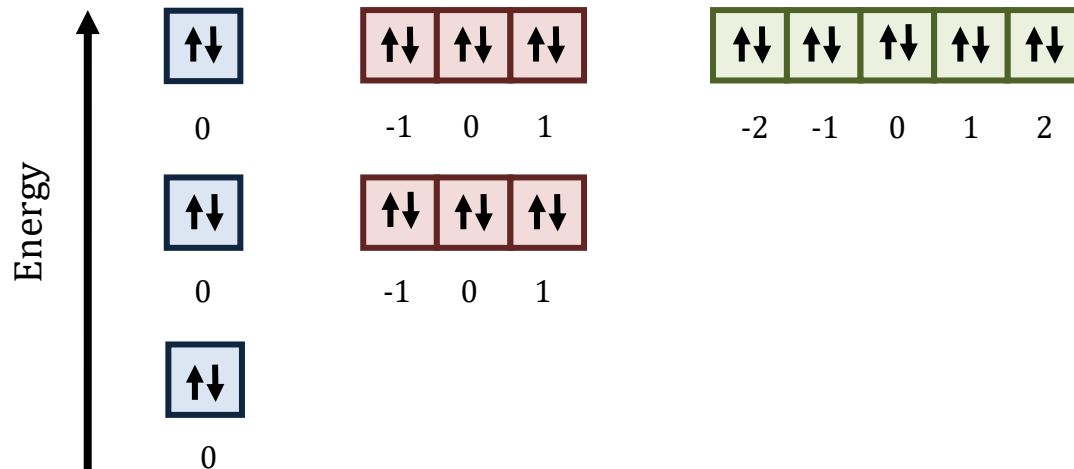


Chapter 6 Part 3

Dr. Turner

Orbital Energy Diagrams

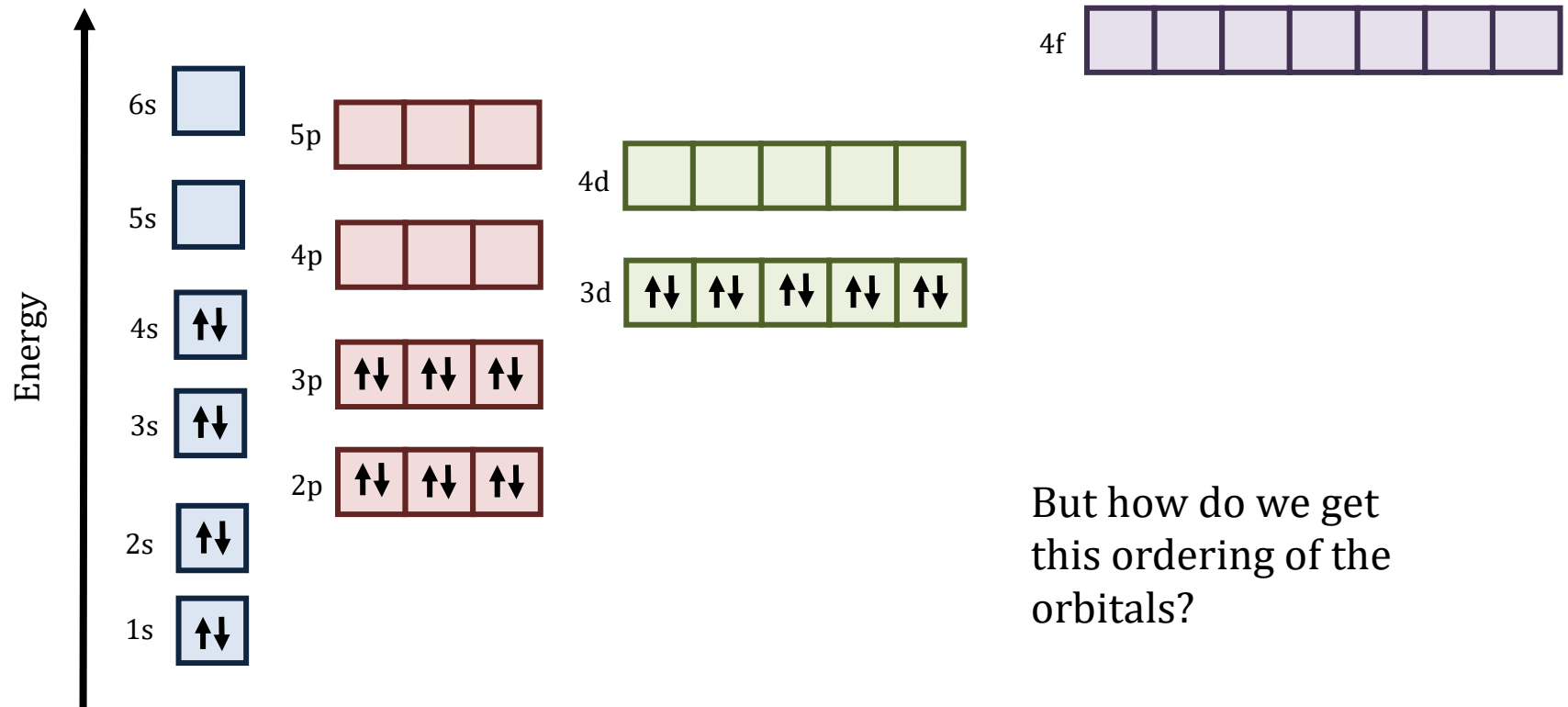
Which sets of orbitals would you expect to have the same energy?



Diagrams for multielectron systems

- For multielectron systems, the energy depends on the quantum numbers n and l
- As n increases, orbital energy increases for orbitals of the same type
 - ▣ $4s > 3s > 2s > 1s$
 - ▣ $4p > 3p > 2p$
- As l increases within a shell, orbital energy increases
 - ▣ Ex. $4f > 4d > 4p > 4s$
- As n increases, the subshell energies become closely spaced and overlapping occurs

Diagrams for multielectron systems



Electron configurations and the periodic table

Electron Configurations in the Periodic Table

1 H 1s																	2 He 1s														
3 Li 2s	4 Be															5 B ←	6 C	7 N 2p	8 O	9 F	10 Ne →										
11 Na 3s	12 Mg															13 Al ←	14 Si	15 P 3p	16 S	17 Cl	18 Ar →										
19 K 4s	20 Ca	21 Sc ←	22 Ti	23 V	24 Cr	25 Mn 3d	26 Fe	27 Co	28 Ni	29 Cu	30 Zn →	31 Ga ←	32 Ge	33 As 4p	34 Se	35 Br	36 Kr →														
37 Rb 5s	38 Sr	39 Y ←	40 Zr	41 Nb	42 Mo	43 Tc 4d	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd →	49 In ←	50 Sn	51 Sb 5p	52 Te	53 I	54 Xe →														
55 Cs 6s	56 Ba	57 La ←	72 Hf	73 Ta	74 W	75 Re 5d	76 Os	77 Ir	78 Pt	79 Au	80 Hg →	81 Tl ←	82 Pb	83 Bi 6p	84 Po	85 At	86 Rn →														
87 Fr 7s	88 Ra	89 Ac ←	104 Rf	105 Db	106 Sg	107 Bh 6d	108 Hs	109 Mt	110	111	112 →	113	114																		
																		58 Ce ←	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd 4f	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu →
																		90 Th ←	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm 5f	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr →

Aufbau Principle

- Says that electrons fill the lowest available energy levels before filling higher levels
- By filling orbitals of lowest energy first, you usually get the lowest total energy (ground state) of the atom

*spdf*notation

- When using *spdf*notation, fill the orbitals using the previously stated rules.
- A superscript is used to show how many electrons are in an orbital
 - ▣ Ex. Li: $1s^22s^1$ & F: $1s^22s^22p^5$

Noble gas notation

- Noble gas notation is often used to represent filled shells
- In noble gas configuration, write the symbol of the most recent noble gas in brackets, and then list the remaining electrons as previously done in *spdf* notation
 - ▣ Ex. Si: $[\text{Ne}]3s^23p^2$ & In $[\text{Kr}]5s^24d^{10}5p^1$
- The electron configuration for chromium is $[\text{Ar}]4s^13d^5$, and the electron configuration for copper is $[\text{Ar}]4s^13d^{10}$. These are irregular and should be memorized.

Electron configurations

Give the electron configurations for the following atoms using *spdf* notation and noble gas notation.

- A. Sulfur
- B. Cobalt
- C. Californium (noble gas notation only)

Electron configurations

K is in the 1st column of the periodic table, and the 4th row. The electron configuration of K ends in

- A. $1s^4$
- B. $4s^1$
- C. $1p^4$
- D. $4p^1$
- E. $4d^1$

Excited State Electron Configurations

Which of the following is not an excited state electron configuration of carbon?

- A. $1s^2 2s^2 2p^2$
- B. $1s^2 2s^2 2p^1 3s^1$
- C. $1s^2 2s^2 3s^2$
- D. $1s^2 2s^1 2p^3$

Adding electrons to form anions

- Electrons are filled in according to the energy ordering of the orbitals and Hund's rule.

Ion Formation

Give the electron configuration of a N^{2-} ion.

Ion Formation

What is the electron configuration for the P^{3-} ion?

- A. $1s^2 2s^2 2p^6 3s^2$
- B. $1s^2 2s^2 2p^6 3s^2 3p^0$
- C. $1s^2 2s^2 2p^6 3s^2 3p^3$
- D. $1s^2 2s^2 2p^6 3s^2 3p^6$

Loss of Electrons

- Electrons are removed corresponding to the shells with the greatest n value because electrons with greater values are farther from the positive pull of the nucleus

Ion Formation

From which orbital would electrons be lost from Zr in the formation of Zr^{2+} ?

- A. 4p
- B. 5s
- C. 4d
- D. 5p

Ion Formation

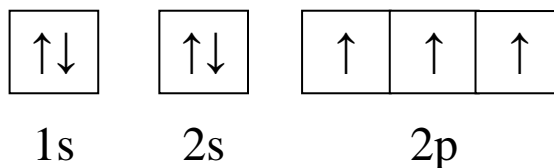
What is the noble gas electron configuration of Zr^{2+} ?

Hund's rule of maximum multiplicity

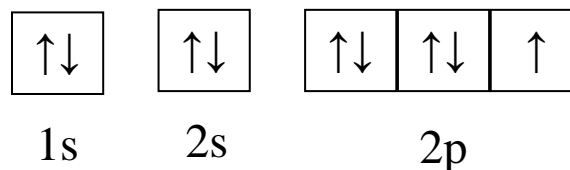
- Hund's rule states that the lowest-energy electron configuration is the one where the maximum number of electrons is unpaired.

Orbital Box Notation

- In orbital box notation, boxes are used to represent orbitals and arrows are used to represent electrons
- In comparison to the *spdf* method, this one places more emphasis on the spin of the atom
- The electron configuration of nitrogen using orbital box notation is



- The electron configuration of fluorine using orbital box notation is



Orbital Box Notation



Write the electron configuration of silicon using orbital box notation.

Electronic Energy-Level Diagram

Which atom is represented by this electronic energy-level diagram?

- A. Beryllium
- B. Carbon
- C. Oxygen
- D. Sulfur

