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What is Chemistry?

Chemistry- study of the structure, properties, and changes of *matter*.

Matter- Anything that has mass and occupies space.

Atom- composed of protons and neutrons (mass) and electrons (occupies space).

2

Structure of the Atom - The Electron

- first *subatomic particle* to be discovered
- The charge on an electron is negative.
 $-1.60217733 \times 10^{-19} \text{ C}$
 this amount of charge is designated as -1
- The mass of an electron is tiny
 $9.19389 \times 10^{-28} \text{ g}$ or 0.00055 amu
 this we will designate as 0 amu

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Structure of the Atom - The Proton

Charge is $+1$
 mass of $1.672623 \times 10^{-24} \text{ g}$
 mass is 1.0087 amu
 This we will call 1 amu

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Structure of the Atom - The Neutron

Deductive reasoning
 uncharged particles
 mass of 1 amu

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Modern View of the Atom

- Very small
- equal number of protons and electrons
- Nucleus: protons and neutrons
- electron cloud
- sports stadium analogy

Subatomic Particle	Charge	Mass	Location
Proton	$+1$	1 amu	Nucleus
Neutron	0	1 amu	Nucleus
Electron	-1	0 amu	cloud

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The *Atomic Number* Indicates the Number of Protons

${}_6\text{C}$

Carbon

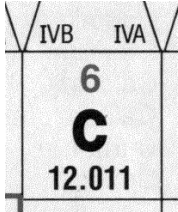
The number of protons determines what element the atom is.

An atom contains an equal number of protons and electrons

IVB	IVA
6	
C	
12.011	

7 The *Mass Number* Indicates the Mass of the Atom

$^{12}_6\text{C}$
Carbon-12



8 Atomic Number and Mass Number Are Used to Determine Number of Neutrons

Atomic number- indicates the number of protons
Mass number- the mass of the atom

$^{12}_6\text{C}$ $^{13}_6\text{C}$ $^{14}_6\text{C}$

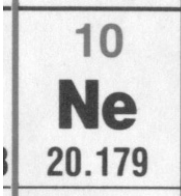
12-6= 6 neutrons 13-6= 7 neutrons

Isotopes- atoms of the same element having different numbers of neutrons.

9 Atomic Mass and Atomic Weight

Atomic Weight- the average mass of the isotopes of an element

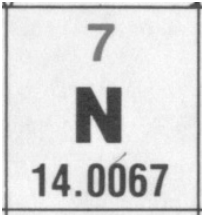
EX: ^{20}Ne ^{21}Ne ^{22}Ne
 90.92% 0.26% 8.82%
 $(0.9092)(20) + (0.0026)(21) + (0.0882)(22)$
 $= 18.184 + 0.0546 + 1.9404$
 $= 20.179$



10 Sample Test Question

1. How many protons, neutrons and electrons are in an atom of ^{41}Ca ?

11 What is the *Percent Composition* of Ammonium Nitrate, NH_4NO_3 ?



N = 14.0
H = 1.0
O = 16.0

12 Development of the Periodic Table

- Properties of elements were known to be similar EX: KCl, NaCl
- atomic masses were different
K=39.10, Na=22.99

How could sense be made of this?
Dmitri Mendeev and Lothar Meyer
Mendeleev predicted the properties of an undiscovered element

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Mendeleev's Periodic Table

Row	Group I R ₂ O	Group II RO	Group III R ₂ O ₃	Group IV RH ₂ RO ₂	Group V RH ₃ R ₂ O ₅	Group VI RH ₂ RO ₃	Group VII RH R ₂ O ₇	Group 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	(Au = 108)	Cd = 112	In = 113	Sn = 118	Sb = 122	Te = 125	I = 127	
8	Cs = 133	Ba = 137	?Di = 138	?Ce = 140				
9								
10			?Er = 178	?La = 180	Ta = 182	W = 184		O ₈ = 195, Ir = 197, Pt = 198, Au = 199
11	(Au = 199)	Hg = 200	Tl = 204	Pb = 207	Bi = 208			
12				Th = 231		U = 240		

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The Modern Periodic Table

Periodic Law- When elements are arranged in the order of their *atomic numbers* their chemical and physical properties show repeating, or periodic, trends.

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Metals and Nonmetals: Dividing line

IIIB	IIIA	IVB	IVA	VB	VIA	VIIA	1.00794 ^A
5 B 10.811 ^A	6 C 12.011	7 N 14.0067	8 O 15.9994 ^F	9 F 18.998403			
13 Al 26.98154	14 Si 28.0855 ^F	15 P 30.97376	16 S 32.066 ^A	17 Cl 35.453			
31 Ga 69.723 ^A	32 Ge 72.59 ^F	33 As 74.9216	34 Se 78.96 ^F	35 Br 79.904			
49 In 114.82	50 Sn 118.710 ^A	51 Sb 121.75 ^F	52 Te 127.60 ^F	53 I 126.9045			
81 Tl 204.383	82 Pb 207.2	83 Bi 208.9804	84 Po (209)	85 At (210)			

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Properties of Metals and Nonmetals

Metal	<i>Metalloid</i>	Nonmetal
solid	<i>intermediate</i>	liquid or gas
shiny	<i>properties</i>	dull
malleable/ductile		brittle
conductive	<i>semiconductors</i>	insulators

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Groups vs. Periods

The image shows a standard periodic table with groups numbered 1 through 18 at the top and periods numbered 1 through 7 on the left side. The elements are arranged in a grid, with noble gases at the far right of each period.

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Group	Name
IA	Alkali metals
IIA	Alkaline earth metals
IIIA	
IVA	
VA	
VIA	(Chalcogens)
VIIA	Halogens
VIIIA	Noble gases
Transition Elements	
	Lanthanides
	Actinides

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Physical Periodicity

- size
- ionization energy- the amount of energy it takes to remove an electron from an atom
- electronegativity- how tightly an atom pulls on another atoms electrons
- melting point/boiling point

Know these four trends!

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Electron Arrangements in Atoms

- Electrons are very important in determining how elements react.
- Light is used to figure out where e^- are located

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Principle Energy Levels

- 1-7

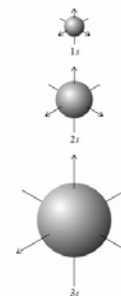


Fig. 2.12 Blei and Odian

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Electron Orbital Shapes

- s- sphere
- p- hourglass shaped, go in 3 directions (x, y, z)
- d and f shapes beyond our scope

These shapes tell us only the probability of where an electron will be found, not what its path looks like.

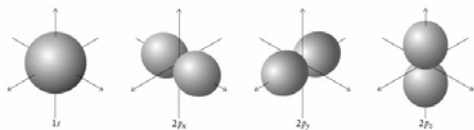


Fig. 2.11 Blei and Odian

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The Maximum Number of Electrons in an *Orbital* Is 2

- s hold 2
- p hold 6 (x, y and z)
- d and f hold 10 and 14

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Electron Configurations

1. The Aufbau Principle- e^- occupy the lowest energy level possible
2. Spin-pair rule- two e^- on same level, opposite directions
3. Hunds Rule- e^- in partially filled sublevels spread out to occupy as many orbitals as possible

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Valence Electrons in Yellow: Groups Have Similar Electron Configuration

H	$1s^1$		
He	$1s^2$	full	Noble gas
Li	$1s^2, 2s^1$		
Be	$1s^2, 2s^2$		
B	$1s^2, 2s^2, 2p^1$		
C	$1s^2, 2s^2, 2p^2$		
N	$1s^2, 2s^2, 2p^3$		
O	$1s^2, 2s^2, 2p^4$		
F	$1s^2, 2s^2, 2p^5$		
Ne	$1s^2, 2s^2, 2p^6$	full	Noble gas

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Sample Test Question

What is the electron configuration of calcium-41?

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Lewis Dot Structures

Outer shell (no matter what level) termed valence e^-

Valence e^- are symbolized by dots around element symbol.

Elements in the same group have the same number of valence e^-

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Group	Name	valence e^-
IA	Alkali metals	1
IIA	Alkaline earth metals	2
IIIA		3
IVA		4
VA		5
VIA	Chalcogens	6
VIIA	Halogens	7
VIIIA	Noble gases	8
	Transition Elements	2*

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Oxidation State

Oxidation State- The charge that develops on an atom due to loss or gain of e^- .

Atoms A and B, while strolling idly down the street, broke into the following exchange:

Atom A : "I think I've lost an electron."

Atom B : "Are you sure?"

Atom A : "I'm positive!"

Group	Name	valence e ⁻	oxidation state
IA	Alkali metals	1	+1
IIA	Alkaline earth metals	2	+2
IIIA		3	+3
IVA		4	±4
VA		5	-3
VIA	Chalcogens	6	-2
VIIA	Halogens	7	-1
VIIIA	Noble gases	8	0
	Transition Elements	2*	+1,+2,+3

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Sample Test Questions

1. Which is larger, an atom of He or Fe?
2. Name two groups of the periodic table.
3. What is the e⁻ configuration of the following:
He Be²⁺ F⁻
4. What is the Lewis dot structure for F? for F⁻?