

CHAPTER 4
ELEMENTS, ATOMS, & IONS

4

CHAPTER 4 ELEMENTS, ATOMS, & IONS

INTRO

Boyle def "element"

ELEMENTS (Overview)

~ 115 elements ; 88 natural
> 84

SYMBOLS

HUMAN

C 20%

O 65%

N 3%

H 10%
~~98%~~

CARBY

O 50%

Si 25%

Al 7.5%

Fe

5%
87.5%

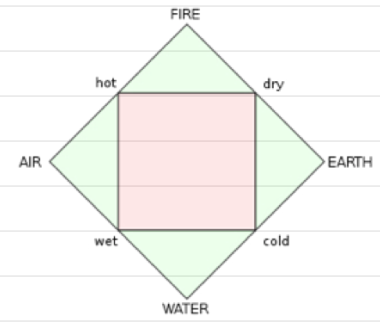
SiO₂
"sand"

("SOAL")
dot

Extremely Brief History of Atomic Theory

- Democritis (500 BC)

- Aristotle

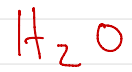
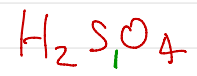
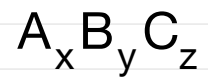


- John Dalton

Atomic Theory

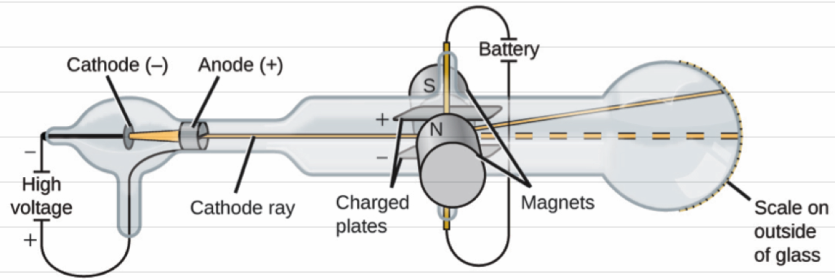
1. Elements are made of tiny particles called ATOMS.
2. All atoms of a given element are identical (“UNIQUE”).
3. The atoms of a given element are DIFFERENT from those of any other element.
4. Atoms of one element can combine with atoms of other elements to form COMPOUNDS.
 - A given compound always has the same relative numbers and types of atoms.
 - LAW OF DEFINITE PROPORTIONS (Joseph Proust, 1799, French)
5. Atoms are INDIVISIBLE in chemical processes. That is, atoms are not created or destroyed in chemical reactions.
 - A chemical reaction simply changes the way the atoms are grouped together.
 - LAW OF CONSERVATION OF MASS (Antoine Lavoisier, 1789)

Writing Formulas



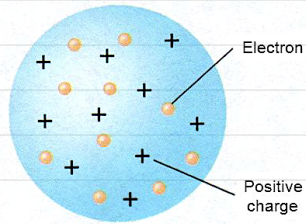
The Atom: ELECTRON

JJ Thompson – CRT – Discovered the Electron



The Atom: Plum Pudding Model

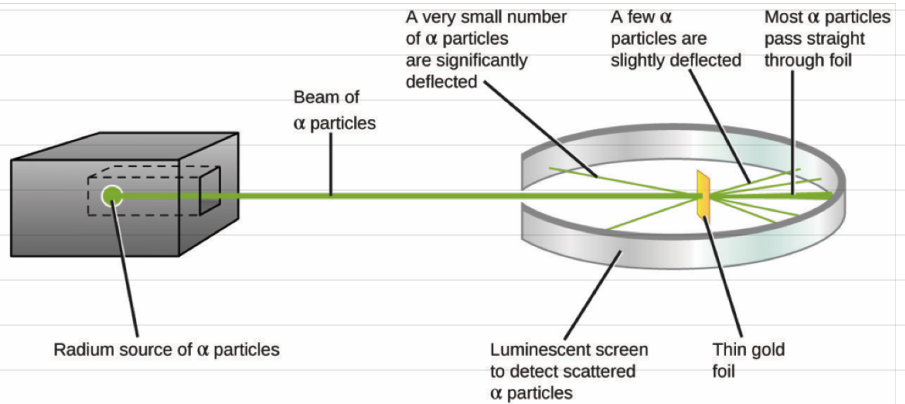
Plum-pudding model



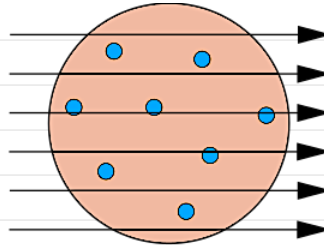
The Atom: NUCLEUS

Ernest Rutherford – Gold Foil – Discovered Nucleus

Experiment →

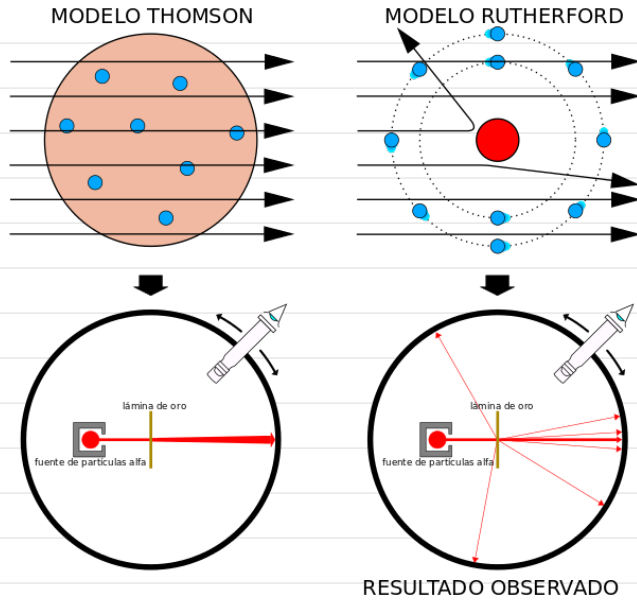


Expectation →



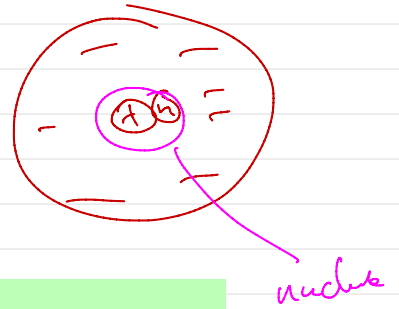
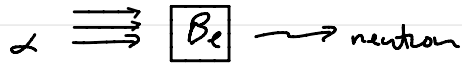
Expectation

Actual Results



"It was quite the most incredible event that has ever happened to me in my life. It was almost as if you fired a 15-inch shell into a piece of tissue paper and it came back and hit you."

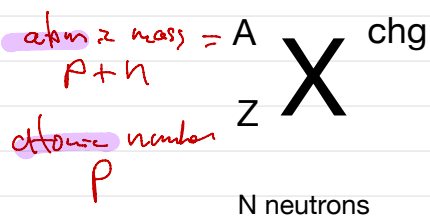
James Chadwick – Radioactive Bombardment – Discovered Neutron



Subatomic Particles

	Mass Rel	Rel chg
electron	1	-1
proton	1836	+1
neutron	1836	0

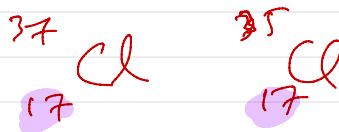
Representing Atoms



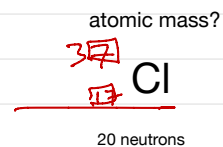
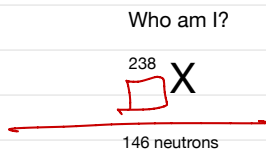
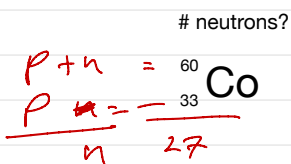
$A - Z = \text{\#neutrons}$
 $Z - \text{\# electrons} = \text{CHG}$

Isotopes

- same Z (or element), different N
- same Z (or element), different A



(Q) ¿What's missing?



$$\begin{array}{r}
 238 \\
 146 \\
 \hline
 92
 \end{array}$$

The PC – Introduction

- 1867 – based on Phys and Chem property patterns
- Dimitri MENDELEV
- PC is “predictive”

Week, Sept 11

The PC – Periods & Groups

- Periods (horizontal) 7

- Groups (vertical)

→ Special Group Names

- 1 = alkaline metals
- 2 = alkaline earth metals
- 17 = halogens
- 18 = noble gases

- Blocks or Areas

→ 8 Representative (‘hillsides’)
 10 Transition (‘valley’)
 14 Inner Transition (‘island’)

Hydrogen 1 H 1.0079																	Helium 2 He 4.0026					
Lithium 3 Li 6.941	Beryllium 4 Be 9.0122											Boron 5 B 10.811	Carbon 6 C 12.011	Nitrogen 7 N 14.007	Oxygen 8 O 15.999	Fluorine 9 F 18.998	Neon 10 Ne 20.180					
Sodium 11 Na 22.990	Magnesium 12 Mg 24.305											Aluminum 13 Al 26.982	Silicon 14 Si 28.086	Phosphorus 15 P 30.974	Sulfur 16 S 32.065	Chlorine 17 Cl 35.453	Argon 18 Ar 39.948					
Potassium 19 K 39.098	Calcium 20 Ca 40.078	Scandium 21 Sc 44.956	Titanium 22 Ti 47.867	Vanadium 23 V 50.942	Chromium 24 Cr 51.996	Manganese 25 Mn 54.938	Iron 26 Fe 55.845	Cobalt 27 Co 58.933	Nickel 28 Ni 58.693	Copper 29 Cu 63.546	Zinc 30 Zn 65.38	Gallium 31 Ga 69.723	Germanium 32 Ge 72.64	Arsenic 33 As 74.922	Selenium 34 Se 78.96	Bromine 35 Br 79.904	Krypton 36 Kr 83.798					
Rubidium 37 Rb 85.468	Sr 38 Sr 87.62	Yttrium 39 Y 88.906	Zirconium 40 Zr 91.224	Niobium 41 Nb 92.906	Molybdenum 42 Mo 95.96	Technetium 43 Tc [98]	Ruthenium 44 Ru 101.07	Rhodium 45 Rh 106.42	Palladium 46 Pd 106.37	Silver 47 Ag 107.87	Cadmium 48 Cd 112.41	Indium 49 In 114.82	Tin 50 Sn 118.71	Antimony 51 Sb 121.76	Tellurium 52 Te 127.60	Iodine 53 I 126.90	Xenon 54 Xe 131.29					
Cesium 55 Cs 132.91	Barium 56 Ba 137.33	Lanthanum 57 La 138.91	Hafnium 72 Hf 178.49	Tantalum 73 Ta 180.95	Tungsten 74 W 183.84	Rhenium 75 Re 186.21	Osmium 76 Os 190.23	Iridium 77 Ir 192.22	Platinum 78 Pt 195.08	Gold 79 Au 196.97	Mercury 80 Hg 200.59	Thallium 81 Tl 204.38	Lead 82 Pb 207.2	Bismuth 83 Bi 208.98	Polonium 84 Po [209]	Astatine 85 At [210]	Ra 86 Rn [222]					
Radium 88 Ra [226]	Actinium 89 Ac [227]											Francium 87 Fr [223]	Radium 88 Ra [226]	Actinium 89 Ac [227]	Rutherfordium 104 Rf [261]	Dubnium 105 Db [262]	Seaborgium 106 Sg [266]	Bohrium 107 Bh [264]	Hassium 108 Hs [277]	Mtnerium 109 Mt [268]	Darmstadtium 110 Ds [271]	Roentgenium 111 Rg [272]

Cerium 58 Ce 140.13	Praseodymium 59 Pr 140.91	Neodymium 60 Nd 144.24	Promethium 61 Pm [145]	Samarium 62 Sm 150.36	Europium 63 Eu 151.96	Gadolinium 64 Gd 157.25	Terbium 65 Tb 158.93	Dysprosium 66 Dy 162.50	Holmium 67 Ho 164.93	Erbium 68 Er 167.26	Thulium 69 Tm 168.93	Ytterbium 70 Yb 173.05	Lutetium 71 Lu 174.97
Thorium 90 Th 232.04	Protactinium 91 Pa 231.04	Uranium 92 U 238.03	Neptunium 93 Np [237]	Plutonium 94 Pu [244]	Americium 95 Am [243]	Curium 96 Cm [247]	Berkelium 97 Bk [247]	Californium 98 Cf [251]	Einsteinium 99 Es [252]	Fermium 100 Fm [257]	Mendelevium 101 Md [258]	Nobelium 102 No [259]	Lavenderium 103 Lr [262]

Periodic Table of the Elements

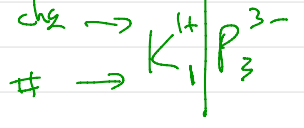
1	2	13	14	15	16	17	18										
1 H 1.008 hydrogen												2 He 4.003 helium					
3 Li 6.94 lithium	4 Be 9.012 beryllium											5 B 10.81 boron	6 C 12.01 carbon	7 N 14.01 nitrogen	8 O 16.00 oxygen	9 F 19.00 fluorine	10 Ne 20.18 neon
11 Na 22.99 sodium	12 Mg 24.31 magnesium											13 Al 26.98 aluminum	14 Si 28.09 silicon	15 P 30.97 phosphorus	16 S 32.06 sulfur	17 Cl 35.45 chlorine	18 Ar 39.95 argon
19 K 39.10 potassium	20 Ca 40.08 calcium	21 Sc 44.96 scandium	22 Ti 47.87 titanium	23 V 50.94 vanadium	24 Cr 52.00 chromium	25 Mn 54.94 manganese	26 Fe 55.85 iron	27 Co 58.93 cobalt	28 Ni 58.69 nickel	29 Cu 63.55 copper	30 Zn 65.38 zinc	31 Ga 69.72 gallium	32 Ge 72.63 germanium	33 As 74.92 arsenic	34 Se 78.97 selenium	35 Br 79.90 bromine	36 Kr 83.80 krypton
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 95.95 molybdenum	43 Tc [97] technetium	44 Ru 101.1 ruthenium	45 Rh 102.9 rhodium	46 Pd 106.4 palladium	47 Ag 107.9 silver	48 Cd 112.4 cadmium	49 In 114.8 indium	50 Sn 118.7 tin	51 Sb 121.8 antimony	52 Te 127.6 tellurium	53 I 126.9 iodine	54 Xe 131.3 xenon
55 Cs 132.9 cesium	56 Ba 137.3 barium	57-71 La-Lu lanthanides	72 Hf 178.5 hafnium	73 Ta 180.9 tantalum	74 W 183.8 tungsten	75 Re 186.2 rhenium	76 Os 190.2 osmium	77 Ir 192.2 iridium	78 Pt 195.1 platinum	79 Au 196.9 gold	80 Hg 200.2 mercury	81 Tl 204.4 thallium	82 Pb 207.2 lead	83 Bi [209] bismuth	84 Po [210] polonium	85 At [210] astatine	86 Rn [222] radon
87 Fr [223] francium	88 Ra [226] radium	89-103 Ac-Lr actinides	104 Rf [261] rutherfordium	105 Db [270] dubnium	106 Sg [271] seaborgium	107 Bh [272] bohrium	108 Hs [277] hassium	109 Mt [276] meitnerium	110 Ds [281] darmstadtium	111 Rg [287] roentgenium	112 Cn [285] copernicium	113 Uut [285] ununtrium	114 Fl [289] flerovium	115 Uup [288] ununpentium	116 Lv [293] livermorium	117 Uus [294] ununseptium	118 Uuo [294] ununoctium

non-metals



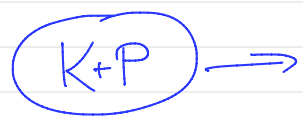
metals

TOTAL $\rightarrow \frac{1}{-9} = -8$

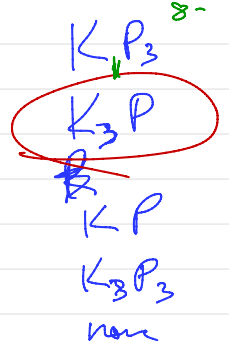
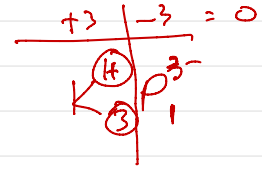
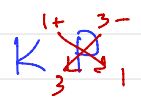
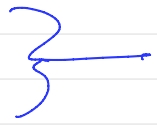
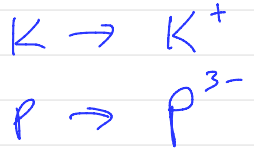


Atomic number \rightarrow 1
 Name \rightarrow hydrogen
 Symbol \rightarrow H
 Atomic mass \rightarrow 1.008

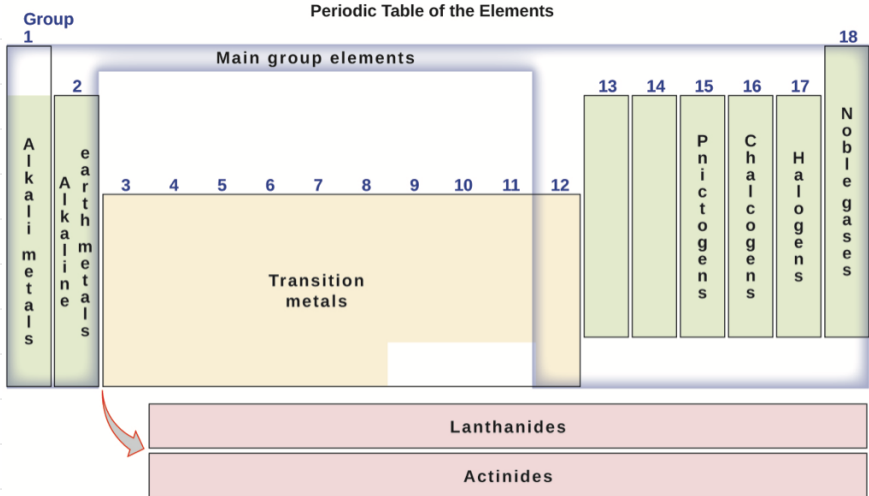
Color Code	
 Metal	 Solid
 Metalloid	 Liquid
 Nonmetal	 Gas



(Representative elements)



Periodic Table of the Elements



Making Molecules From Atoms

ATOMS \leftrightarrow IONS \leftrightarrow MOLECULES

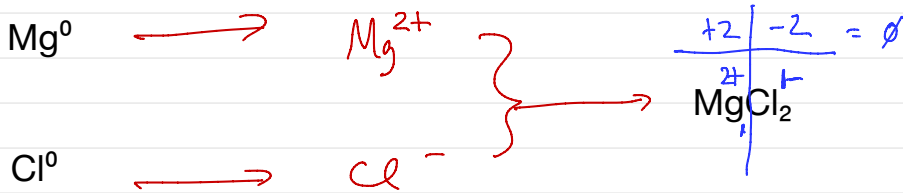
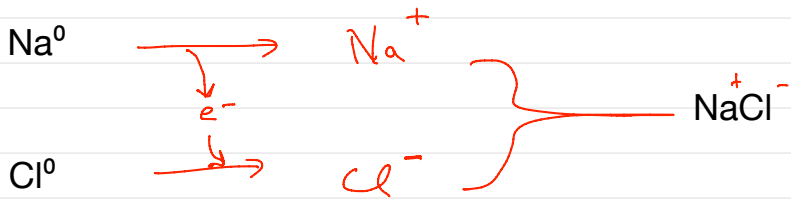
charge
neutral

NOT
charge
neutral

charge
neutral

Mg
+
O

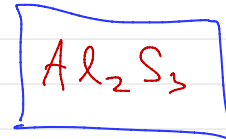
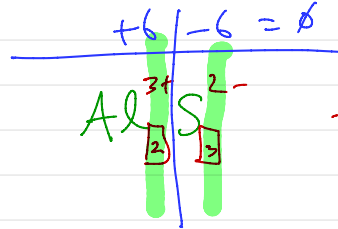
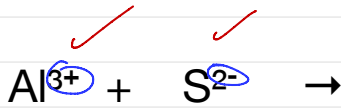
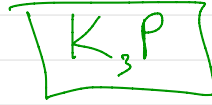
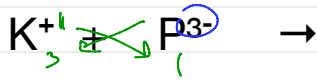
isoelectric
"King's court"



Core Concept

Cross-multiply: det'n charge neutral formulas

For diatomic molecules (2-elements only), if one element has an ODD charge and the other has either an EVEN charge or is equal to 1, then a charge-neutral (correct) formula can be quickly det'n using the elementary math 'trick' of CROSS-MULTIPLICATION.



S

Exam 1 Review Comments

Key Topics

↳ Sig. Figs.

- numbers
- operations
- complex equations

↳ Unit Conversions and Dimensional Analysis

$1.7 \mu\text{L} \rightarrow \boxed{1.7} \mu\text{L}$

↳ Subatomic particles and calculations

- $A - Z = \# \text{neutrons}$
- $Z - \# \text{electrons} = \text{CHG}$

↳ Making charge-neutral compounds from charge-neutral elements

↳ anything else provided in the textbook or notes... above are the key ("big") items only