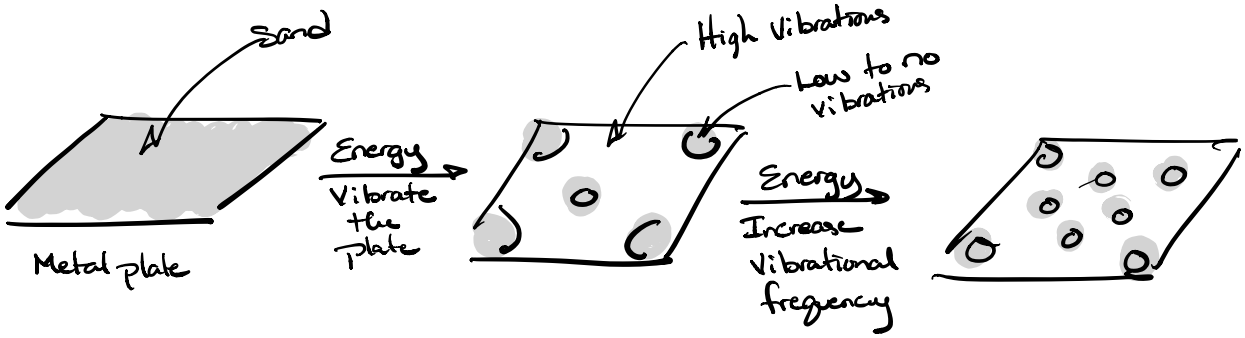
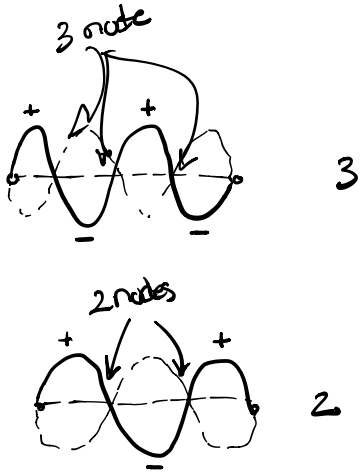
Electronic Configurations



Standing Waves

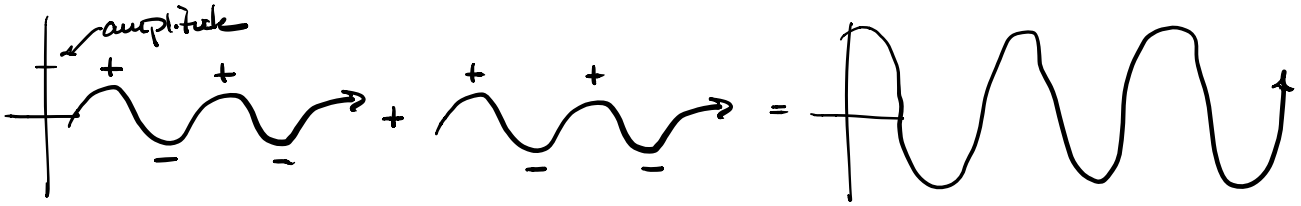


Traveling Wave
Electromagnetic
Radiation

fixed String
bound on both Sides

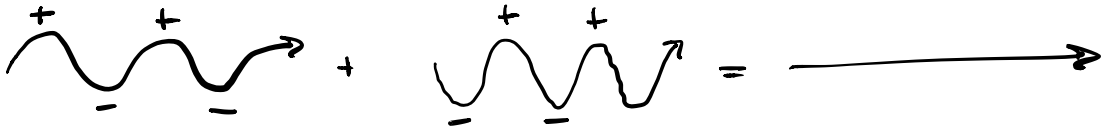
Interference

Constructive



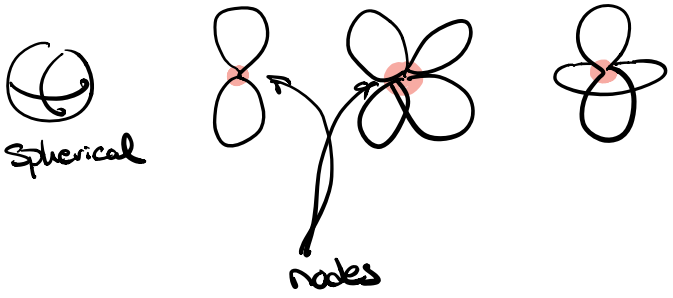
In-phase → addition is constructive

Destructive



out of phase
opposite in-phase = addition is destructive

Electrons have 3D standing waves



Electrons are defined by 4 Quantum Numbers
(properties of the electron)

n principle quantum number (Shell or level)

l azimuthal quantum number (Subshell or Sub level)
(orbital angular momentum)

m_l Magnetic quantum number (orbital)

m_s Spin quantum number (Spin)

$$\langle n, l, m_l, m_s \rangle$$

no 2 e^- can have the same 4 numbers

$\Rightarrow$ no 2e^- can reside within the same place with the same energy in the atom.

Allowable Values

Principle quantum # $n = 1, 2, 3, 4, \ldots$ Integer Value

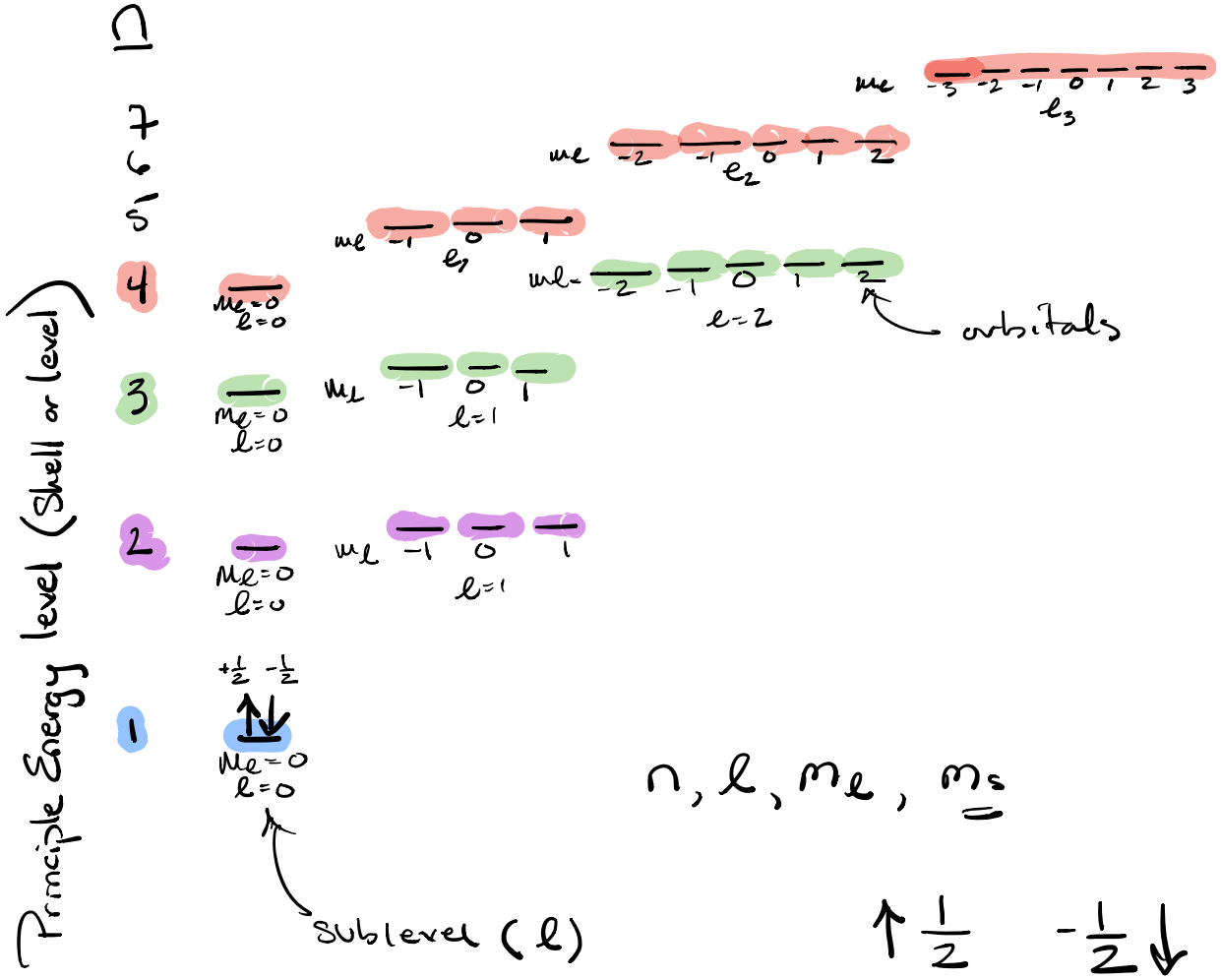
Azimuthal quantum # ℓ = Can be 0 upto $(n-1)$

n	ℓ
1	0
2	0 or 1
3	0 or 1 or 2

Magnetic quantum # $m_\ell = -\ell - 0 - +\ell$ Interger Values

ℓ	m_ℓ
0	0
1	$-1, 0, +1$
2	$-2, -1, 0, 1, 2$
3	$-3, -2, -1, 0, 1, 2, 3$

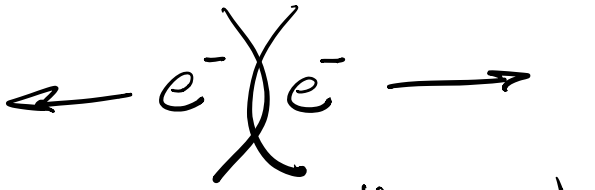
Spin quantum # $= m_s = +\frac{1}{2}$ or $-\frac{1}{2}$

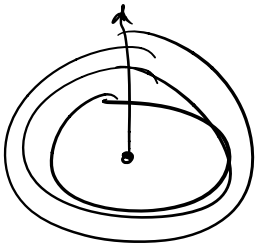


n, ℓ, m_ℓ, m_s

$\uparrow \frac{1}{2}$ up $-\frac{1}{2} \downarrow$ down

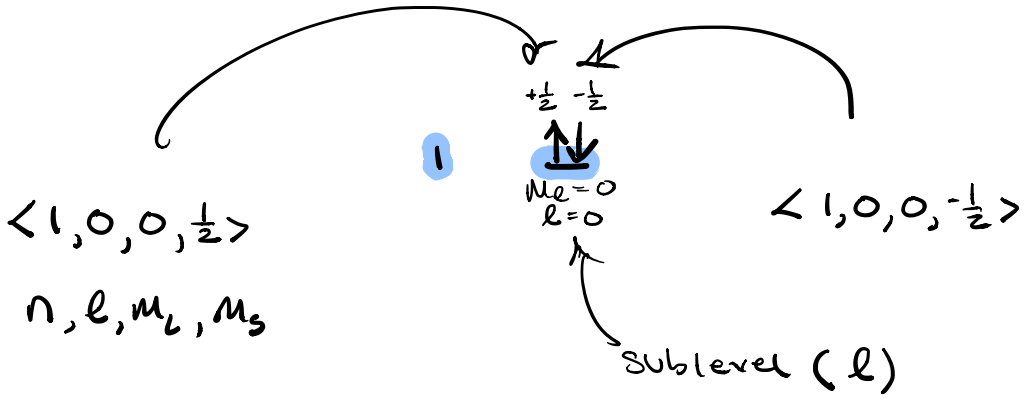
- nucleus



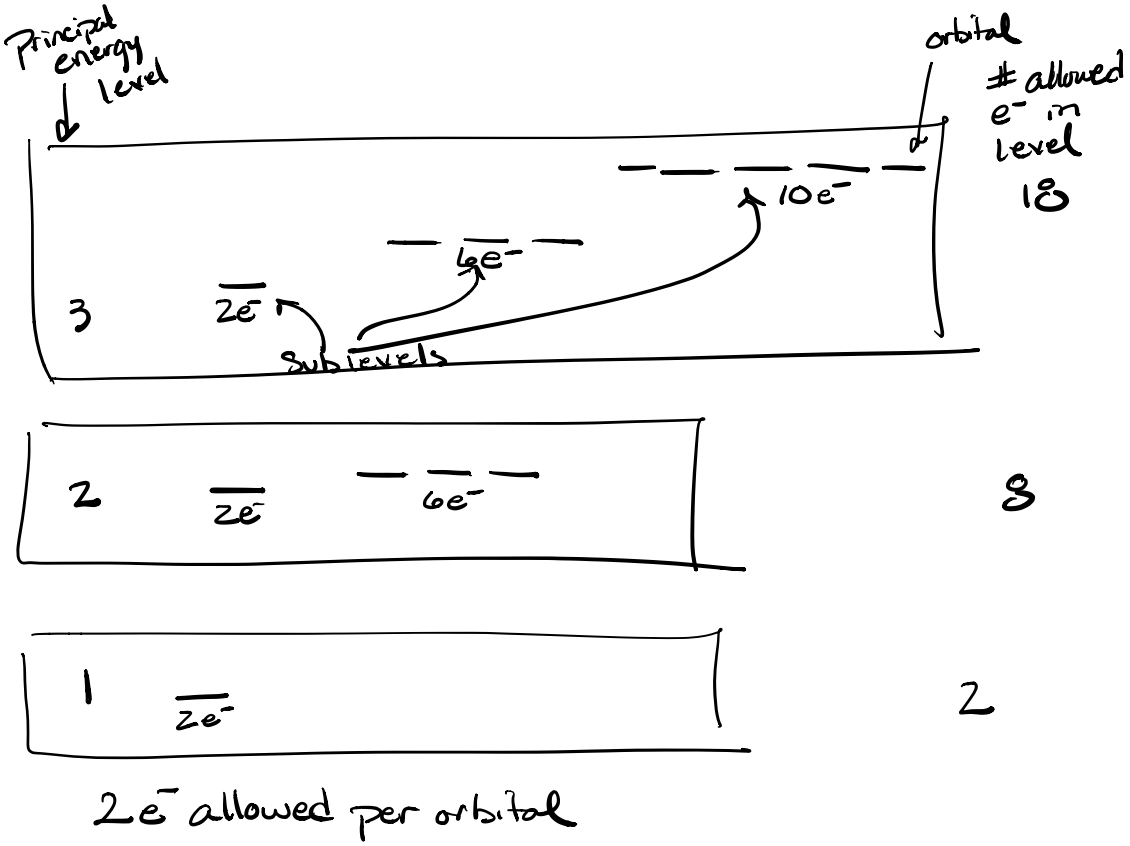


$\uparrow \frac{1}{2}$ e^- e^- $-\frac{1}{2} \downarrow$

Repel less



Each e⁻ gets unique set of 4 numbers



2e⁻ allowed per orbital

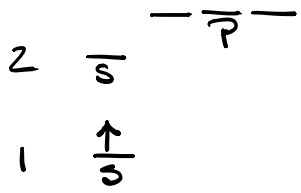
n

Periods in table = Principle Energy level (Shell)

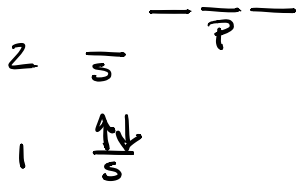
1 1A																	18 8A
1 H Hydrogen 1.008	2 2A											13 3A	14 4A	15 5A	16 6A	17 7A	2 He Helium 4.003
3 Li Lithium 6.941	4 Be Beryllium 9.012											5 B Boron 10.81	6 C Carbon 12.01	7 N Nitrogen 14.01	8 O Oxygen 16.00	9 F Fluorine 19.00	10 Ne Neon 20.18
11 Na Sodium 22.99	12 Mg Magnesium 24.30	3 3B	4 4B	5 5B	6 6B	7 7B	8 8B	9 8B	10 8B	11 1B	12 2B	13 Al Aluminum 26.98	14 Si Silicon 28.09	15 P Phosphorus 30.97	16 S Sulfur 32.07	17 Cl Chlorine 35.45	18 Ar Argon 39.95
19 K Potassium 39.10	20 Ca Calcium 40.08	21 Sc Scandium 44.96	22 Ti Titanium 47.87	23 V Vanadium 50.94	24 Cr Chromium 52.00	25 Mn Manganese 54.94	26 Fe Iron 55.84	27 Co Cobalt 58.93	28 Ni Nickel 58.69	29 Cu Copper 63.55	30 Zn Zinc 65.41	31 Ga Gallium 69.72	32 Ge Germanium 72.64	33 As Arsenic 74.92	34 Se Selenium 78.96	35 Br Bromine 79.90	36 Kr Krypton 83.80
37 Rb Rubidium 85.47	38 Sr Strontium 87.62	39 Y Yttrium 88.91	40 Zr Zirconium 91.22	41 Nb Niobium 92.91	42 Mo Molybdenum 95.94	43 Tc Technetium (98)	44 Ru Ruthenium 101.1	45 Rh Rhodium 102.9	46 Pd Palladium 106.4	47 Ag Silver 107.9	48 Cd Cadmium 112.4	49 In Indium 114.8	50 Sn Tin 118.7	51 Sb Antimony 121.8	52 Te Tellurium 127.6	53 I Iodine 126.9	54 Xe Xenon 131.3
55 Cs Cesium 132.9	56 Ba Barium 137.3		72 Hf Hafnium 178.5	73 Ta Tantalum 180.9	74 W Tungsten 183.8	75 Re Rhenium 186.2	76 Os Osmium 190.2	77 Ir Iridium 192.2	78 Pt Platinum 195.1	79 Au Gold 197.0	80 Hg Mercury 200.6	81 Tl Thallium 204.4	82 Pb Lead 207.2	83 Bi Bismuth 209.0	84 Po Polonium (209)	85 At Astatine (210)	86 Rn Radon (222)
87 Fr Francium (223)	88 Ra Radium (226)		104 Rf Rutherfordium (261)	105 Db Dubnium (262)	106 Sg Seaborgium (266)	107 Bh Bohrium (264)	108 Hs Hassium (277)	109 Mt Meitnerium (268)	110 Ds Darmstadtium (281)	111 Rg Roentgenium (272)	112 Cn Copernicium (285)	113 Nh Nihonium (284)	114 Fl Flerovium (289)	115 Mc Moscovium (288)	116 Lv Livermorium (289)	117 Ts Tennessine	118 Og Oganesson
	Lanthanides		57 La Lanthanum 138.9	58 Ce Cerium 140.1	59 Pr Praseodymium 140.9	60 Nd Neodymium 144.2	61 Pm Promethium (145)	62 Sm Samarium 150.4	63 Eu Europium 152.0	64 Gd Gadolinium 157.2	65 Tb Terbium 158.9	66 Dy Dysprosium 162.5	67 Ho Holmium 164.9	68 Er Erbium 167.3	69 Tm Thulium 168.9	70 Yb Ytterbium 173.0	71 Lu Lutetium 175.0
	Actinides		89 Ac Actinium (227)	90 Th Thorium 232.0	91 Pa Protactinium 231.0	92 U Uranium 238.0	93 Np Neptunium (237)	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 (262)

Pure Appl.Chem., Vol.85, pp.1047–1078, 2013.
Values rounded to four significant figures

H



He

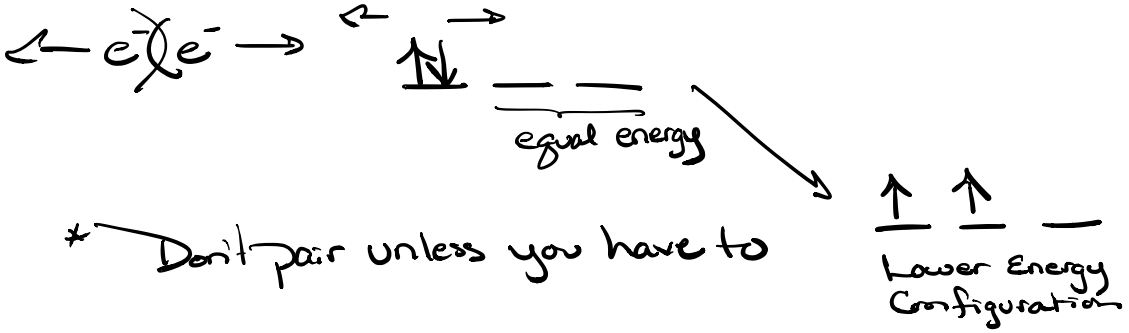


Rules for filling Energy Diagrams

① Electrons fill from the bottom up. Fill the lowest possible orbital fist befor moving to the next level up.

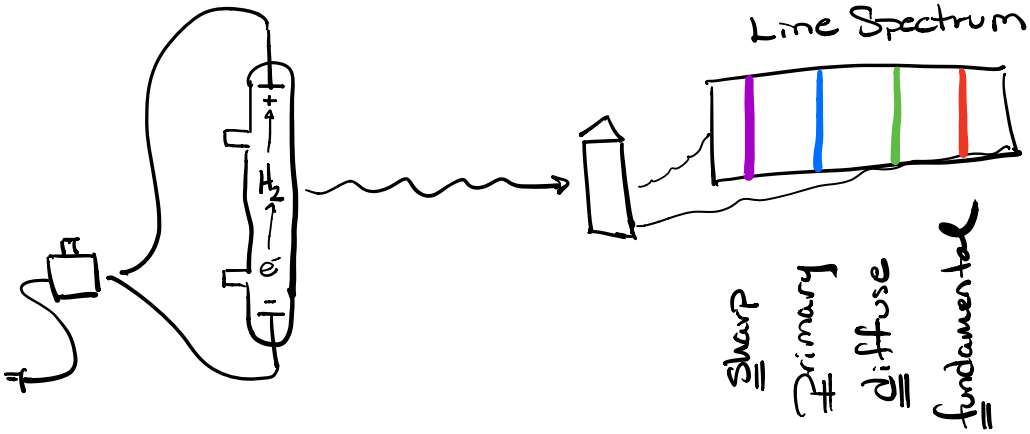
② Each orbital can hold $2e^-$, one spin up the other spin down. Paired e^- must have opposite spins

③ For orbitals of the same energy, electrons will spread out half filling each orbital until all orbitals are half filled

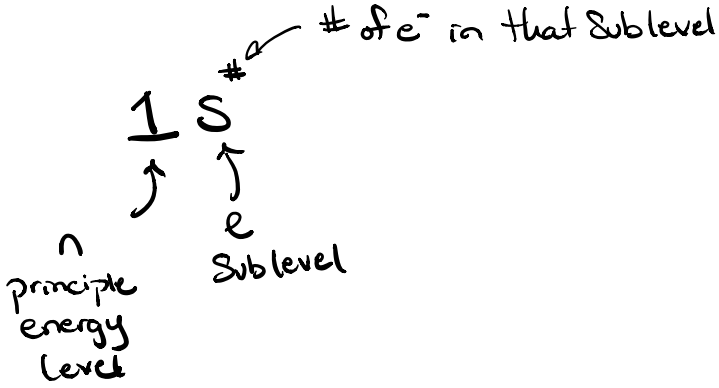


* Don't pair unless you have to

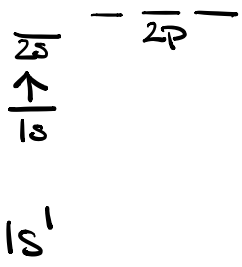
Gas Discharge Tube



Short hand notation

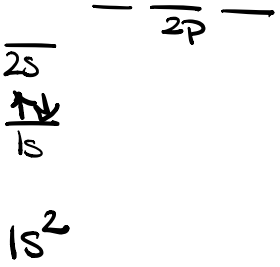


H

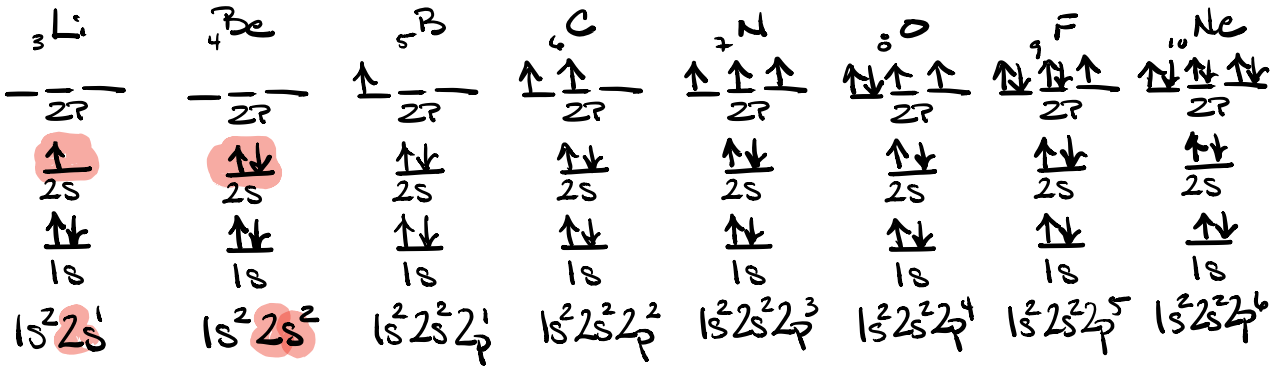


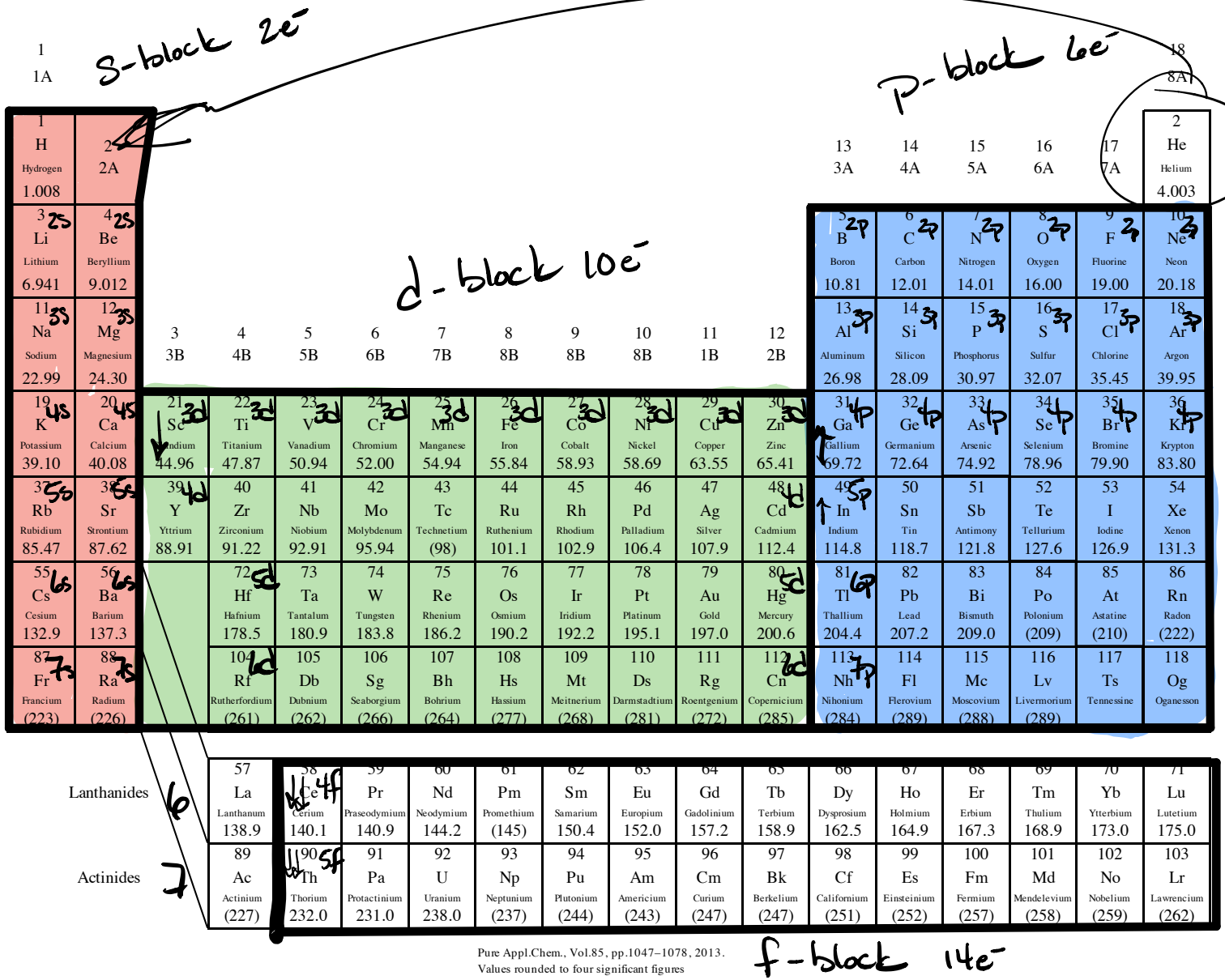
$1s^1$

He

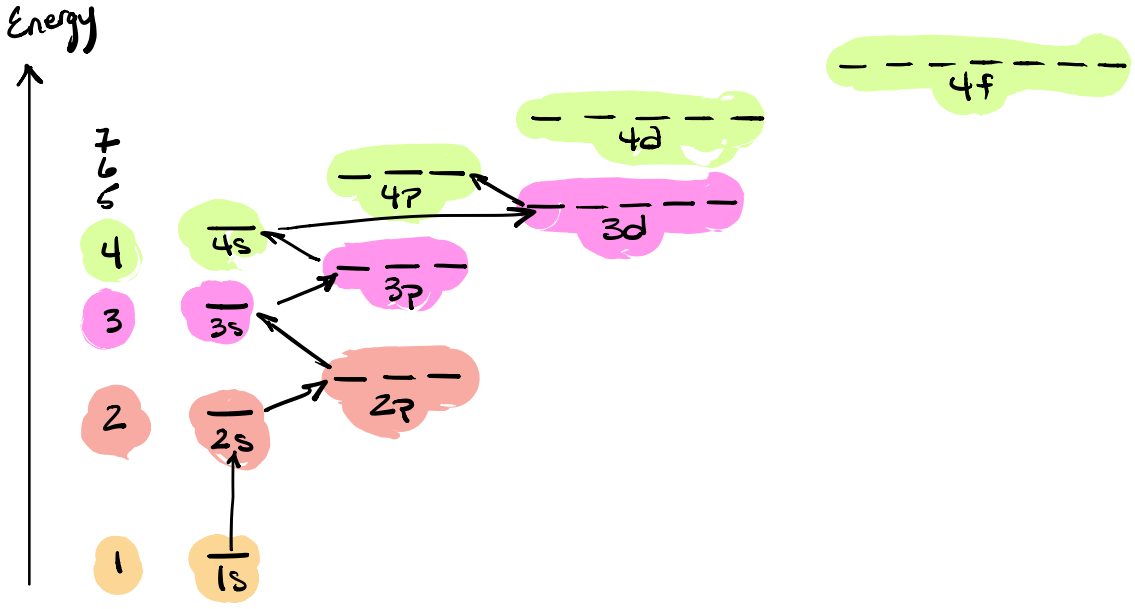


$1s^2$


3Li
4Be
5B
6C
7N
8O
9F
10Ne
2p
2s
1s
1s2 2s1
1s2 2s2
1s2 2s2 2p1
1s2 2s2 2p2
1s2 2s2 2p3
1s2 2s2 2p4
1s2 2s2 2p5
1s2 2s2 2p6

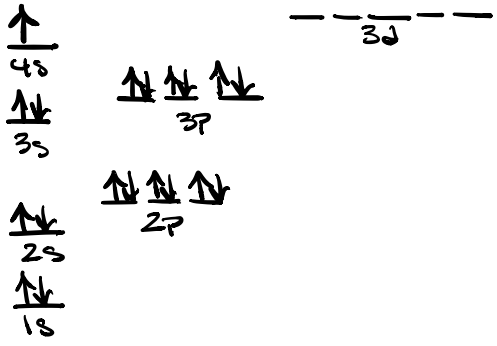


Pure Appl.Chem., Vol.85, pp.1047–1078, 2013.
Values rounded to four significant figures



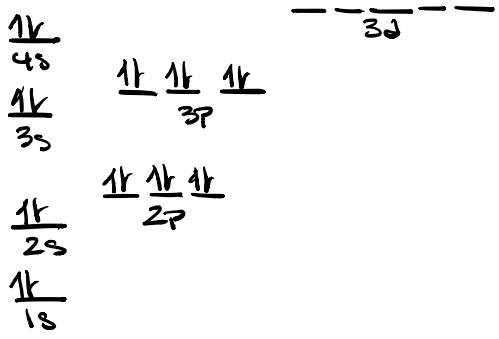
- nucleus

$_{19}K$



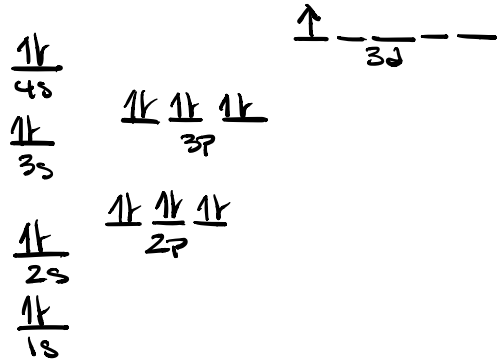
$1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$

$_{20}Ca$



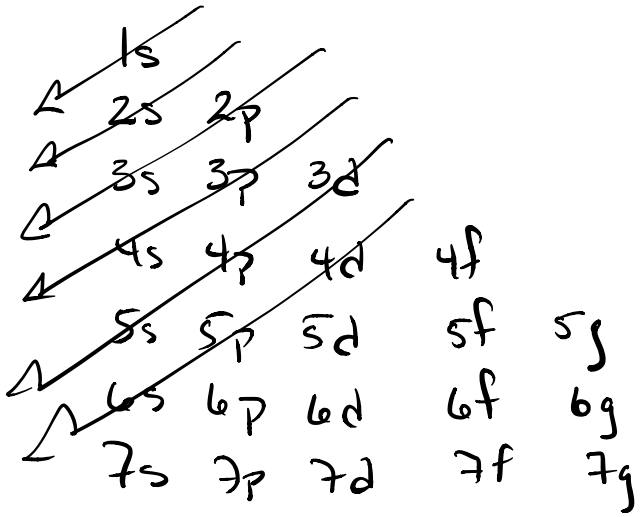
$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$

21 Sc



$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^1$

Filling Order



1s 2s 2p 3s 3p 4s 3d 4p 5s 4d 5p 6s

filling order