Chemistry 11

Atomic Theory III

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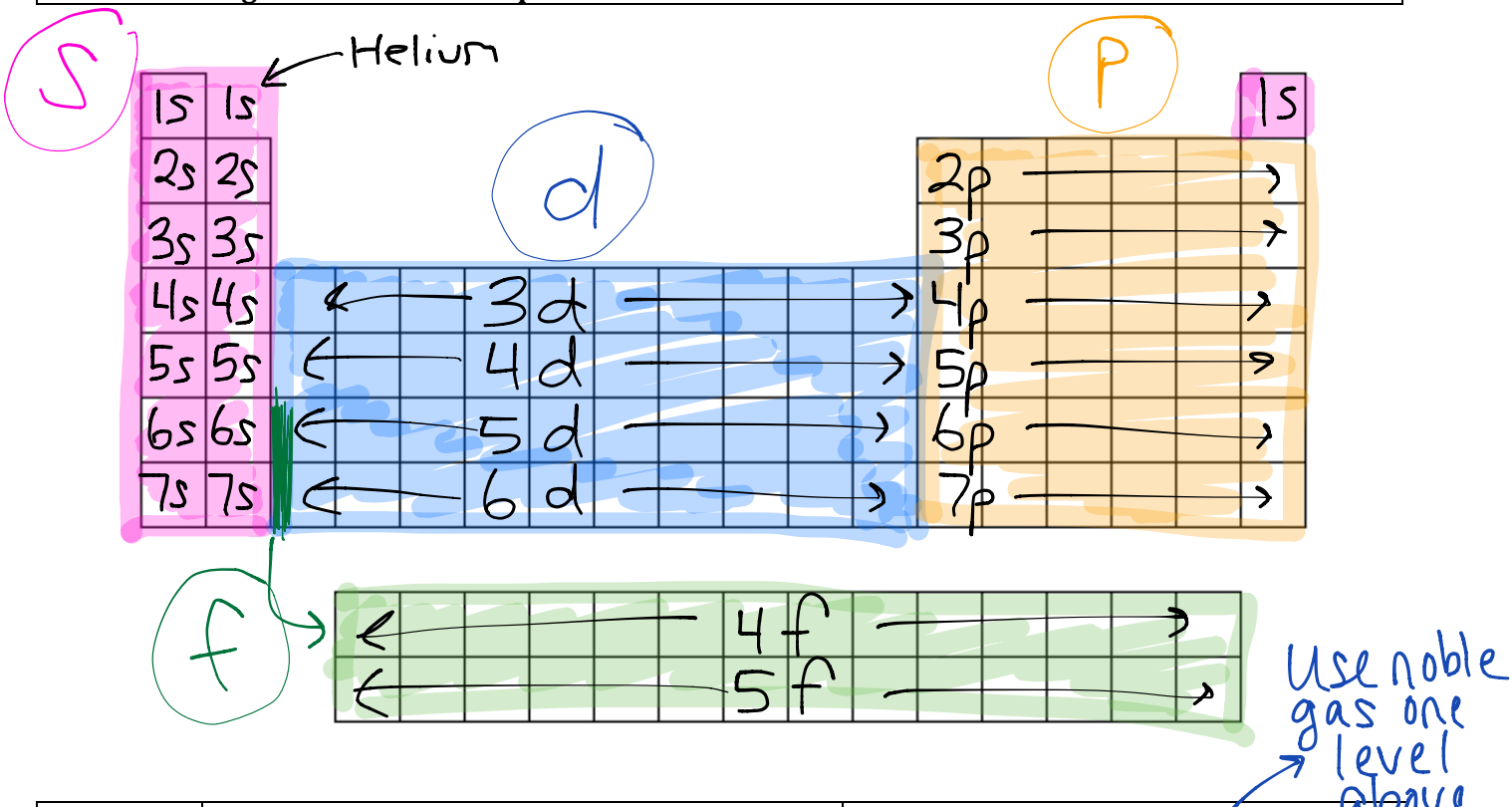
1. EC Relationship to Periodic Table
2. Electron Configuration Exceptions
3. Electron Configuration of Ions

Electron Configuration Relationship to Periodic Table



Use noble gas one 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] $3s^2$	Magnesium
[Ar] $4s^2\ 3d^5$	Manganese
[Kr] $5s^2\ 4d^{10}\ 5p^3$	Antimony
[Xe] $6s^2\ 4f^7$	Europium

(−) → add e⁻
(+) → remove e⁻

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

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 the same # of outer electrons

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

- overall # 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: $[Ar]4s^2 3d^4 \rightarrow [Ar]4s^1 3d^5$

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-}

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

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

① p-orbitals ② s-orbitals ③ d-orbital

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

P → s → d

Example:

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

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

$Vanadium^{2+}$: $[Ar]4s^2 3d^3 \rightarrow [Ar]3d^3$

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