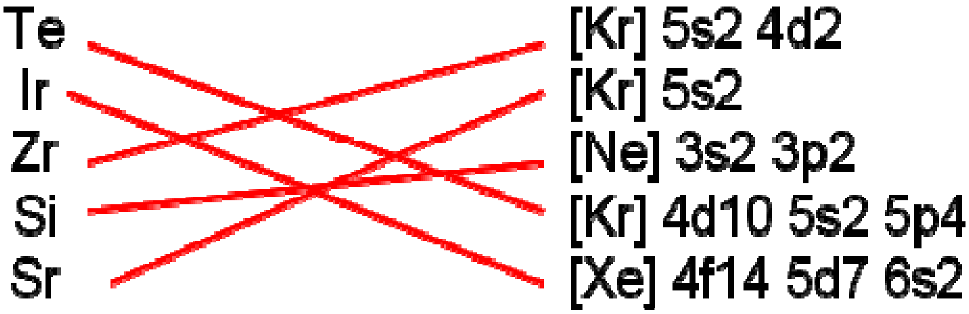
CH301 Fall 2010 Worksheet 3 Answer Key: Electron Configurations and Periodic Trends

1. Match the following elements with their corresponding electron configurations



2. Write the electron configuration of arsenic (As) in long notation and in short (noble gas) notation.

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

3. Write the electron configuration of a divalent cobalt cation (Co^{2+}) in long and in short notation.

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^5$
[Ar] $4s^2\ 3d^5$

4. Write the electron configuration of a monovalent astatine anion (At^-) in long and in short notation.

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

5. Write the electron configuration of ununoctium (Uuo), atomic number 118, in long and in short notation.

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^6\ 5s^2\ 4d^{10}\ 5p^6\ 6s^2\ 4f^{14}\ 5d^{10}\ 6p^6\ 7s^2\ 5f^{14}\ 6d^{10}\ 7p^6$
[Rn] $7s^2\ 5f^{14}\ 6d^{10}\ 7p^6$

6. Although it can’t be found on any periodic table, what would element 120’s electron configuration be, in long and short notation?

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^6\ 5s^2\ 4d^{10}\ 5p^6\ 6s^2\ 4f^{14}\ 5d^{10}\ 6p^6\ 7s^2\ 5f^{14}\ 6d^{10}\ 7p^6\ 8s^2$
[Uuo] $8s^2$

7. Which ground state element corresponds to the following electron configurations?

a. [Rn] $7s^2\ 5f^{14}\ 6d^5$
bohrium (Bh)

b. [Ne] $3s^2\ 3p^2$
silicon (Si)

c. [Xe] $6s^2\ 4f^{14}\ 5d^2$
halfnium (Hf)

d. [Kr] $5s^1\ 3f^{14}\ 4d^{10}$ (note: this might not make sense until Thursday’s lecture)
silver (Ag)

e. [Ar] $4s^1\ 3d^5$
chromium (Cr)

8. Consider the element calcium (Ca). What is the effective nuclear charge experience by electrons in the following of Ca's subshells?

a. 4s

    2

b. 3p

    10

c. 3s

    10

d. 1s

    20

9. If a helium atom had an electron had one of its electrons excited from its 1s subshell to a 2s sbshell, what would be the ENC experienced by that electron?

    He has two protons, and the unexcited electron would now be screening the excited electron.

10. Consider an electron in the orbitals given and rank them from most attracted to the nucleus to least attracted to the nucleus by comparing their effective nuclear charges that they each experience.

(i) 3p in Mg   (ii) 2p in O   (iii) 4s in Ca   (iv) 2s in K

    iv > ii > iii > i

11. Do what you did in 10, but rank them from least attracted to most attracted.

(i) 2s in N   (ii) 3p in Sc   (iii) 3s in S   (iv) 2p in Fe

    i < iii < ii < iv

12. Consider the trends below. As effective nuclear charge increases, do these trends increase or decrease?

a. electron affinity

    increases

b. atomic radius

    decreases

c. ionozation energy

    increases

d. metallic character

    decreases

13. For the trends above (electron affinity, atomic radius, ionozation energy, metallic character) we are comparing elements to other elements. How is the ionic radius trend different?

For ionic radius, we are not comparing neutral elements to other neutral elements. We are comparing isolectronic sets, groups of ions with the same total electron count.

14. For each species below, write its set of isoelectronic species

a. S^{2-}

    P^{3-} Cl-   Ar K^{+} Ca^{2+}

b. He

    H^{-} Li^{+} Be^{2+}

15. Write the set of isolectronic species for Mg^{2+} and arrange them from smallest to largest

    N^{3-} O^{2-} F^{-} Ne Na^{+}

    $Mg^{2+} < Na^{+} < Ne < F^{-} < O^{2-} < N^{3-}$

16. Arrange the elements Cs, P, K, O, He, F by:

a. increasing electron affinity

He < Cs < K, < P < O < F

b. decreasing atomic radius

Cs > K > P > O > F > He

c. decreasing ionozation energy

He > F > O > P > K > Cs

17. Why do noble gases have exceptionally low electron affinities and exceptionally high ionization energies?

Because noble gases have completely filled shells, which are highly stable, they have little energetic motivation to acquire or release electrons. They're rather quite happy just as they are.

18. What effects do filled and half-filled subshell conisderations have on electron configurations?

The additional stability afforded by filled and half-filled subsells can result in transition metals sometimes "borrowing" 1 electron to half fill their d subshell, or borrowing up to 2 electrons in order to completely fill their d subshell. Also, this can effect the the removal of electrons from post-transition metal ions, which are sometimes isoelectronic with transition metals.

19. Arrange the following sets of elements as described.

a. Si, P, S, Cl - increasing electron affinity

P < Si < S < Cl

b. C, N, O, F - decreasing ionization energy

F > N > O > C

20. Explain the "hiccups" in the periodic trends below in terms of filled and half-filled subshells.

a. electron affinity

Electron affinity increases with ENC, but the additional stability afforded by a filled or half-filled subshell makes elements with these configurations less interested in additional electrons than you might expect. Consequently, elements such as N and P have lower (sometimes much lower) electron affinities than you would predict without considering this effect.

b. ionization energy

Ionization energy increases with ENC, but the additional stability afforded by a filled or half-filled subshell makes elements with these configurations less willing to lose an electron than you might expect. Consequently, elements such as N and P have higher (sometimes much higher) ionization energies than you would predict without considering this effect.