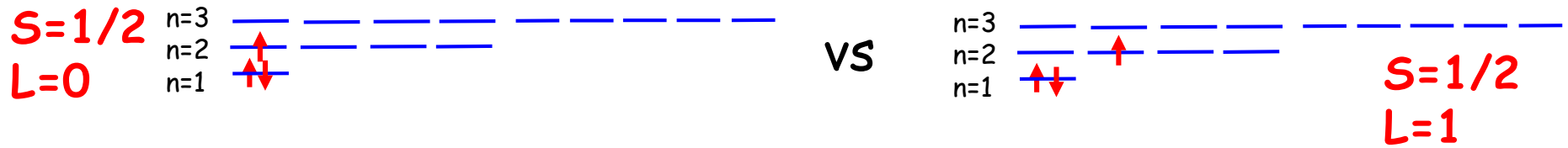
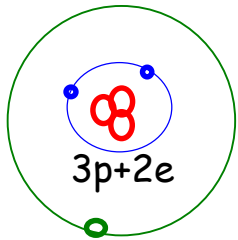


If there is a **degeneracy total $S=0$** vs total **$S=1$** , the **triplet wins** due to e-e repulsion.

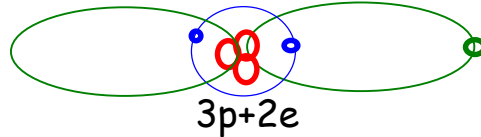
But how do you order states if the **degeneracy** is between say **$l=0$** vs **$l=1$** for the same n ?



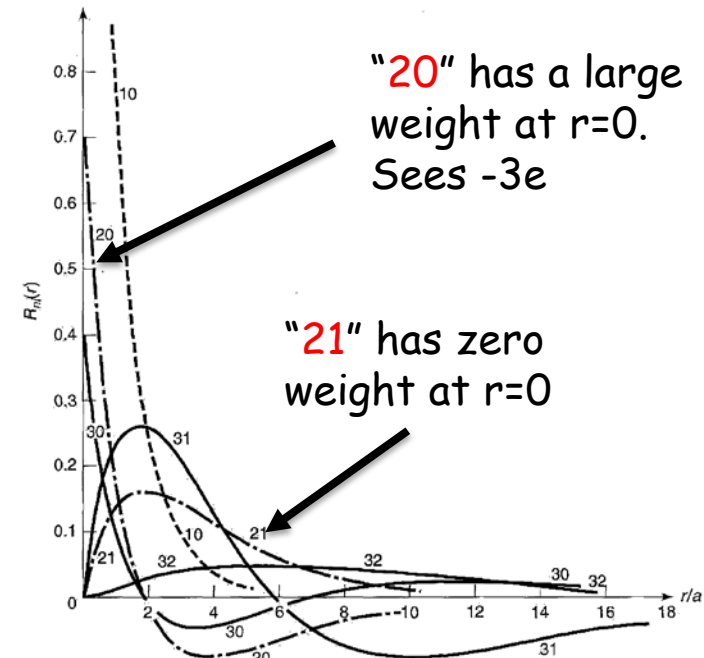
e-p attraction favors the **lowest total " l "** between subshells (like s vs p) due to "screening" of p:



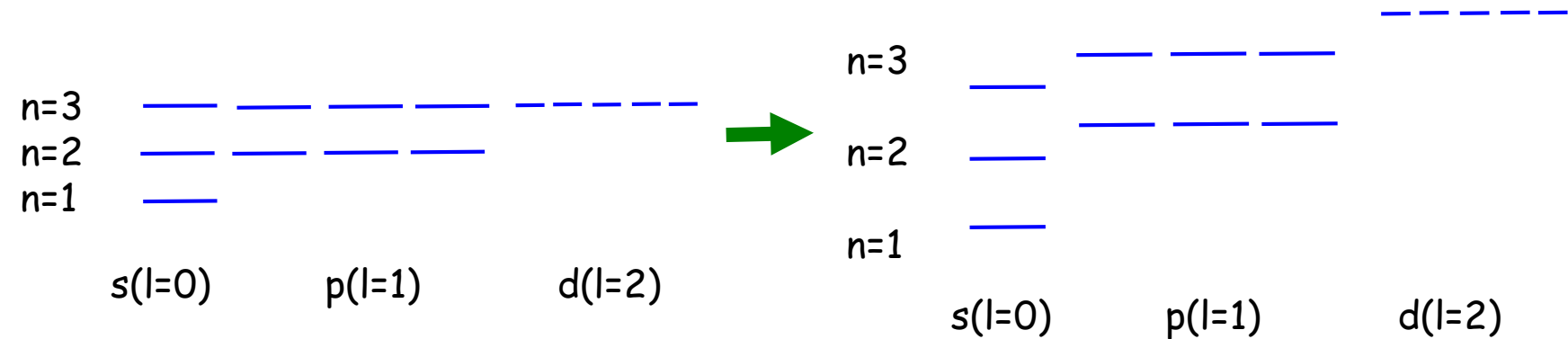
Sees the nuclear $-3e$ often



Sees a net central charge $-1e$ often (screening)

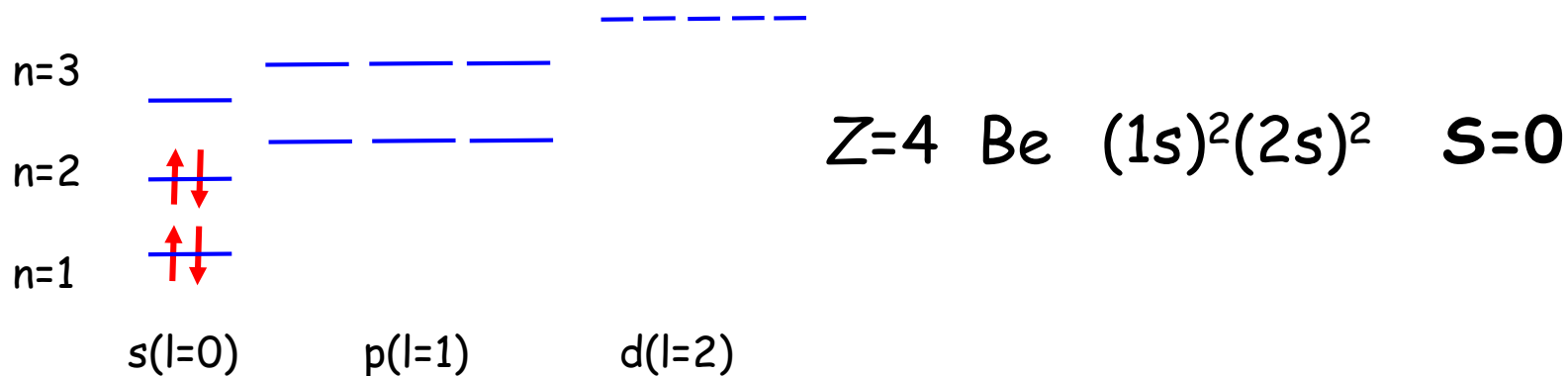
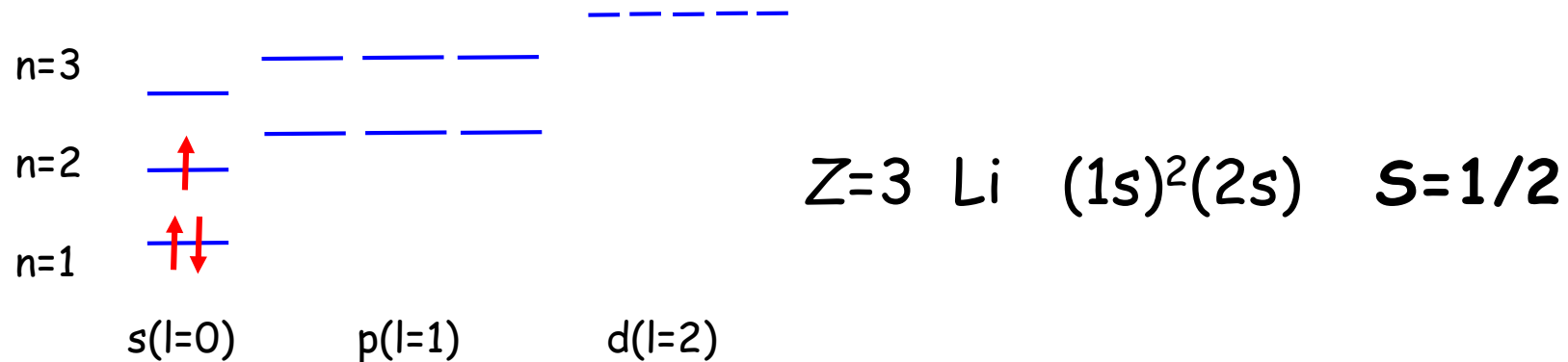
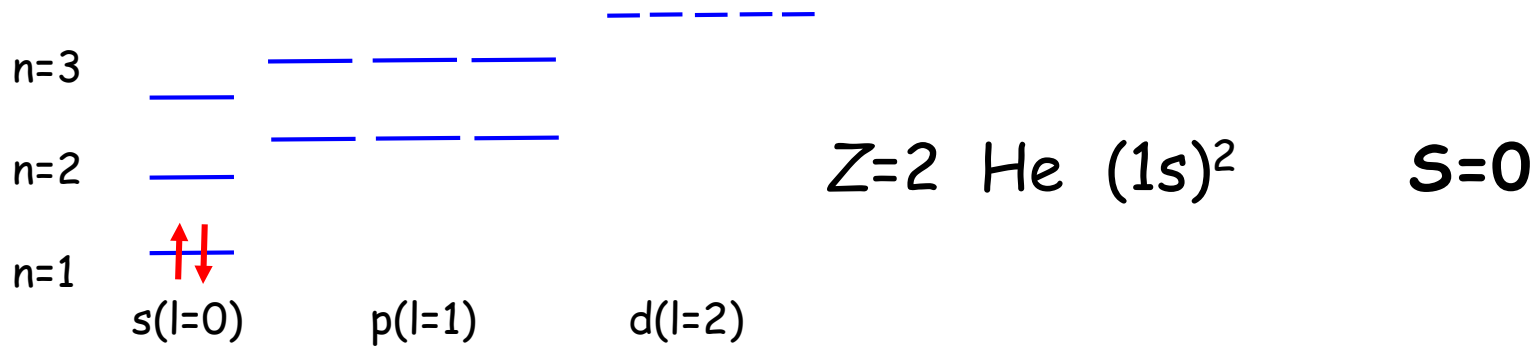


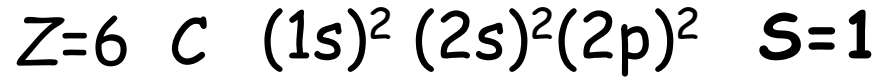
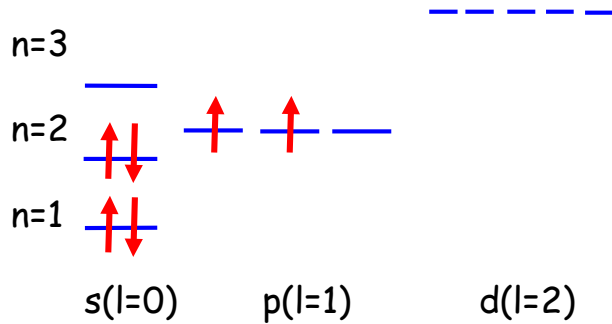
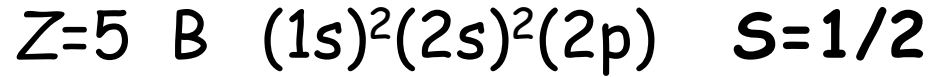
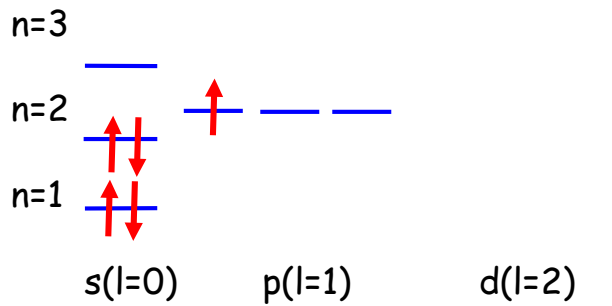
Then, because of the effect in the previous page that distinguishes between $l=0$, $l=1$, $l=2$, etc there is a small split of "degenerate" orbitals:



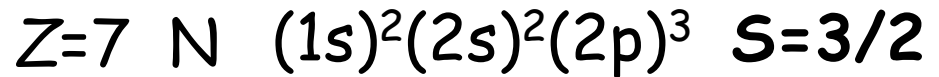
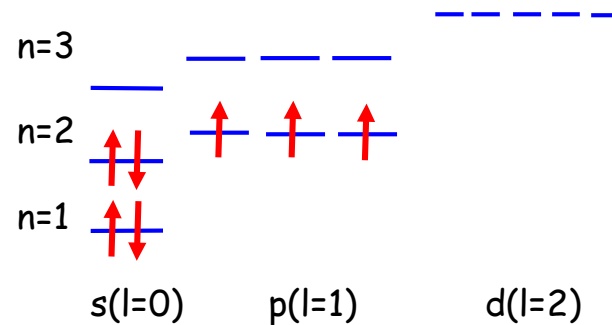
This is the order we have to use to construct the periodic table from now on.

5.2.2 Periodic table (ground states only)

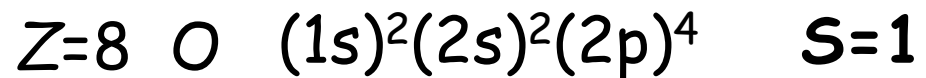
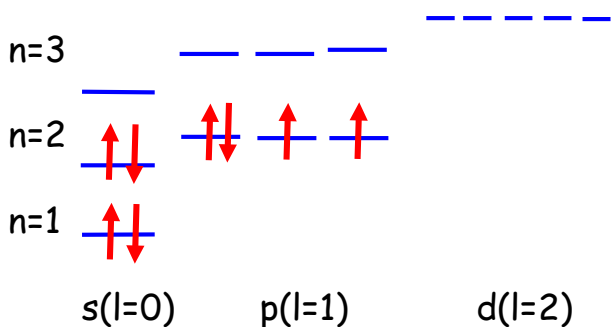




Hund's rule (e-e repulsion)



Hund's rule (e-e repulsion)



Hund's rule (e-e repulsion)

n=3

n=2

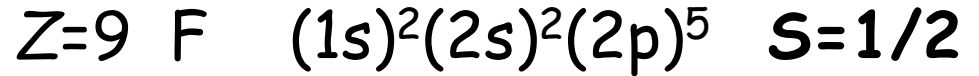
n=1



s(l=0)

p(l=1)

d(l=2)



n=3

n=2

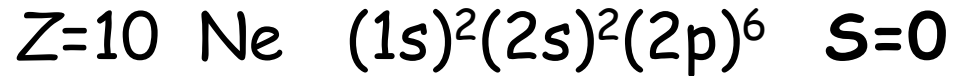
n=1



s(l=0)

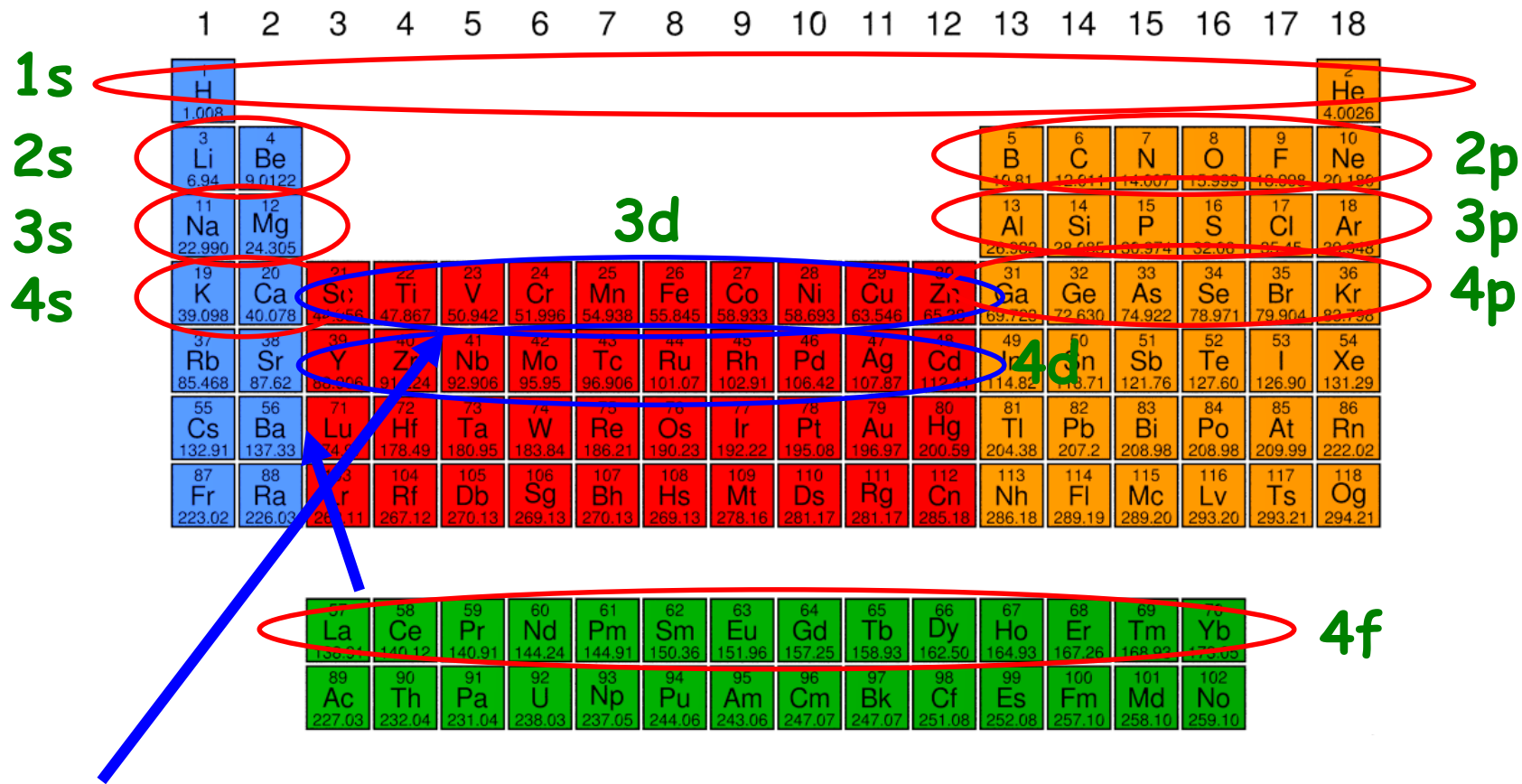
p(l=1)

d(l=2)



Noble gas

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
	1 H 1.008																	2 He 4.0026	
	3 Li 6.9	4 Be 9.0122											5 B 10.81	6 C 12.011	7 N 14.007	8 O 15.999	9 F 18.998	10 Ne 20.180	
	11 Na 22.990	12 Mg 24.305											13 Al 26.982	14 Si 28.085	15 P 30.974	16 S 32.06	17 Cl 35.45	18 Ar 39.948	
	19 K 39.098	20 Ca 40.078	21 Sc 44.956	22 Ti 47.867	23 V 50.942	24 Cr 51.996	25 Mn 54.938	26 Fe 55.845	27 Co 58.933	28 Ni 58.693	29 Cu 63.546	30 Zn 65.38	31 Ga 69.723	32 Ge 72.630	33 As 74.922	34 Se 78.971	35 Br 79.904	36 Kr 83.796	
	37 Rb 85.468	38 Sr 87.62	39 Y 88.906	40 Zr 91.224	41 Nb 92.906	42 Mo 95.95	43 Tc 98.906	44 Ru 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.76	52 Te 127.60	53 I 126.90	54 Xe 131.29	
	55 Cs 132.91	56 Ba 137.33	57 La 138.905	71 Lu 174.967	72 Hf 178.49	73 Ta 180.948	74 W 183.84	75 Re 186.21	76 Os 190.23	77 Ir 192.22	78 Pt 195.08	79 Au 196.967	80 Hg 200.59	81 Tl 204.38	82 Pb 207.2	83 Bi 208.98	84 Po 209	85 At 209	86 Rn 222.02
	87 Fr 223.02	88 Ra 226.03	103 Lr 260.11	104 Rf 261.12	105 Db 261.13	106 Sg 261.13	107 Bh 264.13	108 Hs 269.13	109 Mt 269.13	110 Ds 271.13	111 Rg 271.13	112 Cn 277.13	113 Nh 284.13	114 Fl 284.13	115 Mc 284.13	116 Lv 289.13	117 Ts 289.13	118 Og 294.13	
	57 La 138.91	58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm 144.91	62 Sm 150.36	63 Eu 151.96	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 173.05					
	89 Ac 139	90 Th 140	91 Pa 140	92 U 140	93 Np 140	94 Pu 140	95 Am 140	96 Cm 140	97 Bk 140	98 Cf 140	99 Es 140	100 Fm 140	101 Md 140	102 No 140					



Anomaly: in the split s vs p vs d,
3d ends up having more energy
than 4s

S

$$2S+1L_J$$

Z	Element	Configuration	S	L	J
1	H	(1s)	1/2	0	$^2S_{1/2}$
2	He	(1s) ²	0	0	1S_0
3	Li	(He)(2s)	1/2	0	$^2S_{1/2}$
4	Be	(He)(2s) ²	0	0	1S_0
5	B	(He)(2s) ² (2p)	1/2	1	$^2P_{1/2}$
6	C	(He)(2s) ² (2p) ²	1	0	3P_0
7	N	(He)(2s) ² (2p) ³	3/2	1	$^4S_{3/2}$
8	O	(He)(2s) ² (2p) ⁴	1	2	3P_2
9	F	(He)(2s) ² (2p) ⁵	1/2	2	$^2P_{3/2}$
10	Ne	(He)(2s) ² (2p) ⁶	0	0	1S_0
11	Na	(Ne)(3s)	1/2	0	$^2S_{1/2}$
12	Mg	(Ne)(3s) ²	0	0	1S_0
13	Al	(Ne)(3s) ² (3p)	1/2	1	$^2P_{1/2}$
14	Si	(Ne)(3s) ² (3p) ²	1	0	3P_0
15	P	(Ne)(3s) ² (3p) ³	3/2	1	$^4S_{3/2}$
16	S	(Ne)(3s) ² (3p) ⁴	1	2	3P_2
17	Cl	(Ne)(3s) ² (3p) ⁵	1/2	2	$^2P_{3/2}$
18	Ar	(Ne)(3s) ² (3p) ⁶	0	0	1S_0

All 3 numbers are TOTAL
 In each subshell, like 2p, the state with max S total wins. Example: N has 2S+1=4 i.e. S=3/2 due to e-e repulsion.

About L: "S" means L=0, "P" means L=1, "D" means L=2,...

J, the total angular momentum, could be L+S, ..., |L-S| depending on small energy differences.

The Hund's rules for L and J are more chaotic, with many exceptions. Just read about them in some book ...