Chemistry 11

Atomic Theory III

Name:
Date:
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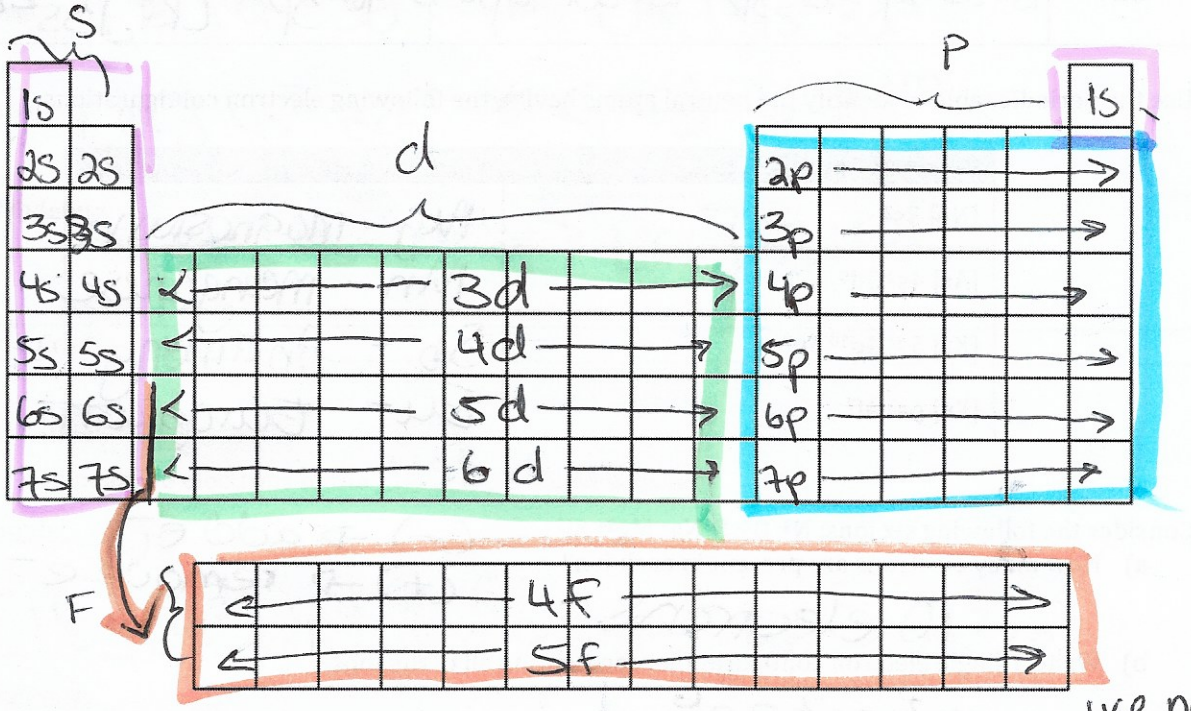
1. EC Relationship to Periodic Table
2. Electron Configuration Exceptions
3. Electron Configuration of Ions

Electron Configuration Relationship to Periodic Table



use noblegas 1 level above!!

Element	Full Electron Configuration	Core Notation
Al	$1s^2 2s^2 2p^6 3s^2 3p^1$	$[Ne]3s^2 3p^1$
Tc	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^5$	$[Kr]5s^2 4d^5$
Kr	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6$	$[Ar]4s^2 3d^{10} 4p^6$
Ca	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$	$[Ar]4s^2$
Zr	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^2$	$[Kr]5s^2 4d^2$
Ga	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^1$	$[Ar]4s^2 3d^{10} 4p^1$

Element	Full Electron Configuration	Core Notation
Rh	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^7$	$[Kr]\,5s^2 4d^7$
Li	$1s^2 2s^1$	$[He]\,2s^1$
Sn	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^2$	$[Kr]\,5s^2 4d^{10} 5p^2$

Use the periodic table to identify the <u>neutral atoms</u> having the following electron configurations:

Electron Configuration	Element Name
[Ne] $3s^2$	Mg - Magnesium
[Ar] $4s^2\ 3d^5$	Mn - Manganese
[Kr] $5s^2\ 4d^{10}\ 5p^3$	Sb - Antimony
[Xe] $6s^2\ 4f^7$	Eu - Europium

Consider the following six ions: N^{3-} O^{2-} F^- Na^+ Mg^{2+} Al^{3+}

(−) → add e⁻
(+) → remove e⁻

a) How many electrons are present in each ion?

10 electrons

b) Write a single electron configuration representing all of the ions.

$1s^2 2s^2 2p^6$

c) Which neutral atom posses this electron configuration?

Neon.

Complete the following table for some elements in two families of the periodic table:

Alkali metals	Core Notation	# Outer Electrons	Halogens	Core Notation	# Outer Electrons
Lithium	$[He]\,2s^1$	1	Fluorine	$[He]\,2s^2 2p^5$	7
Sodium	$[Ne]\,3s^1$	1	Chlorine	$[Ne]\,3s^2 3p^5$	7
Potassium	$[Ar]\,4s^1$	1	Bromine	$[Ar]\,4s^2 3d^{10} 4p^5$	7
Rubidium	$[Kr]\,5s^1$	1	Iodine	$[Kr]\,5s^2 4d^{10} 5p^5$	7

a) Consider the number of outer electrons present and suggest a reason why elements belonging to the same chemical family demonstrate similar chemical behavior.

- all have same # of outer electrons

b) What change occurs in the atoms as we move down each chemical family?

- # of electrons increase
- more orbitals are filled

Electron Configuration Exceptions

⇒ A filled or exactly half-filled d-subshell is very stable

- Half filled: d^5
- Filled: d^{10}

Example:

Chromium: $[Ar]\,4s^2\,3d^4 \longrightarrow [Ar]\,4s^1\,3d^5$

Copper: $[Ar]\,4s^2\,3d^9 \rightarrow [Ar]\,4s^1\,3d^{10}$

Molybdenum: $[Kr]\,5s^2\,4d^4 \rightarrow [Kr]\,5s^1\,4d^5$

Electron Configuration of Ions

Negative Ions:

- Add negative electrons to the last unfilled subshell

Example: O^{2-}

$[He]\,2s^2\,2p^4 + 2e^- \longrightarrow [He]\,2s^2 2p^6$

Positive Ions:

Two Rules:

1. Electrons in the outermost shell (largest n-value) are removed first
2. If there are electrons in the p and s-orbitals, remove the p-orbital electrons first

Important Note:

- Even though d-orbitals fill after the s-orbital of the next energy level, the s-orbital electrons of the higher energy level get removed first

Write the core notation for the atom, then remove electrons in the order:

p-electrons before s-electrons before d-electrons

Example:

$Tin^{2+} \longrightarrow [Kr]\,5s^2\,4d^{10}\,\cancel{5p^2} \longrightarrow [Kr]\,5s^2\,4d^{10}$

$Tin^{4+} \longrightarrow [Kr]\,\cancel{5s^2}\,4d^{10}\,\cancel{5p^2} \rightarrow [Kr]\,4d^{10}$

$Vanadium^{2+} \longrightarrow [Ar]\,\cancel{4s^2}\,3d^3 \longrightarrow [Ar]\,3d^3$

Use the periodic table to complete the following table:

Atom or Ion	Electron Configuration	Core Notation
Zn	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10}$	$[Ar]\ 4s^2 3d^{10}$
Zn^{2+}	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10}$	$[Ar]\ 3d^{10}$
Br	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^5$	$[Ar]\ 4s^2 3d^{10} 4p^5$
Br^-	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6$	$[Ar]\ 4s^2 3d^{10} 4p^6$
In	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^1$	$[Kr]\ 5s^2 4d^{10} 5p^1$
In^{3+}	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 4d^{10}$	$[Kr]\ 4d^{10}$

Write the electron configuration of the following ions, using core notation:

1. H^- $1s^2$
2. Sr^{2+} $[Ar]\ 4s^2 3d^{10} 4p^6$
3. Br^- $[Ar]\ 4s^2 3d^{10} 4p^6$
4. N^{3+} $[He]\ 2s^2$
5. Ti^{2+} $[Ar]\ 3d^2$
6. N^{2-} $[He]\ 2s^2 2p^5$
7. Mn^{2+} $[Ar]\ 3d^5$
8. Ge^{4+} $[Ar]\ 3d^{10}$
9. Fe^{3+} $[Ar]\ 3d^5$
10. Ge^{2+} $[Ar]\ 4s^2 3d^{10}$
11. Ru^{3+} $[Kr]\ 4d^5$
12. Sb^{3+} $[Kr]\ 5s^2 4d^{10}$