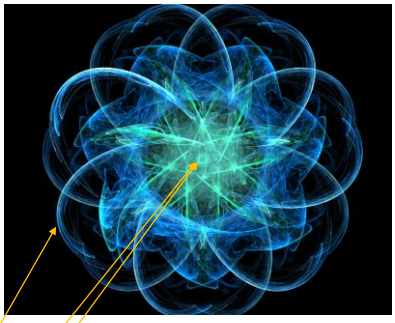
The atom



SUBATOMIC PARTICLE	SYMBOL	LOCATION	RELATIVE CHARGE	RELATIVE MASS
electron	e^-	outside nucleus	−1	1/1836
proton	p^+	inside nucleus	+1	1
neutron	n^0	inside nucleus	0	1

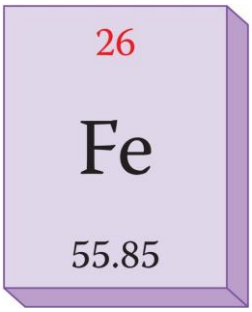
1

Atomic Notation

mass number (p^+ and n^0)

atomic number (p^+)

$^{A}_{Z}Sy$ — symbol of the element



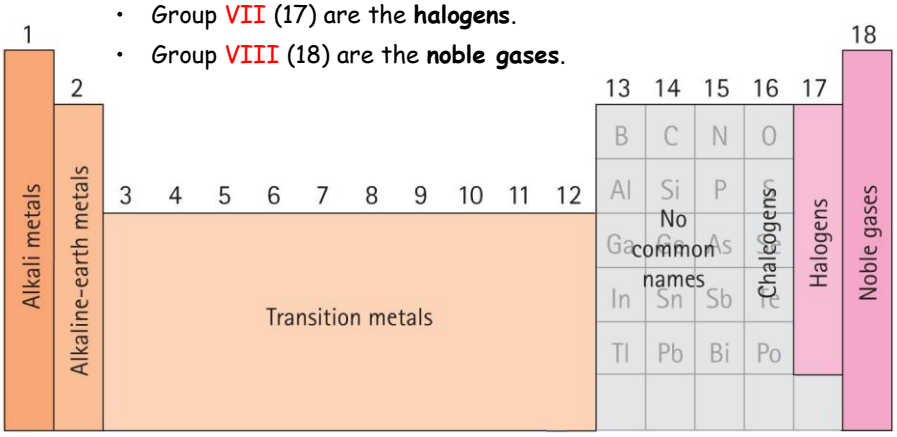
Periodic Table Notation

2

Common Names of Groups (Families)

Several families have common trivial names.

- Group I are the **alkali** metals.
- Group II are the **alkaline** earth metals.
- Group VII (17) are the **halogens**.
- Group VIII (18) are the **noble gases**.



3

Valence Electrons

Stability → Octet

IA 1	IIA 2	IIIB 3	IVB 4	VB 5	VIB 6	VIIB 7	VIII 8	VIII 9	VIII 10	IB 11	IIB 12	IIIA 13	IVA 14	VA 15	VIA 16	VIIA 17	VIIIA 18
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 24.31	21 Sc 44.96	22 Ti 47.88	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 65.39	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	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc (99)	44 Ru 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	31 Ga 69.72	32 Ge 72.61	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	57 La 138.91	72 Hf 178.49	73 Ta 180.95	74 W 183.85	75 Re 186.21	76 Os 190.2	77 Ir 192.22	78 Pt 195.08	79 Au 196.97	80 Hg 200.59	49 In 114.82	50 Sn 118.71	51 Sb 121.75	52 Te 127.60	53 I 126.90	54 Xe 131.29
55 Cs 132.91	56 Ba 137.33	89 Ac (227)	104 Rf (261)	105 Db (262)	106 Sg (263)	107 Bh (262)	108 Hs (265)	109 Mt (266)	110 Ds (271)	111 Rg (272)	112 -- (277)	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)												114 -- (285)		116 -- (289)		

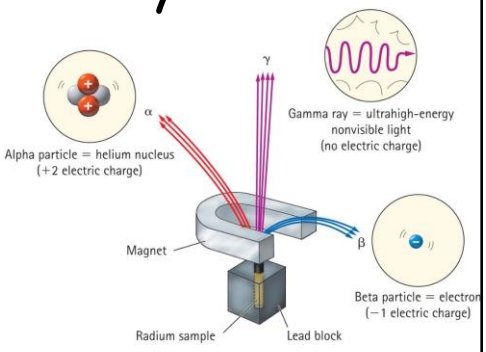
58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm (147)	62 Sm 150.36	63 Eu 151.97	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.04	71 Lu 174.97
90 Th (232)	91 Pa (231)	92 U (238)	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (260)

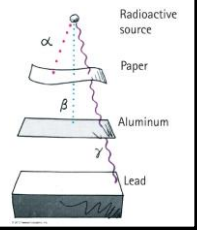
4

Radioactivity

Types of radiation:

- alpha (α)
  carries positive electrical charge
- beta (β)
  carries negative electrical charge
- gamma (γ)
  carries no charge

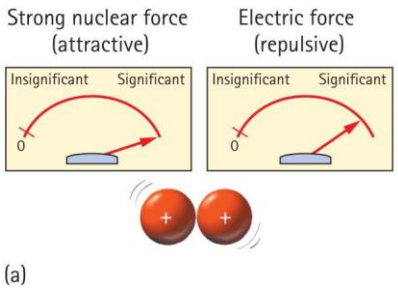


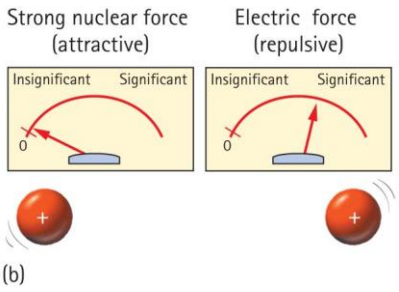


5

The Atomic Nucleus and the Strong Nuclear Force

The strong nuclear force **:** a very distance sensitive attraction between nucleons.





6

Half-Life and Transmutation

Natural transmutation:

Alpha emission from a nucleus:

- *mass number decreases by 4*
- *atomic number decreases by 2*
- resulting atom belongs to an element two places back in periodic table

Naturally

$^{238}_{92}U \rightarrow {}^{234}_{90}Th + {}^{4}_{2}He$

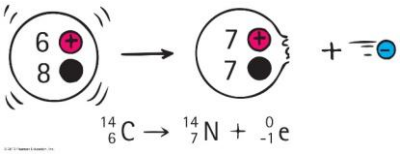
7

Half-Life and Transmutation

Naturally

Beta emission from a nucleus:

- no change in mass number—no loss in nucleons
- *atomic number increases by 1*
- resulting atom belongs to an element one place forward in periodic table



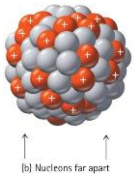
$^{14}_{6}C \rightarrow {}^{14}_{7}N + {}^{0}_{-1}e$

Gamma emission from a nucleus:

- no change in mass number
- no change in atomic number

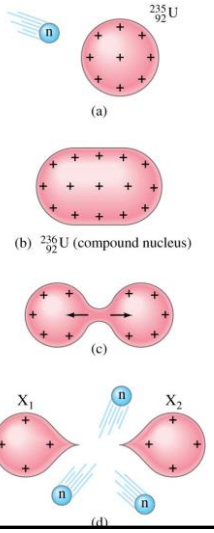
8

Nuclear Fission



After absorbing a neutron, a uranium-235 nucleus will split into two roughly equal parts.

One way to visualize this is to view the nucleus as a kind of liquid drop.

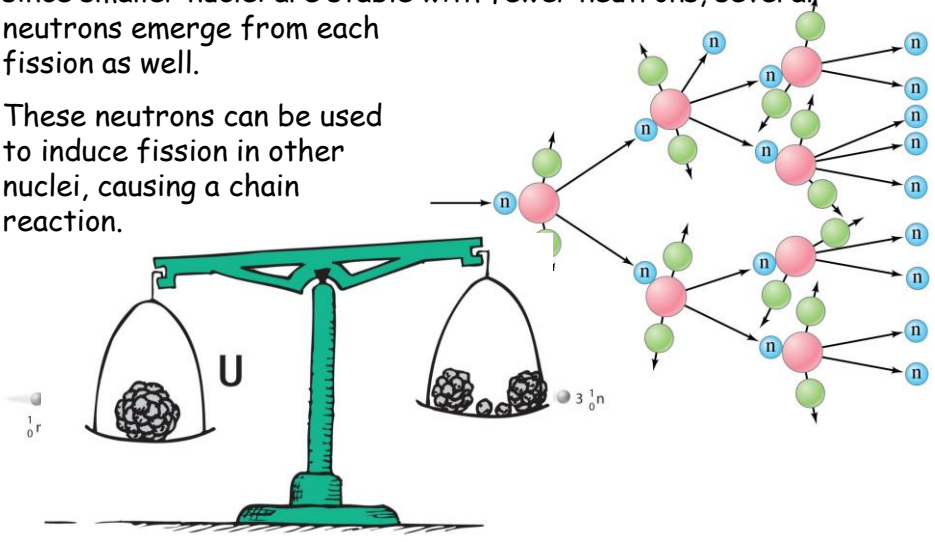


9

Nuclear Fission

The energy release in a fission reaction is quite large. Also, since smaller nuclei are stable with fewer neutrons, several neutrons emerge from each fission as well.

These neutrons can be used to induce fission in other nuclei, causing a chain reaction.



10

Mass-Energy Equivalence: $E = mc^2$

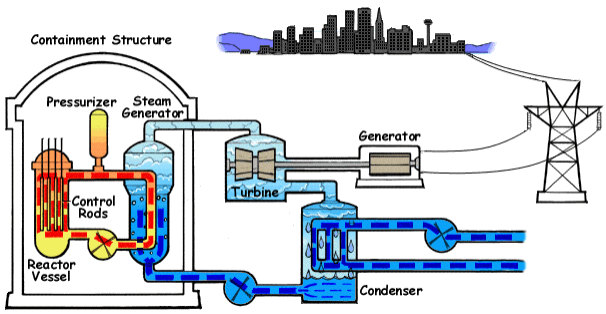
Albert Einstein in the early 1900s:

- discovered that mass is congealed energy.
- formulated the famous equation, $E = mc^2$, which is the key to understanding why and how energy is released in nuclear reactions.

11

Nuclear Fission; Nuclear Reactors

Rancho Seco
Nuclear Generating Station
SMUD



12

Half-Life and Transmutation

Half-life:

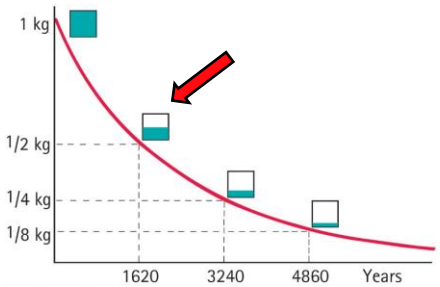
- is the *rate of decay* for a *radioactive isotope*.
- is the time required for *half of an original quantity* of an element to decay.
- is *constant* and independent of any physical or chemical change the atom may undergo.
- *can be calculated* at any given moment by measuring the rate of decay of a known quantity using a radiation detector.

13

Half-Life and Transmutation

Radioactive isotopes decay at a rate characteristic of each isotope. Rates are described by half-life.

The shorter the half-life of a substance ⇒ the faster it disintegrates and the more active the substance.



14

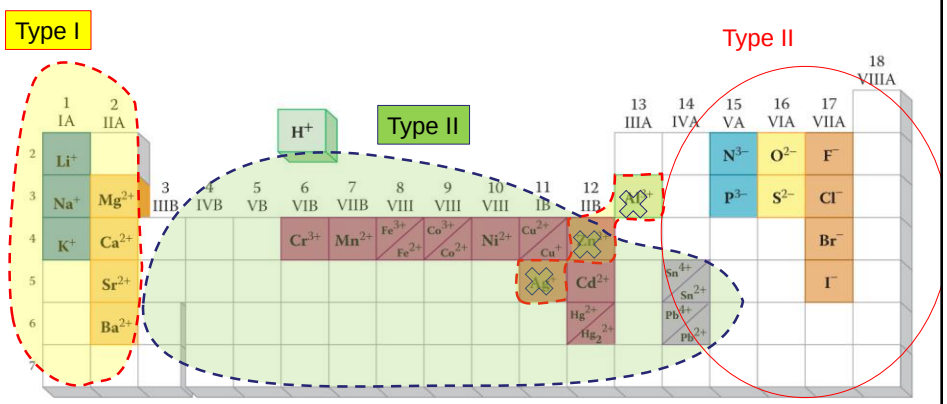
Nomenclature----IUPAC

- The **I**nternational **U**nion of **P**ure and **A**pplied **C**hemistry, IUPAC, has set rules for naming compounds.
- IUPAC set the rules for the naming and classification of inorganic compounds in 1940.
- These rules, referred to as ***IUPAC nomenclature***, are still in use today.

15

Nomenclature ->Binary--- X_y

- Shown are the elements on the periodic table and their common charges.



16

Nomenclature (binary compounds)

Type I
Metal + nonmetal

The metal has only one charge and takes the name of the element

Ending changes to -ide

Example:
KCl Potassium chloride
$MgBr_2$ Magnesium bromide

Common Type I cations

Alkali,
Alkaline
Al^{3+},
Ag^{+},
Zn^{2+}

Type II
Metal + nonmetal

The metal has a variable oxidation state (different charge). A Roman number indicates the charge

Ending changes to -ide

Examples: CuBr Copper(I) bromide
FeS Iron(II) sulfide

Table 5.2 Common Type II Cations

Ion	Systematic Name
Fe^{3+}	iron(III)
Fe^{2+}	iron(II)
Cu^{2+}	copper(II)
Cu^{+}	copper(I)
Co^{3+}	cobalt(III)
Co^{2+}	cobalt(II)
Sn^{4+}	tin(IV)
Sn^{2+}	tin(II)
Pb^{4+}	lead(IV)
Pb^{2+}	lead(II)
Hg^{2+}	mercury(II)
Hg_2^{2+}*	mercury(I)

*Mercury(I) ions always occur bound together in p

Type III
nonmetal + nonmetal

For nonmetal+nonmetal, prefixes indicate the number of atoms.

Ending changes to -ide

Example: tetranitrogen nonachloride
Step 1: N_4
Step 2: N_4Cl_9

Example: O_2F
Step 1: dioxygen
Step 2: dioxygen monofluoride

Prefixes
1 – mono
2 – di
3 – tri
4 – tetra
5 – penta
6 – hexa
7 – hepta
8 – octa
9 – nona
10 - deca

17

Rules for Writing Lewis Structures

1) **Count the total number of valence e^-**
Notes: Add one more electron for each negative charge in the composition. Subtract one electron for each positive charge in the composition.

2) **Write the skeleton structure**
Notes: -Element that needs the most e^- go in the center
-H are terminal atoms
-Least electronegative atom go on the center

3) **Use two electrons to connect elements**

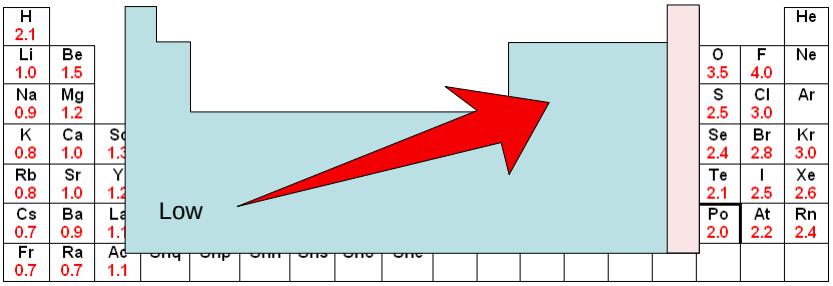
4) **Complete octets by distributing the remaining e^-**

5) **Make double or triple bonds if octets not complete**

18

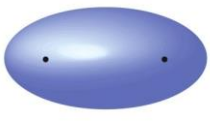
Polar Covalent Bonds

- **Electronegativity:** The ability of a bonded atom to pull on shared electrons. Greater electronegativity means greater "pulling power."



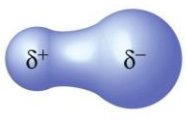
19

- The polarity of a **bond** depends on the difference between the electronegativity (EN) values of the atoms forming the bond.



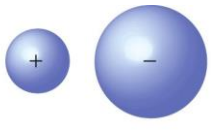
a

A covalent bond formed between identical atoms.



b

A polar covalent bond, with both ionic and covalent components



c

An ionic bond, with no electron sharing.

If | $EN_{atom1} - EN_{atom2}$ | is:

EN < 0.5
nonpolar

1.7 > EN ≥ 0.5
polar

EN ≥ 1.7
ionic

Symmetry

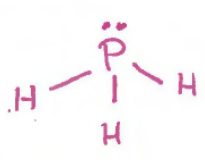
Non- Symmetric

20

LDS and Polarity

1) N_2  Non-Polar

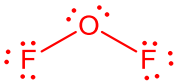
2) CS_2  Non-Polar

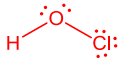
3) PH_3  Polar

22

LDS and polarity

1) C_2H_2  Non-Polar

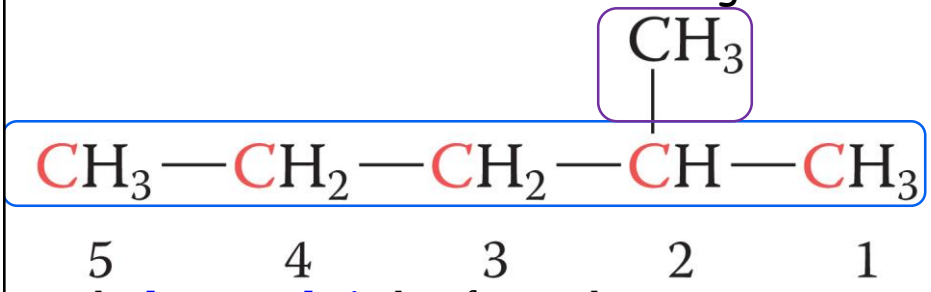
2) OF_2  Polar

3) HOCl  Polar

23

Nomenclature of Alkanes

- What is the name of the following alkane?

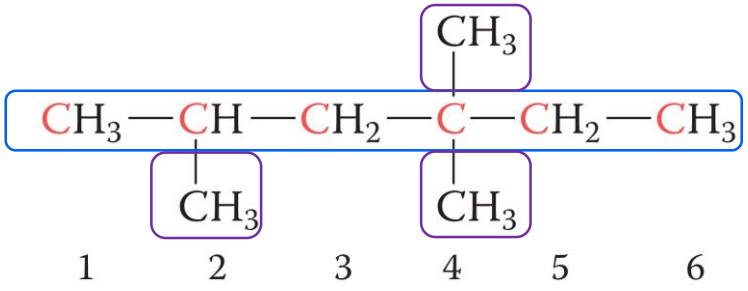


- The **longest chain** has five carbons, so it is a *pentane* derivative. The **methyl group** is in the 2 position.
- The name is 2-methylpentane.

24

Nomenclature of Alkanes, Continued

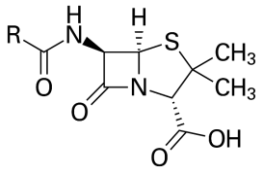
- What is the name of the following alkane?



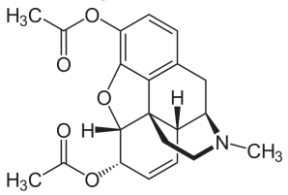
- The longest chain has six carbons, so it is a *hexane* derivative. The methyl groups are in the 2, 4, and 4 positions.
- The name is 2,4,4-trimethylhexane.

25

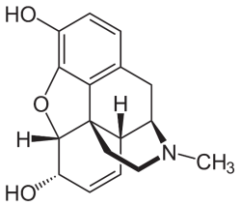
Functional Groups



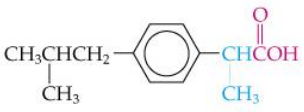
Penicillin



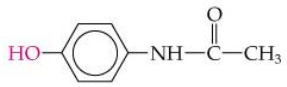
Heroin



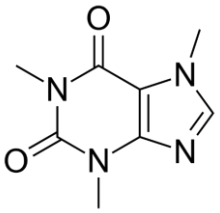
Morphine



Ibuprofen



Acetaminophen

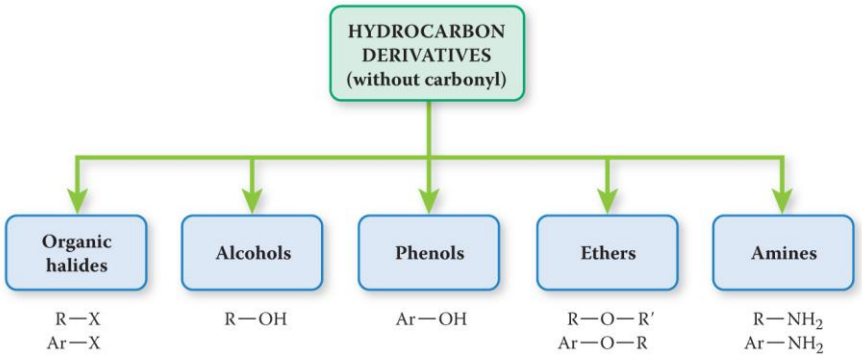


Caffeine

26

Non-Carbonyl Hydrocarbon Derivatives

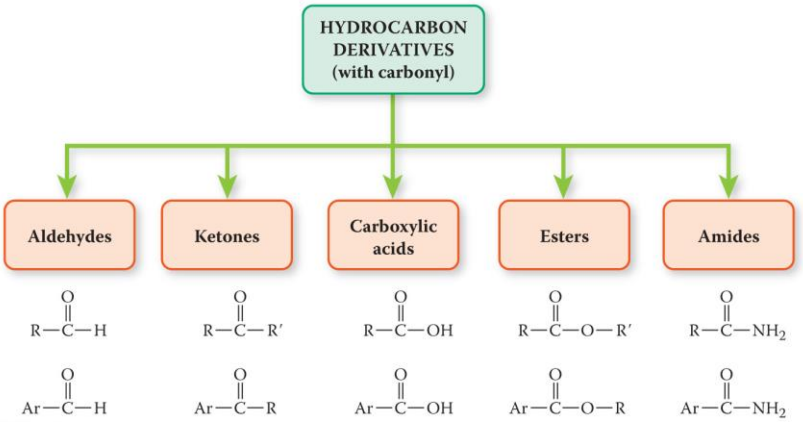
- Here are the basic hydrocarbon classes without carbonyl groups. R is an alkyl group and Ar is an aryl group.



27

Carbonyl Hydrocarbon Derivatives

- Here are the basic hydrocarbon classes with carbonyl groups. R is an alkyl group and Ar is an aryl group.



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