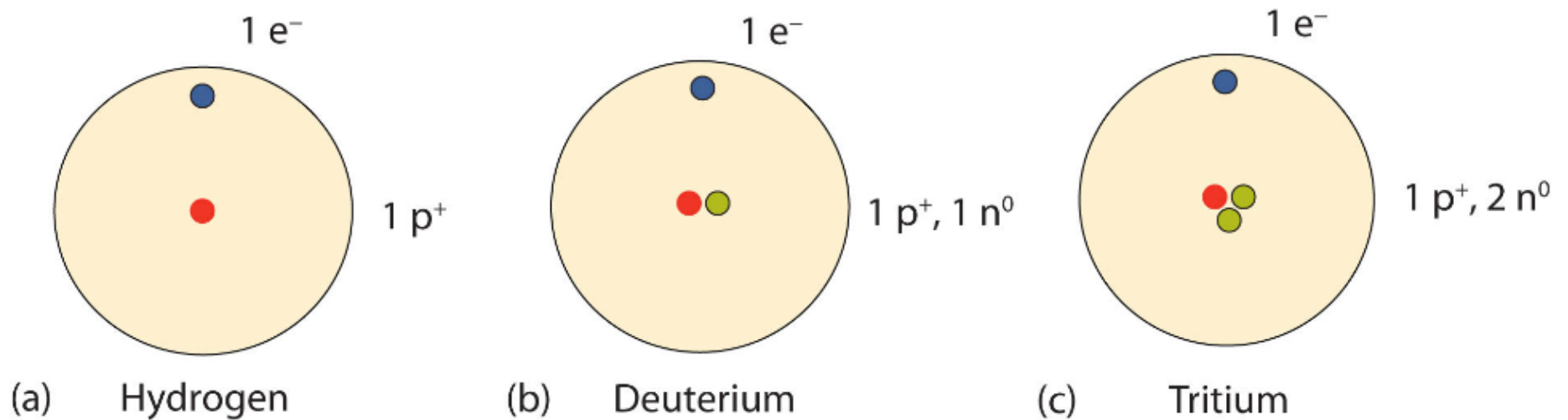
Atomic Number (Z) = # of protons = # of electrons

The Nuclei of Atoms (Section 2.4 and 2.5)



Mass Number (A) = # of protons + # of neutrons

Isotopes



Atomic mass is the average mass of
all isotopes of element

Concept Check

List the subatomic particles in each atom below:

$$Z = 12, A = 24$$

$$Z = 14, A = 28$$

$$Z = 44, A = 101$$

Give the **Z** and **A** for each atom below:

protons = 9, electrons = 9, neutrons = 10

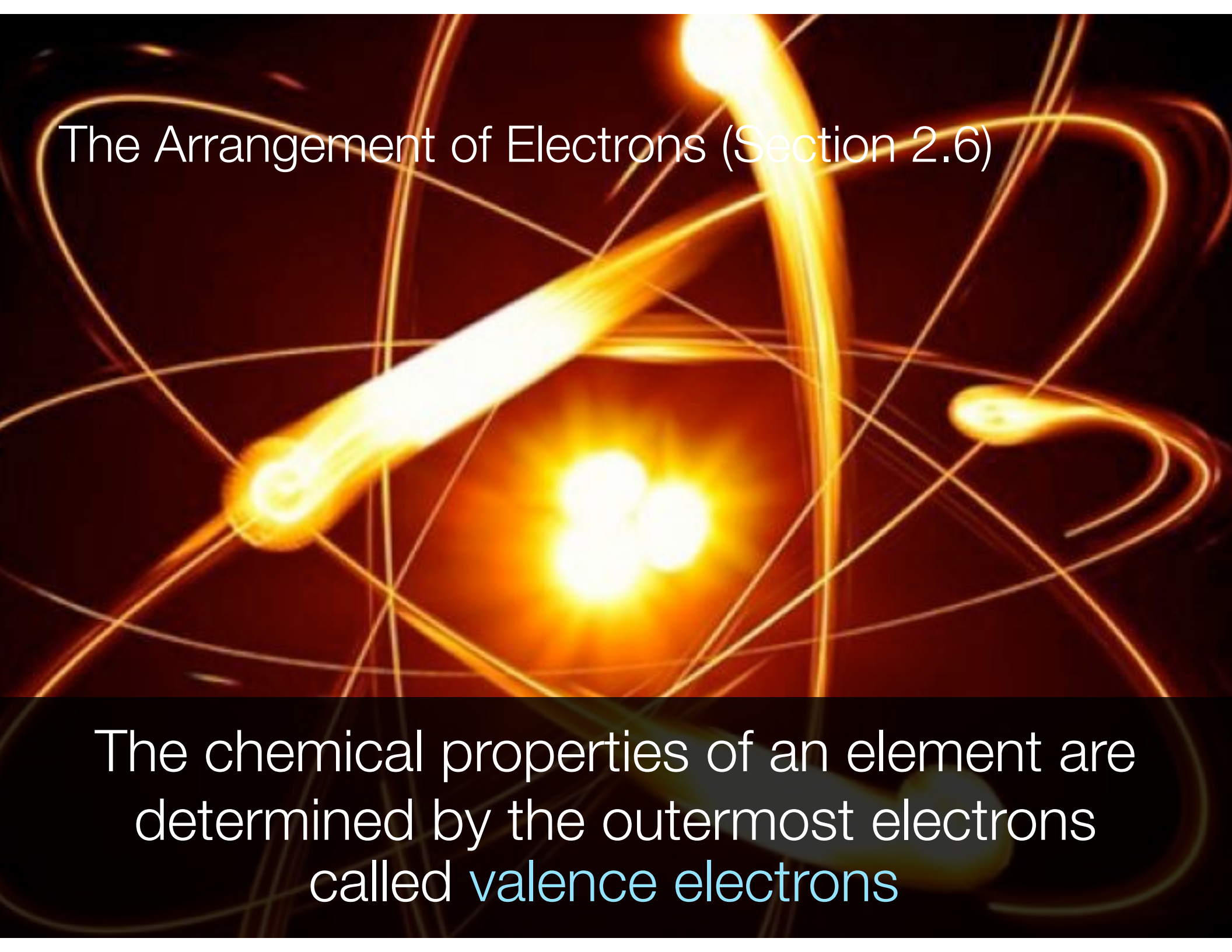
protons = 11, electrons = 11, neutrons = 12

Concept Review (Sections 2.4 and 2.5)

CONCEPT REVIEW EXERCISES

1. Why is the atomic number so important to the identity of an atom?
2. What is the relationship between the number of protons and the number of electrons in an atom?
3. How do isotopes of an element differ from each other?
4. What is the mass number of an element?

Practice Problems: 1-14 in Section 2.4



The Arrangement of Electrons (Section 2.6)

The chemical properties of an element are determined by the outermost electrons called **valence electrons**

Valence Electrons

Period																	3A	4A	5A	6A	7A	8A
	1A 1											2A 2	13	14	15	16	17	18				
1	1 H 1.0079																	2 He 4.0026				
2	3 Li 6.941	4 Be 9.0122											5 B 10.811	6 C 12.011	7 N 14.0067	8 O 15.9994	9 F 18.9984	10 Ne 20.1797				
3	11 Na 22.9898	12 Mg 24.3050	3B 3	4B 4	5B 5	6B 6	7B 7	8B 8 9 10		1B 11	2B 12	13 Al 26.9815	14 Si 28.0855	15 P 30.9738	16 S 32.066	17 Cl 35.453	18 Ar 39.948					
4	19 K 39.0983	20 Ca 40.078	21 Sc 44.9559	22 Ti 47.88	23 V 50.9415	24 Cr 51.9961	25 Mn 54.9380	26 Fe 55.845	27 Co 58.9332	28 Ni 58.693	29 Cu 63.546	30 Zn 65.41	31 Ga 69.723	32 Ge 72.64	33 As 74.9216	34 Se 78.96	35 Br 79.904	36 Kr 83.80				
5	37 Rb 85.4678	38 Sr 87.62	39 Y 88.9059	40 Zr 91.224	41 Nb 92.9064	42 Mo 95.94	43 Tc (98)	44 Ru 101.07	45 Rh 102.9055	46 Pd 106.42	47 Ag 107.8682	48 Cd 112.411	49 In 114.82	50 Sn 118.710	51 Sb 121.760	52 Te 127.60	53 I 126.9045	54 Xe 131.29				
6	55 Cs 132.9054	56 Ba 137.327	57 La 138.9055	72 Hf 178.49	73 Ta 180.9479	74 W 183.84	75 Re 186.207	76 Os 190.2	77 Ir 192.22	78 Pt 195.08	79 Au 196.9665	80 Hg 200.59	81 Tl 204.3833	82 Pb 207.2	83 Bi 208.9804	84 Po (209)	85 At (210)	86 Rn (222)				
7	87 Fr (223)	88 Ra (226)	89 Ac (227)	104 Rf (267)	105 Db (268)	106 Sg (271)	107 Bh (272)	108 Hs (270)	109 Mt (276)	110 Ds (281)	111 Rg (280)	112 — (285)		114 — (289)		116 — (293)						

Lanthanides	6	58 Ce 140.115	59 Pr 140.9076	60 Nd 144.24	61 Pm (145)	62 Sm 150.36	63 Eu 151.964	64 Gd 157.25	65 Tb 158.9253	66 Dy 162.50	67 Ho 164.9303	68 Er 167.26	69 Tm 168.9342	70 Yb 173.04	71 Lu 174.967	6
	Actinides	7	90 Th 232.0381	91 Pa 231.03588	92 U 238.0289	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (262)

 Main group elements

 Transition metal elements

Inner transition metal elements

Electron Dot Structures

Dots are placed on each side of an element symbol.

Each **dot** represents **one valence electron**.

Element:	H	C	O	Cl
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of Valence electrons:

Electron dot symbol:

Concept Check

Draw the **electron dot symbol** for each element:

Mg

N

Ca

Si

I

Kr

The Periodic Table (Section 2.7)

1A 1																	8A 18				
1 H Hydrogen 1.00794																	2 He Helium 4.00260				
3 Li Lithium 6.941	4 Be Beryllium 9.01218															5 B Boron 10.811	6 C Carbon 12.011	7 N Nitrogen 14.0067	8 O Oxygen 15.9994	9 F Fluorine 18.998403	10 Ne Neon 20.1797
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Classes of Elements

Metals



Shiny solids

Good conductors of heat
and electricity

Metalloids



Look for the angled line

Hybrid properties

Non-Metals



Variable appearance

Can be solids, liquids
or gases

The Periodic Table

A row is called a period

A column is called a group

A column is called a group

Period	1A 1																	3A 13	4A 14	5A 15	6A 16	7A 17	8A 18	
1	1 H 1.0079																						2 He 4.0026	1
2	3 Li 6.941	4 Be 9.0122											5 B 10.811	6 C 12.011	7 N 14.0067	8 O 15.9994	9 F 18.9984	10 Ne 20.1797	2					
3	11 Na 22.9898	12 Mg 24.3050	3B 3	4B 4	5B 5	6B 6	7B 7	8B 8	9 10	1B 11	2B 12	13 Al 26.9815	14 Si 28.0855	15 P 30.9738	16 S 32.066	17 Cl 35.453	18 Ar 39.948	3						
4	19 K 39.0983	20 Ca 40.078	21 Sc 44.9559	22 Ti 47.88	23 V 50.9415	24 Cr 51.9961	25 Mn 54.9380	26 Fe 55.845	27 Co 58.9332	28 Ni 58.693	29 Cu 63.546	30 Zn 65.41	31 Ga 69.723	32 Ge 72.64	33 As 74.9216	34 Se 78.96	35 Br 79.904	36 Kr 83.80	4					
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Lanthanides

Actinides

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Main group elements

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Inner transition metal elements

[illegible]

Inner transition metal elements

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		140.115	140.9076	144.24	(145)	150.36	151.964	157.25	158.9253	162.50	164.9303	167.26	168.9342	173.04	174.967	
	7	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	103 Lr	7
232.0381		231.03588	238.0289	(237)	(244)	(243)	(247)	(247)	(251)	(252)	(257)	(258)	(259)	(262)		

Inner transition metal elements

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Inner transition metal elements

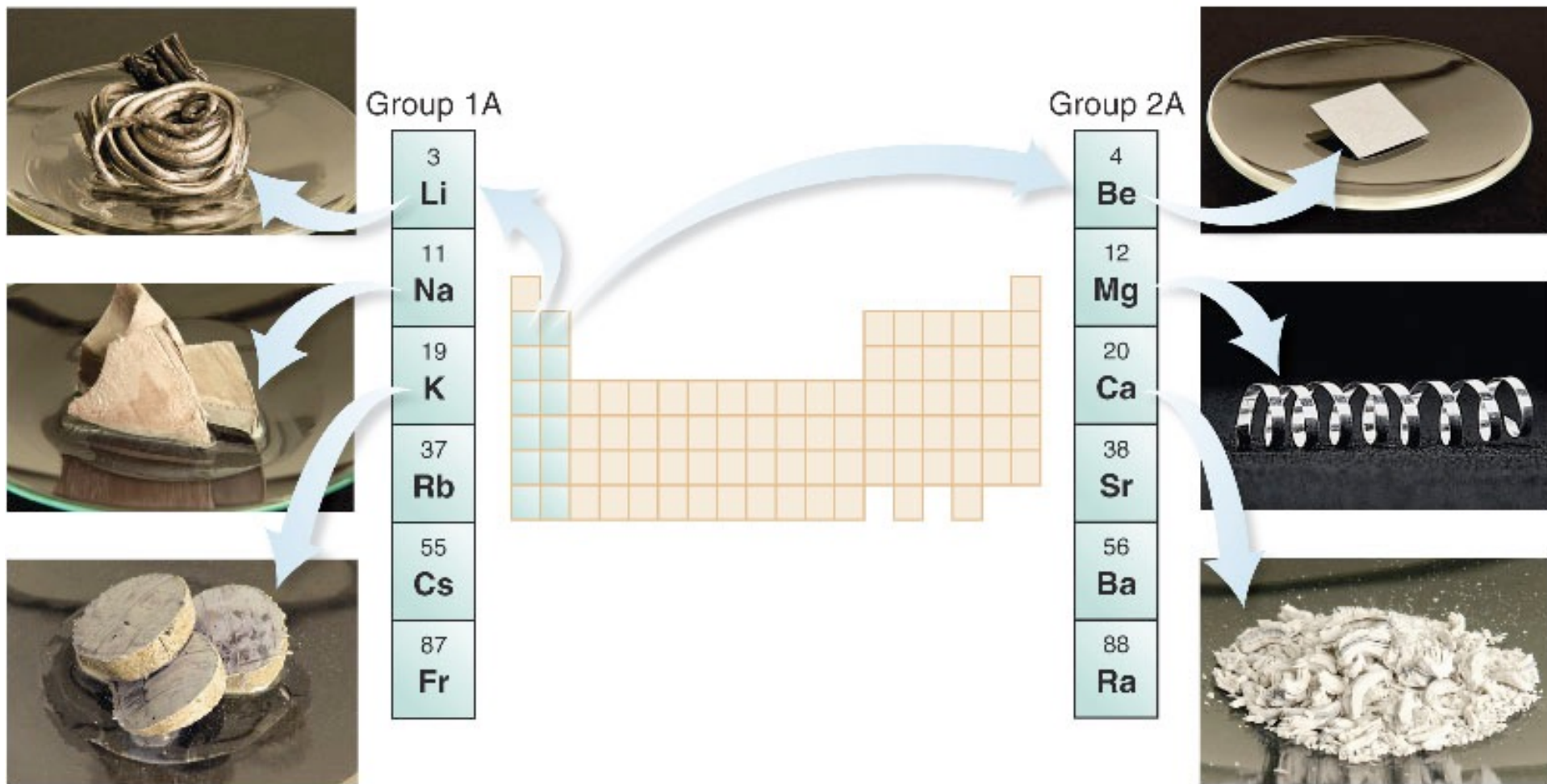
Periodic Table and Electron Arrangement

Diagram illustrating the arrangement of atomic orbitals (AOs) for principal quantum numbers $n=1$ to $n=7$. The orbitals are organized into columns and rows, with colors indicating their type:

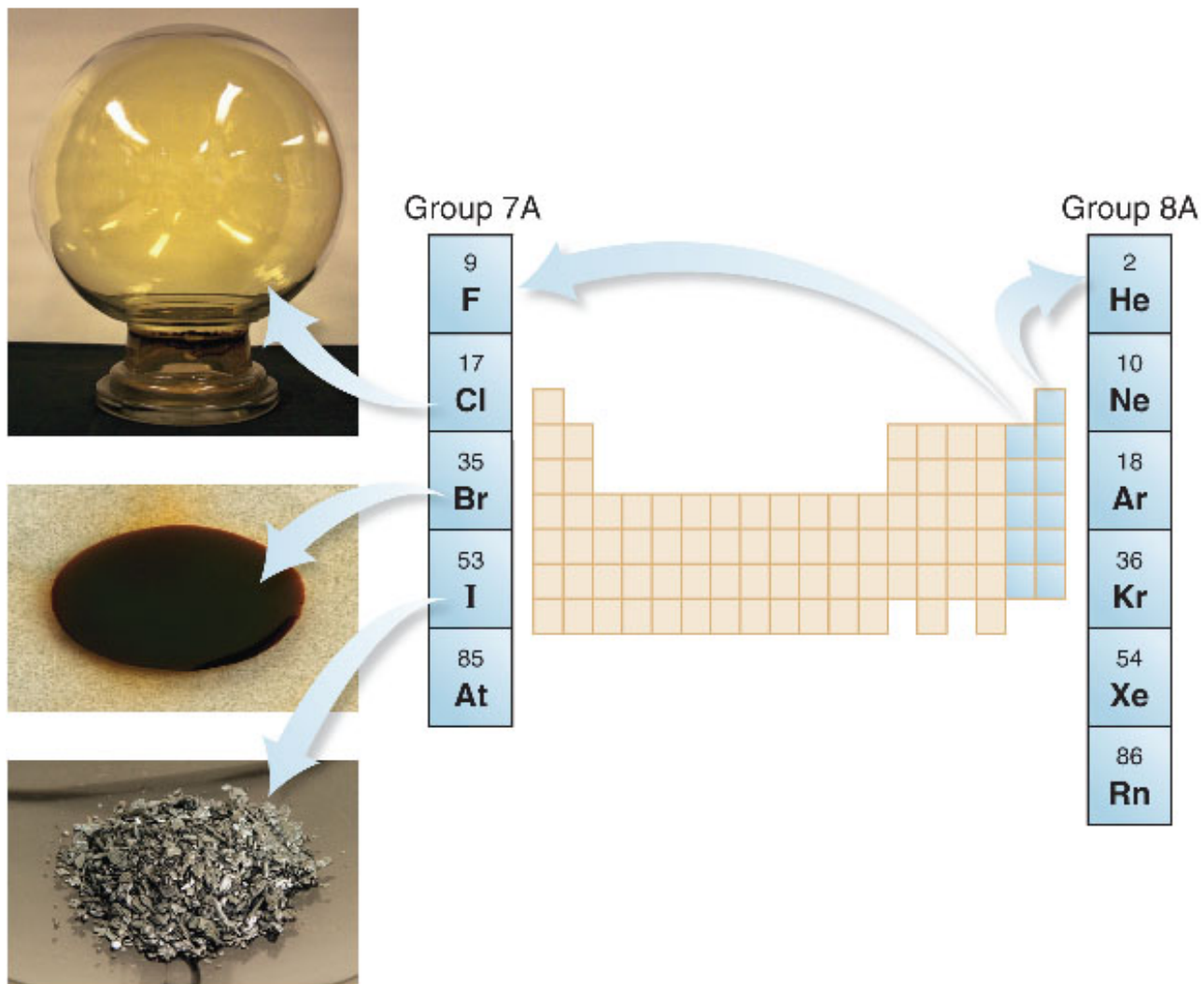
- Column 1 (s-orbitals):** 1s, 2s, 3s, 4s, 5s, 6s, 7s (light blue).
- Column 2 (d-orbitals):** 3d, 4d, 5d, 6d (light orange).
- Column 3 (p-orbitals):** 2p, 3p, 4p, 5p, 6p, 7p (light purple).
- Column 4 (f-orbitals):** 4f, 5f (light teal).

The orbitals are arranged in a grid-like structure, with the principal quantum number n indicated by the row number. The orbitals are labeled with their principal quantum number and subshell letter (e.g., 1s, 2s, 3s, 4s, 5s, 6s, 7s, 3d, 4d, 5d, 6d, 2p, 3p, 4p, 5p, 6p, 7p, 4f, 5f).

4 Special Groups



4 Special Groups



Alkali metal in Period 4

Second row element in Group 7A

Noble gas in Period 3

Element in Period 5, Group 2A

Halogen in row 4

Atomic Size/Radius



The size of atoms **increases** down a column.

The size of atoms **increases** right to left across a row.

Atomic Size/Radius

A periodic table illustrating atomic size/radius trends. The table is organized into rows (1 to 6) and columns (1A to 8A). Red circles of varying sizes represent atoms, with the size increasing from top-left to bottom-right. The circles are arranged in a grid, with the size of the circles increasing from top-left to bottom-right, indicating that atomic size increases in this direction.

	1A		2A	3A	4A	5A	6A	7A	8A
1	H								He
2	Li	Be	B	C	N	O	F		Ne
3	Na	Mg	Al	Si	P	S	Cl		Ar
4	K	Ca	Ga	Ge	As	Se	Br		Kr
5	Rb	Sr	In	Sn	Sb	Te	I		Xe
6	Cs	Ba	Tl	Pb	Bi	Po	At		Rn

Concept Review (Section 2.7)

CONCEPT REVIEW EXERCISES

1. How are the elements organized into the periodic table?
2. Looking at the periodic table, where do the following elements appear?
 - a. the metals
 - b. the nonmetals
 - c. the halogens
 - d. the transition metals
3. Describe the trends in atomic radii as related to an element's position on the periodic table.

Practice Problems: 1-14 in Section 2.7