Announcements for Wednesday, 25SEP2024

- Practice Exam 1 on Canvas
  - located under “General Course information,” “Practice Exams”
- Exam I is Tuesday, 01OCT2024, 7:45-9:05 **PM** (EDT)
  - Coverage: Chapters E-3.5; exam consists of 19 multiple-choice questions and open-ended questions; see “Other Resources” on Canvas for periodic table and formula sheet to be used on the exam
  - See Canvas announcement from Sep 25 about Exam Locations
- Exam I Calculator Policy
  - Scientific calculators and ***most*** graphing calculators are allowed
  - **TI-Nspire CX series & other calculators with *QWERTY* keyboards are NOT allowed**

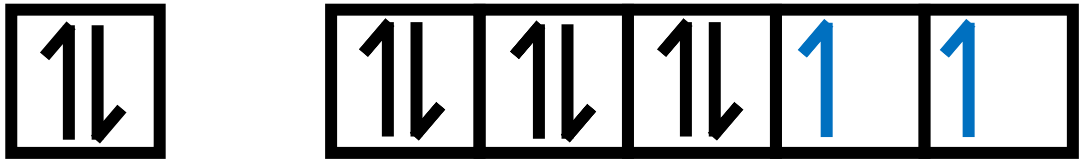
- Any **TECHNICAL ISSUES** associated with eLearning (quizzes, practice assignments, etc.) must be reported to **eLearning Tech Support** **(https://techsupport.elearning.rutgers.edu)**

ANY GENERAL QUESTIONS? Feel free to see me after class!

Try This On Your Own

- Give the full electron configuration for nickel (Z = 28)
- Give the orbital diagram of the last two sublevels
- Determine the number of unpaired electrons in a nickel atom

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^8$



4s **3d**

2 unpaired electrons

Noble-Gas-Core Abbreviation

- electron configurations can be written in shorthand using Noble-Gas-Core notation

nickel (Z=28)

<u>full electron configuration</u>

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^8$

<u>noble-gas-core abbreviation:</u>

$[Ar]\ 4s^2\ 3d^8$

$1s^2$ = **[He]**

$1s^2\ 2s^2\ 2p^6$ = **[Ne]**

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$ = **[Ar]**

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^6$ = **[Kr]**

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^6\ 5s^2\ 4d^{10}\ 5p^6$ = **[Xe]**

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^6\ 5s^2\ 4d^{10}\ 5p^6\ 6s^2\ 4f^{14}\ 5d^{10}\ 6p^6$ = **[Rn]**

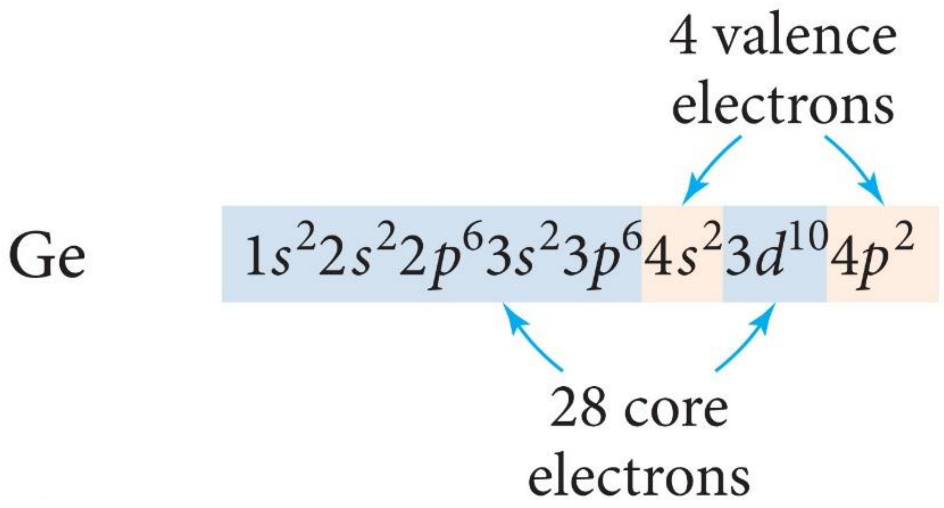
Valence vs. Core Electrons

valence electrons

- for Main Group Elements, electrons in the outermost principal energy level (i.e., highest value of n)
  - *for Transition Elements, electrons in outermost d shell are also included though they are not in outermost principal level*
  - we will be focusing primarily on MAIN GROUP ELEMENTS
- one of the most important factors in the way an atom behaves, both chemically and physically
  - largely responsible for chemical bonding

core electrons

  - inner electrons in complete principal energy levels
- not responsible for bonding
  - responsible for shielding effects



Valence Electrons

Valence Electron Configurations of Elements 1A-8A

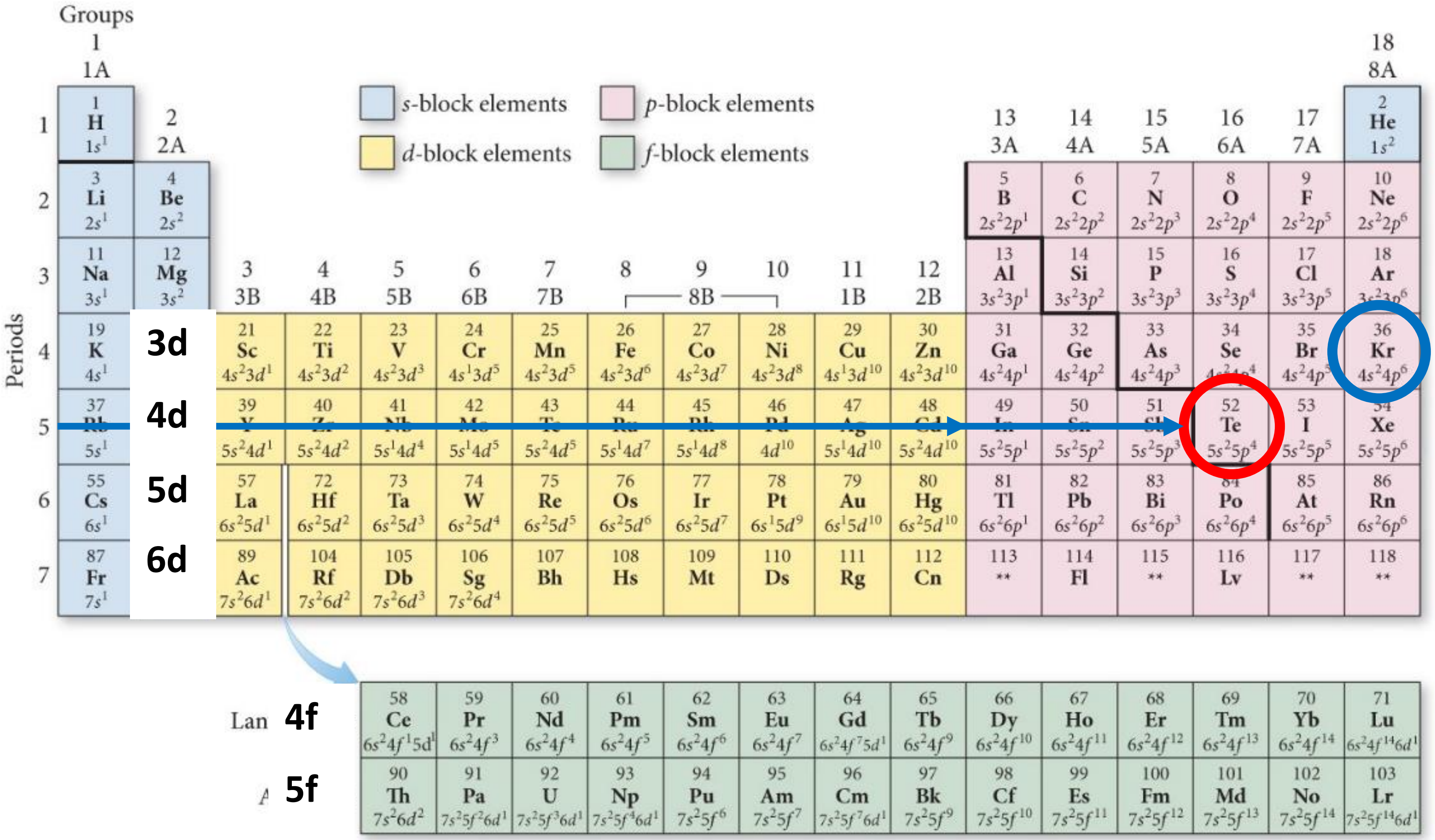
	1A	2A	3A	4A	5A	6A	7A	8A
1	1 **H** $1s^1$							2 **He** $1s^2$
2	3 **Li** $2s^1$	4 **Be** $2s^2$	5 **B** $2s^22p^1$	6 **C** $2s^22p^2$	7 **N** $2s^22p^3$	8 **O** $2s^22p^4$	9 **F** $2s^22p^5$	10 **Ne** $2s^22p^6$
3	11 **Na** $3s^1$	12 **Mg** $3s^2$	13 **Al** $3s^23p^1$	14 **Si** $3s^23p^2$	15 **P** $3s^23p^3$	16 **S** $3s^23p^4$	17 **Cl** $3s^23p^5$	18 **Ar** $3s^23p^6$

- **Main group number** corresponds to the number of valence electrons
  - for 1A, 2A, and aluminum, group number gives charge of ***cations***
  - for 7A, 6A, and 5A, (Group Number – 8) gives charge of ***anions***
- length of each "block" is the maximum number of electrons the subshell can hold
  - 2 columns for s-subshell = 2 electrons
  - 6 columns for p-subshell = 6 electrons
- **period number** corresponds to the principal energy level of the valence electrons

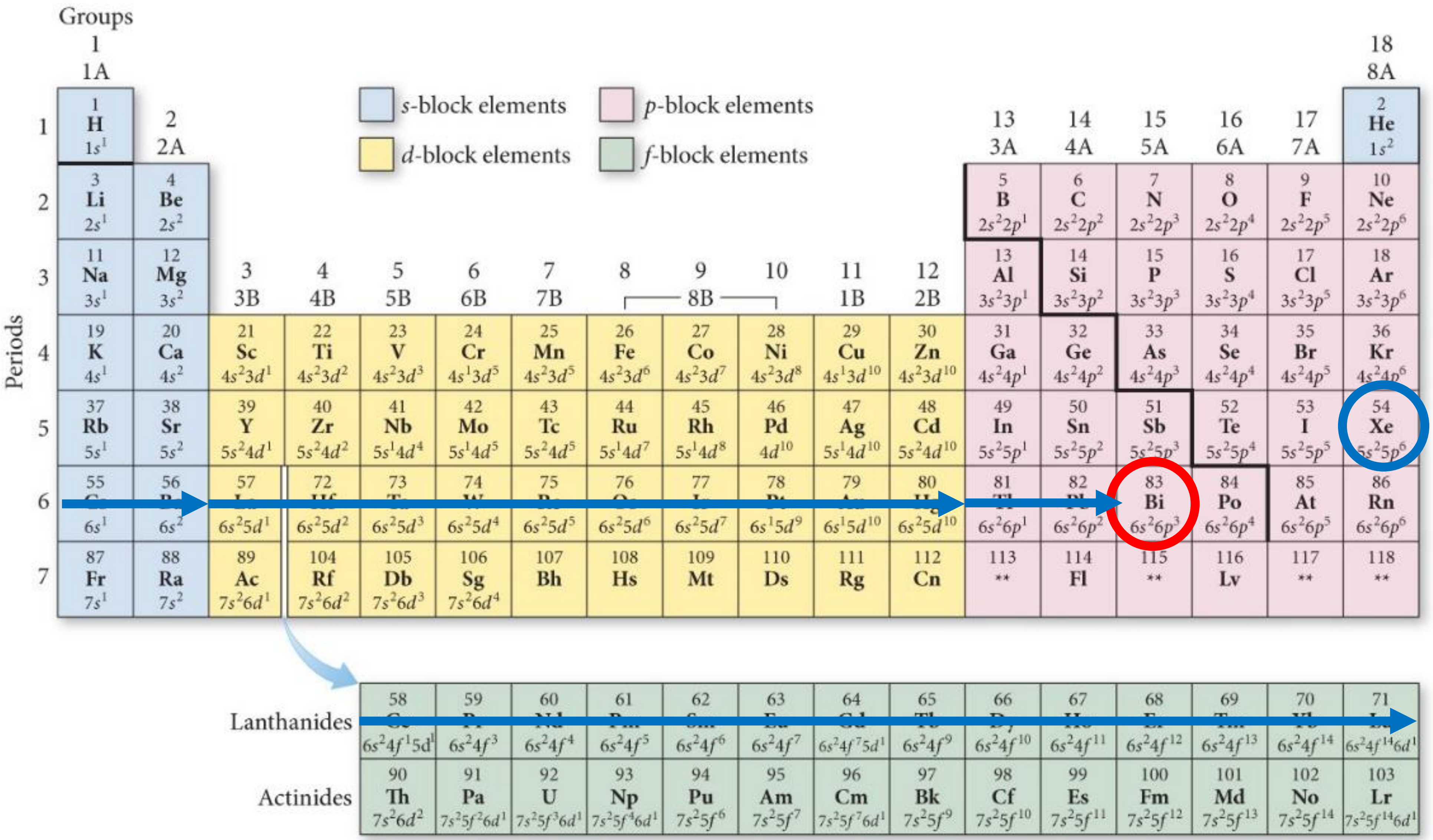
Orbital Blocks and Electron Configurations

- the periodic table is divisible into four blocks corresponding to the filling of the four quantum sublevels (s, p, d, and f)
  - Groups 1A and 2A = s-block
  - Groups 3A – 8A = p-block
  - Groups 1B – 8B = d-block
  - inner transition groups = f-block
- the outer electron configuration can be established by tracing the elements between the previous noble gas and the element of interest
- example tellurium (Te)

  [Kr] $5s^2$ **4**d^{10} $5p^4$



Write the Electron Configuration for Bismuth (Bi)



[Xe] $6s^2$ $\mathbf{4f^{14}}$ $\mathbf{5d^{10}}$ $6p^3$

Electron Configurations of Transition and Inner-Transition Elements

4	21 **Sc** $4s^2 3d^1$	22 **Ti** $4s^2 3d^2$	23 **V** $4s^2 3d^3$	24 **Cr** $4s^1 3d^5$	25 **Mn** $4s^2 3d^5$	26 **Fe** $4s^2 3d^6$	27 **Co** $4s^2 3d^7$	28 **Ni** $4s^2 3d^8$	29 **Cu** $4s^1 3d^{10}$	30 **Zn** $4s^2 3d^{10}$
5	39 **Y** $5s^2 4d^1$	40 **Zr** $5s^2 4d^2$	41 **Nb** $5s^1 4d^4$	42 **Mo** $5s^1 4d^5$	43 **Tc** $5s^2 4d^5$	44 **Ru** $5s^1 4d^7$	45 **Rh** $5s^1 4d^8$	46 **Pd** $4d^{10}$	47 **Ag** $5s^1 4d^{10}$	48 **Cd** $5s^2 4d^{10}$

- many exceptions to the Aufbau principle exist in the electron configurations
- make sure you are familiar with the following irregular configurations

	expected configuration	**experimentally determined (i.e., actual)**
Cr	[Ar] $4s^2\ 3d^4$	**[Ar] $4s^1\ 3d^5$**
Cu	[Ar] $4s^2\ 3d^9$	**[Ar] $4s^1\ 3d^{10}$**
Mo	[Kr] $5s^2\ 4d^4$	**[Kr] $5s^1\ 4d^5$**
Ag	[Kr] $5s^2\ 4d^9$	**[Kr] $5s^1\ 4d^{10}$**

half-filled subshells are energetically favorable

Electron Configurations of Ions

- step 1: write the electron configuration of the neutral parent atom
- step 2a: for anions, add extra electrons to lowest energy orbitals available
- step 2b: for cations, remove electrons from the outermost valence shell (i.e., orbitals having the highest value of n)
- COMMON MISTAKE! Remove *n* s-electrons before *n-1* d-electrons

Al: $[Ne]\ 3s^2\ 3p^1$

Al^{3+}: $[Ne]\ 3s^0\ 3p^0$

Noble gas configuration is achieved!
DRIVING FORCE: FULL VALENCE SHELL

O: $[He]\ 2s^2\ 2p^4$

O^{2-}: $[He]\ 2s^2\ 2p^6$: $[Ne]$

Noble gas configuration is achieved!
DRIVING FORCE: FULL VALENCE SHELL

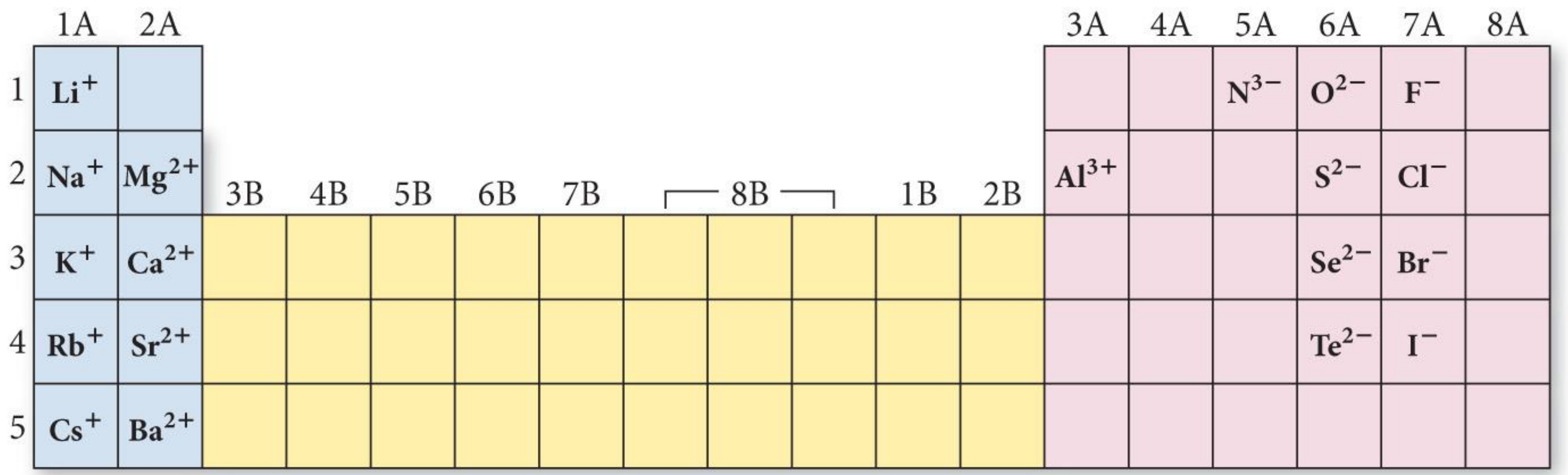
Co: $[Ar]\ 4s^2\ 3d^7$

Co^{3+}: $[Ar]\ 4s^0\ 3d^6$

Ions from Atoms

- metals tend to form cations *(due to low ionization energies)*
- nonmetals tend to form anions (*due to negative electron affinities*)

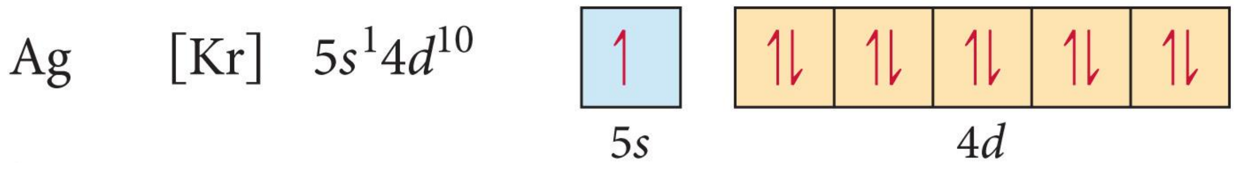
Elements That Form Ions with Predictable Charges

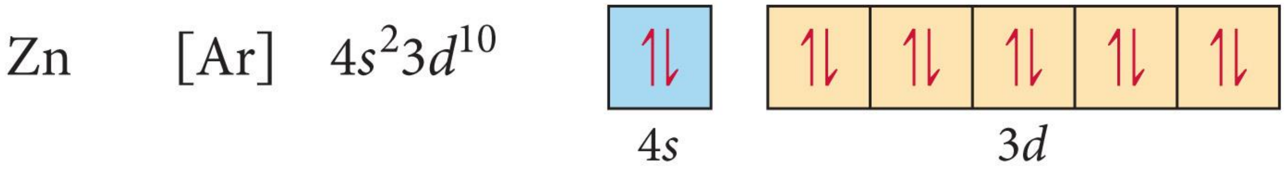


- charges of many main group elements are predictable (see above)
- charges of transition and inner-transition element ions not as predictable and also variable
- more on this in Chapter 4

Paramagnetism vs. Diamagnetism

- **paramagentism =** a property of an atom or ion whereby it is attracted by an external magnetic field
  - comes from unpaired electrons
- **diamagnetism =** a property of an atom or ion whereby it is slightly repelled by an external magnetic field
  - all electrons are paired





Try This On Your Own

Which of the following species has the MOST unpaired electrons?

Cu^{+}, N^{2-}, Kr, Mo, Mo^{+}, Fe^{3+}