Ions – An element with more or less e^- than the number of protons.

Neutral Element

$_{53}I^{\phi} + e^- \longrightarrow {}_{53}I^{-}$

Ion ← Charge

#p 53 = 53+	#p 53 = 53+
#e^- 53 = 53−	#e^- 54 = 54−
net charge = 0	net charge = 1−

Cation – Positive ion, results from less e^- than total protons

Anion – negative ion results from more e^- than total protons

Anions

O^{2-}, N^{3-}, F^-

1−, 2−, 3−

Cations

Na^+, Fe^{3+}, Co^{2+}

Cr^{6+}, Mn^{7+}

1+, 2+ ... 7+

$^{7+}_{25}Mn$

#p 25^{+} = 25+

#e^- = $18e^-$

To find #e^-

25_p - 7+ charge

= $18e^-$

25^+

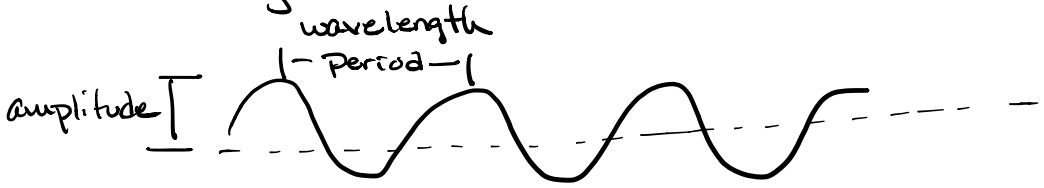
18^-

net charge 7+

Never change # of p

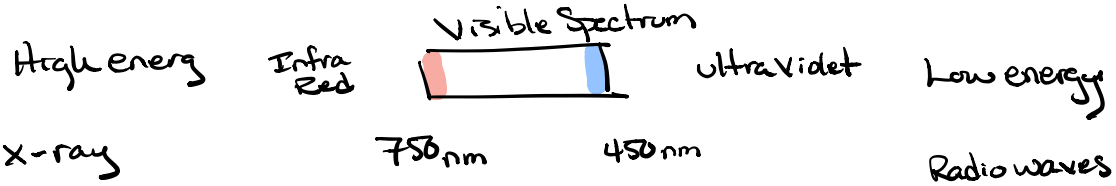
Chapter 3 ⇒ Electronic Configurations

Electromagnetic radiation

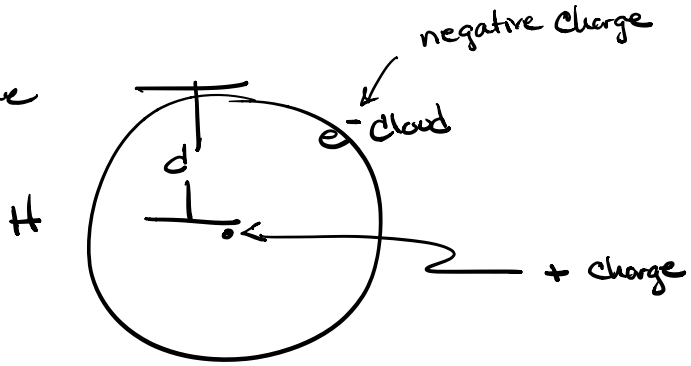


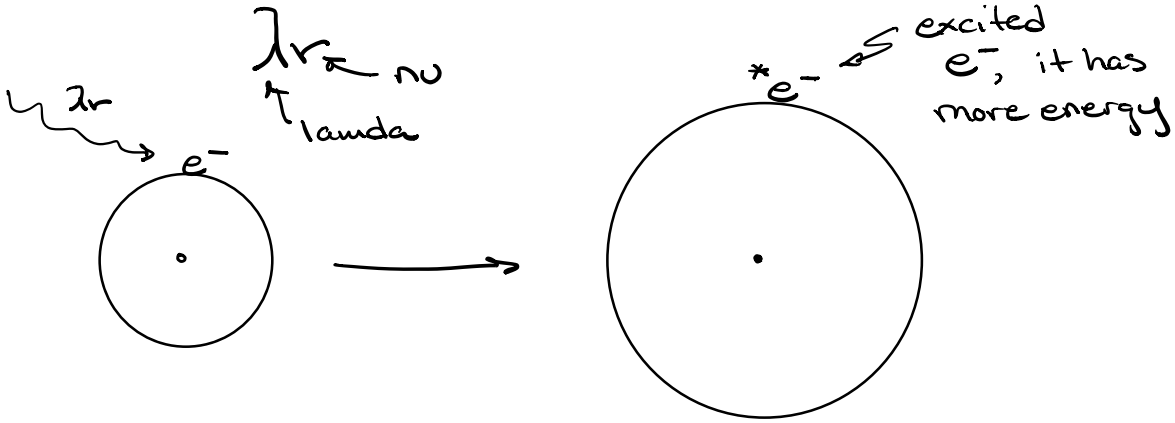
Energy ∝ period

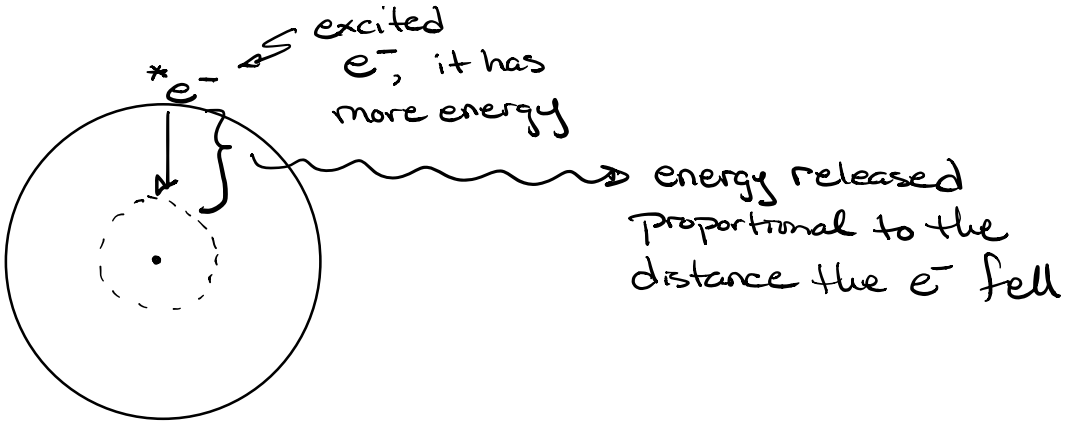
The smaller the period the higher the energy

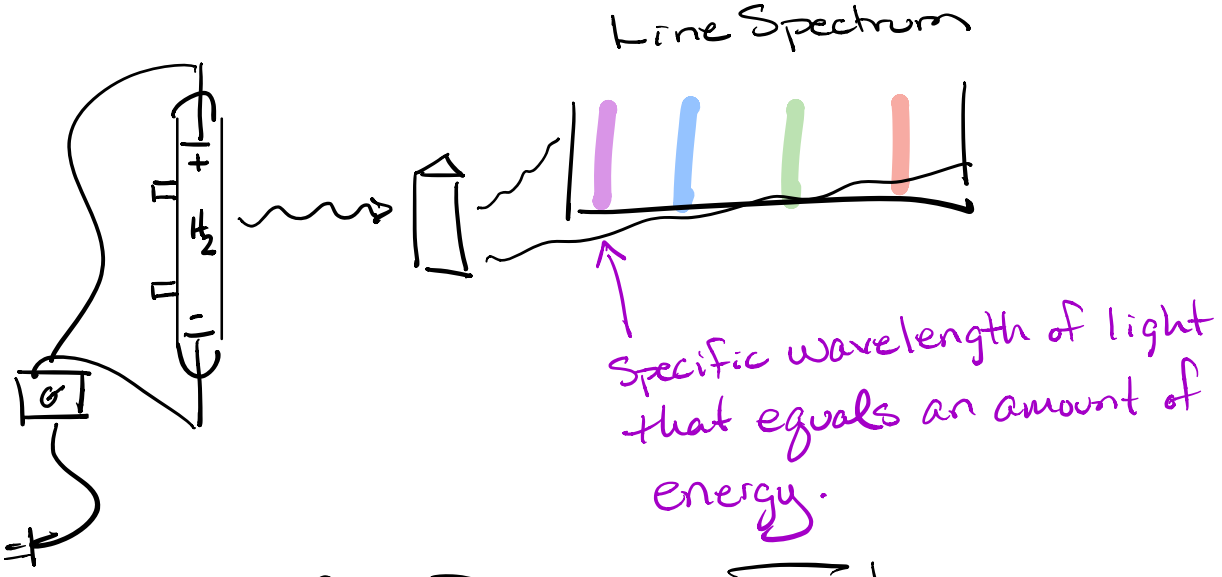


distance from the nucleus is the potential energy of the e⁻

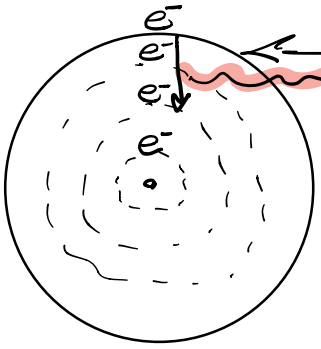








Gas Discharge Tube

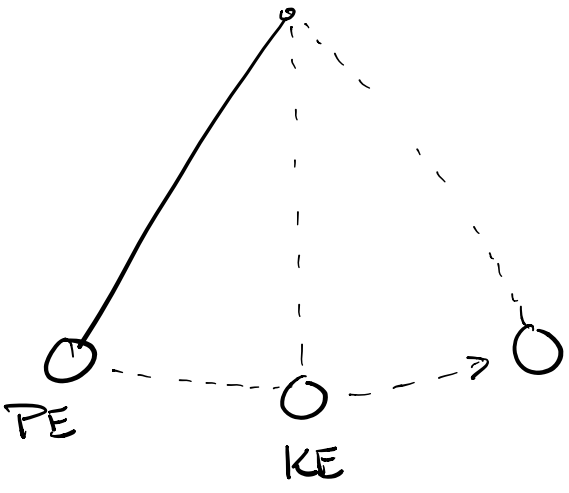


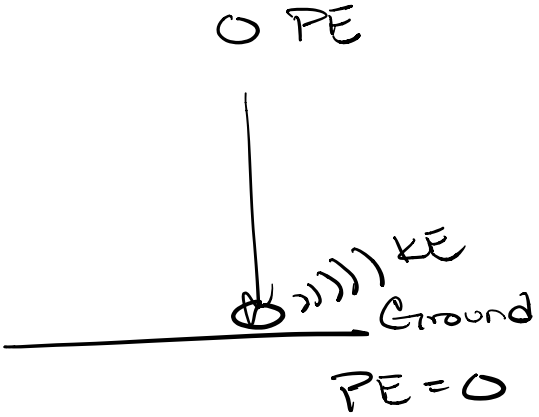
e^- has specific locations where it can go.

$\Rightarrow$ orbital = locations where the e^- can reside

$\Rightarrow$ There is structure in the atom

$\Rightarrow$ Electronic Structure

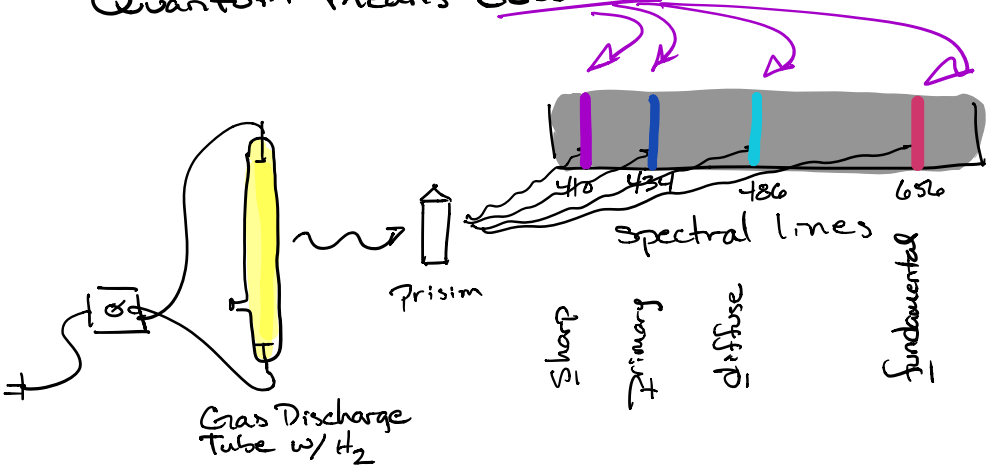




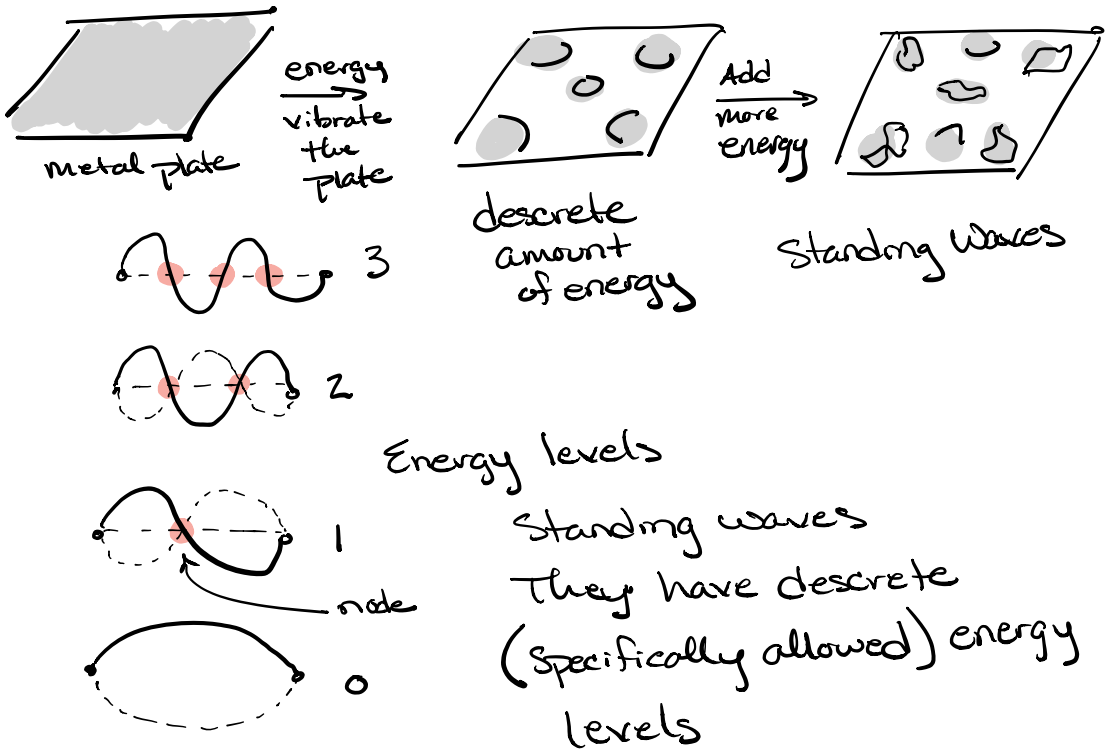
$E = PE + KE$

Quantum Mechanics

Quantum means descrete allowed amount of energy.



Experiment



Energy levels

Standing waves

They have descrete (specifically allowed) energy levels

Electrons are defined by 4 Quantum Numbers

n principal quantum numbe

l azimuthal quantum number (orbital angular momentum)

m_l magnetic quantum number

m_s Spin quantum number

Electron described by the 4 numbers

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

no $2e^-$ can have the same 4 numbers

$\Rightarrow$ each e^- must be unique

Allowable values

Principal Quantum # $n = 1, 2, 3, \ldots$ Integer values

Azimuthal Quantum # l = Integers from 0 up to $(n-1)$

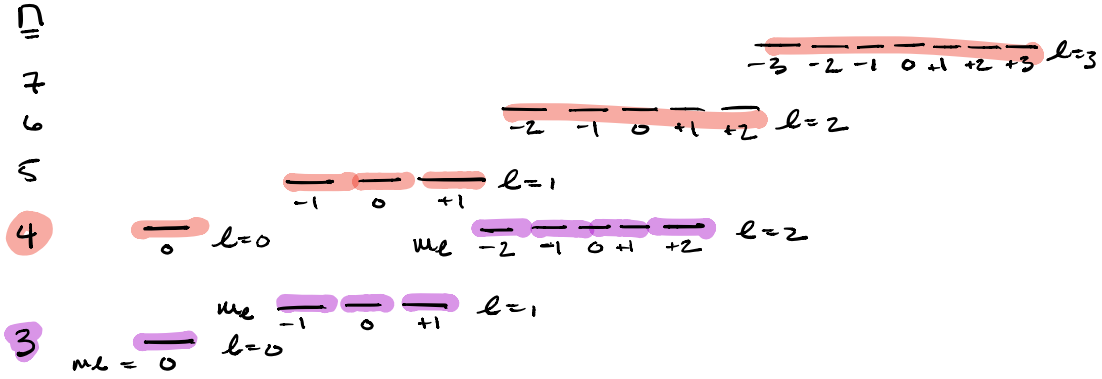
	$n=1$	$n=2$	$n=3$
l	0	0, 1	0, 1, 2

Magnetic Quantum # m_l = Integer values $-l \cdots 0 \cdots l+$

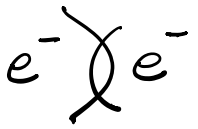
	$l=0$	$l=1$	$l=2$
m_l	0	-1, 0, +1	-2, -1, 0, 1, 2

Spin Quantum # $m_s = \pm 1/2$

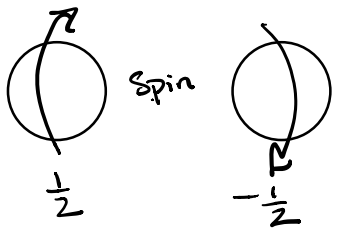
either be $\frac{1}{2}$ or $-\frac{1}{2}$

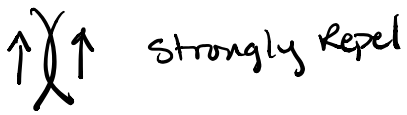


actual e^-



• nucleus

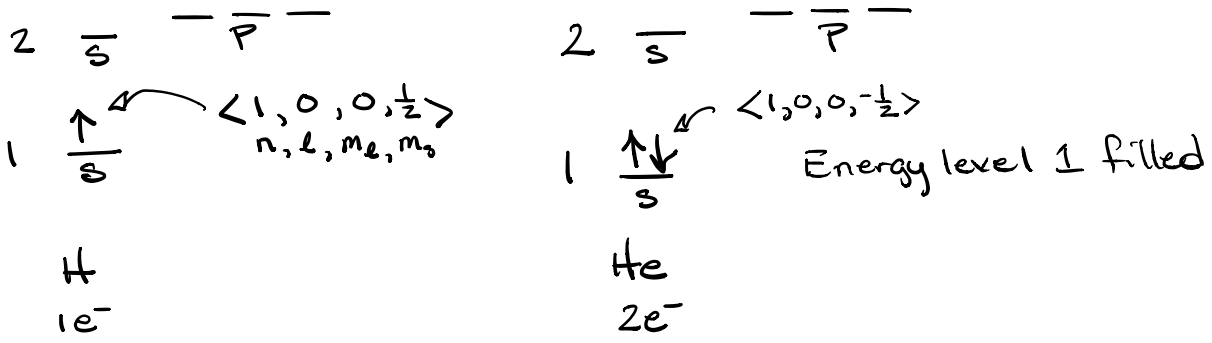


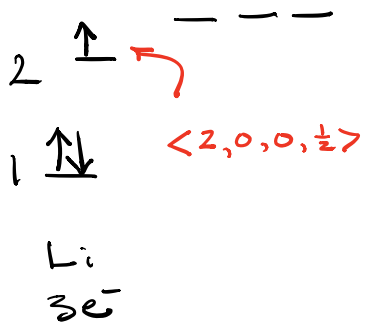


Principle energy level

	1 1A												13 3A	14 4A	15 5A	16 6A	17 7A	18 8A
1	1 H Hydrogen 1.008	2 2A																2 He Helium 4.003
2	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
3	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
4	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 65.39	31 Ga Gallium 69.72	32 Ge Germanium 72.61	33 As Arsenic 74.92	34 Se Selenium 78.96	35 Br Bromine 79.90	36 Kr Krypton 83.80
5	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 95.95	43 Tc Technetium 97.91	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
6	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
7	87 Fr Francium 223	88 Ra Radium 226		104 Rf Rutherfordium 261	105 Db Dubnium 262	106 Sg Seaborgium 263	107 Bh Bohrium 262	108 Hs Hassium 265	109 Mt Meitnerium 266	110 Ds Darmstadtium 269	111 Uuu Ununnium 272	112 Uub Ununbium 277	113	114 Uuq Ununquadium 289	115	116 Uuh Ununhexium 289	117	118
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

Energy diagram of Electronic Configuration

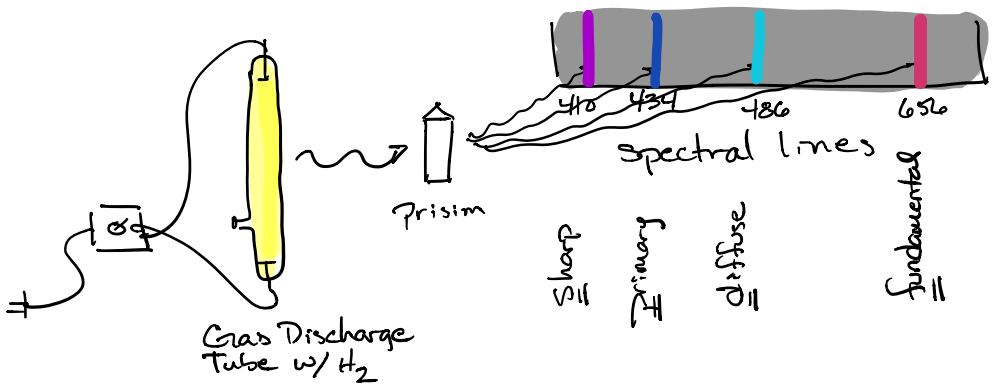




Rules

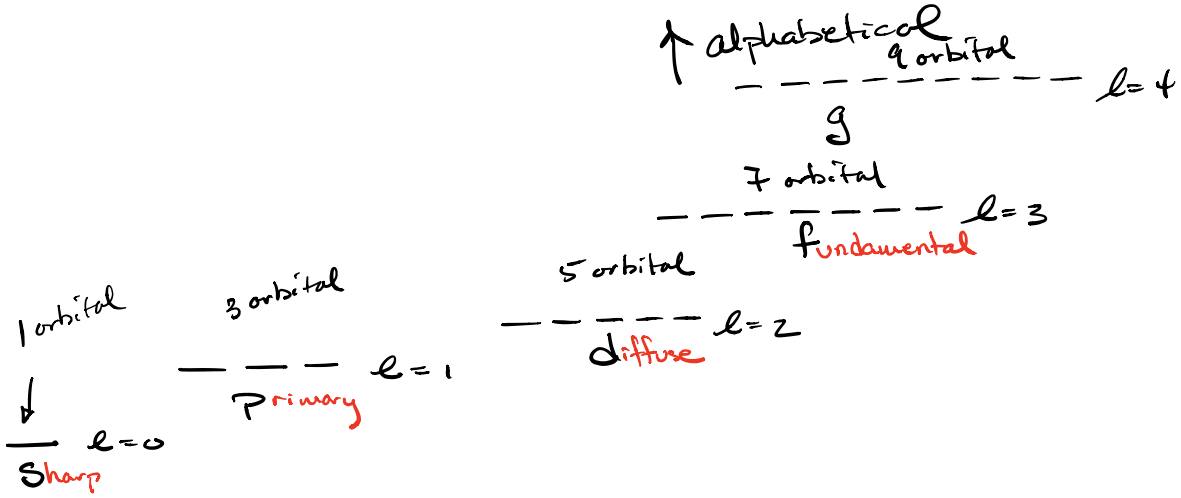
1. Electrons fill from bottom up
2. First e⁻ in an orbital always goes spin up
3. Don't pair e⁻ unless you have to

↑ ↑ — — not ↑↓ — —



n Principal Quantum # = Shell or Level

ℓ azimuthal Quantum # = Sub Shell or Sublevel



n = level = periods = rows in PT

ℓ = Sub-level = s, p, d, f, g, h →

m_ℓ = orbital

#e⁻ allowed in sub level

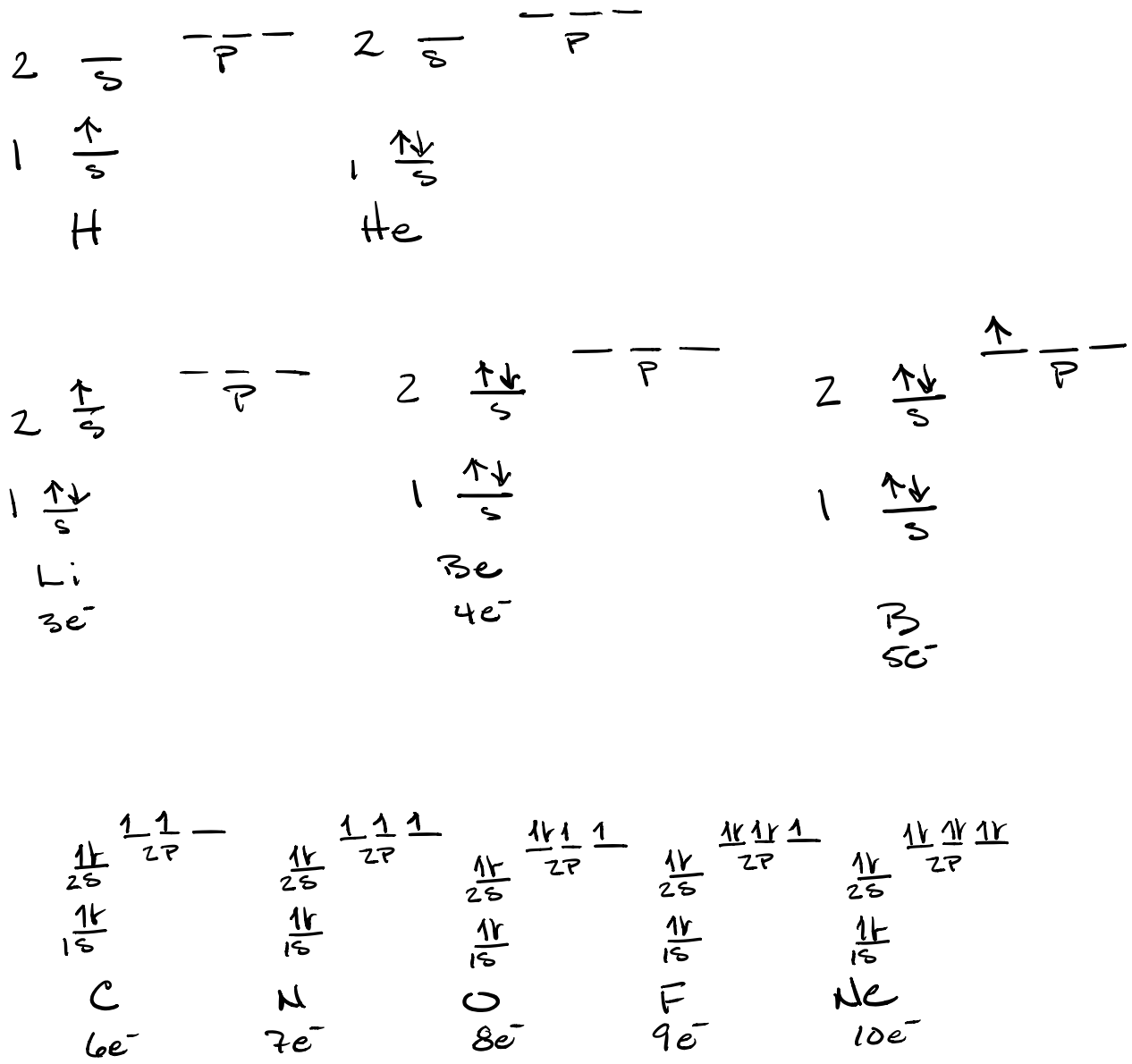
f — — — — — — — 14e⁻

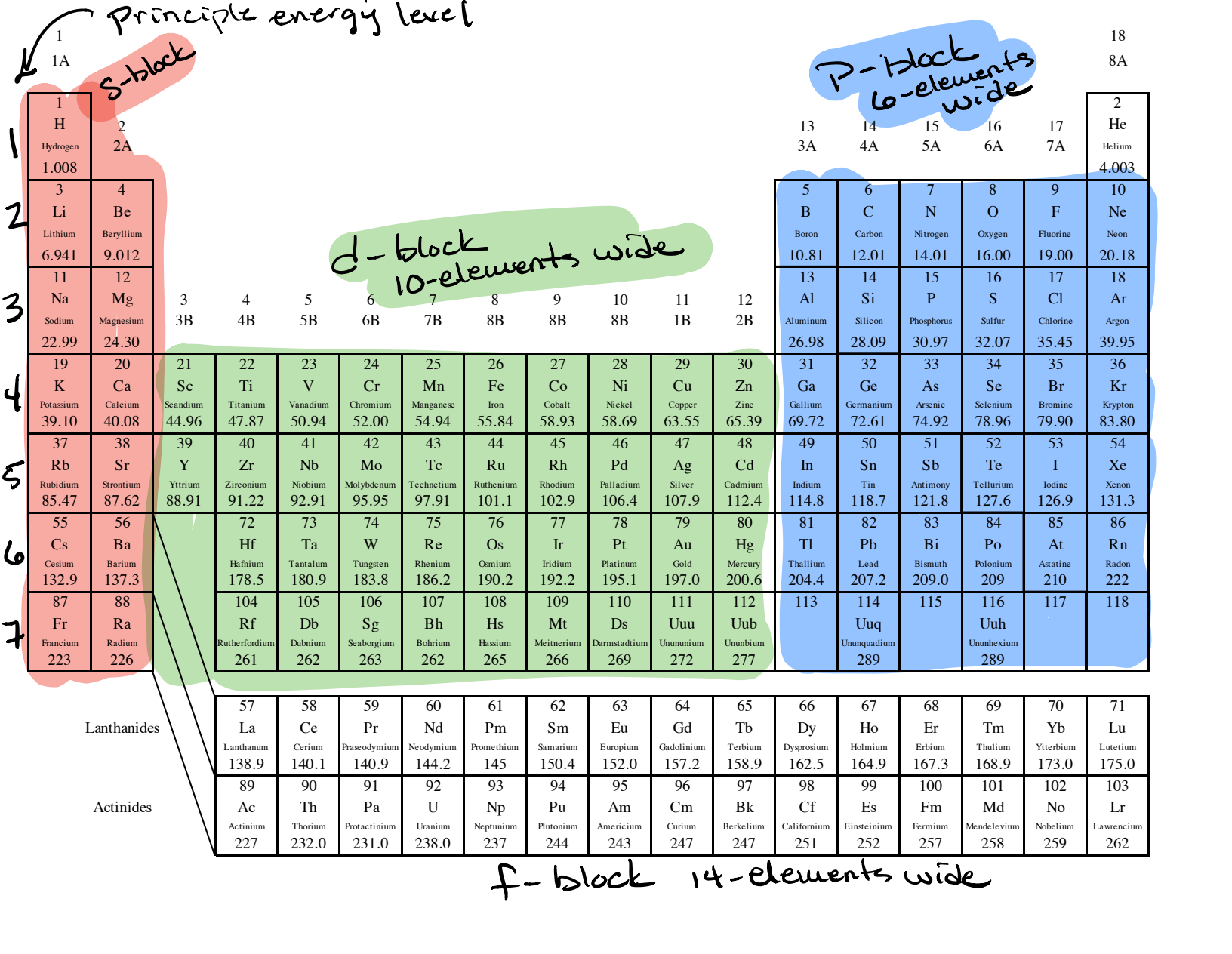
d — — — — — 10e⁻

p — — — 6e⁻

s — 2e⁻

m_s ↑↓


2 s
2p
1 s
H
2 s
2p
1 s
He
2 s
2p
1 s
Li
3e⁻
2 s
2p
1 s
Be
4e⁻
2 s
2p
1 s
B
5e⁻
1s 1s
2s
2p
C
6e⁻
1s 1s 1s
2s
2p
N
7e⁻
1s 1s 1s
2s
2p
O
8e⁻
1s 1s 1s
2s
2p
F
9e⁻
1s 1s 1s
2s
2p
Ne
10e⁻



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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 65.39	31 Ga Gallium 69.72	32 Ge Germanium 72.61	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 95.95	43 Tc Technetium 97.91	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
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