BMEN 343 **NAME (PRINT)**_______________________________________

HOMEWORK #1 (60 PTS) **SIGNATURE:**_______________________________________

DUE: <u>11 September 2009</u> at the BEGINNING OF CLASS:

- There are 2 pages to this homework. Answers should be given neatly, in order, and in the space provided. <u>Show work for full credit</u>. Put the final answer in a box when appropriate.

<u>True or False: (Circle T or F)</u>

1. **(2 pt)** T F Before being filled with electrons, the 3d subshell is lower in energy than the 4s subshell.-FALSE
2. **(2 pt)** T F Orbitals with same "n" belong to same shell. -TRUE
3. **(2 pt)** T F A B (boron) atom is more electronegative than an O (oxygen) atom. -FALSE
4. **(2 pt)** T F A Fe (iron) atom is smaller than a Ti (titanium) atom. -TRUE
5. **(2 pt)** T F The angular quantum number designates orbital shape. -TRUE
6. **(2 pt)** T F For polar molecules, permanent dipoles exist. -TRUE
7. **(2 pt)** T F The number of atoms in 1 BCC unit cell is 4. -FALSE

<u>Brief Answer</u>

1. **(11 pts)** What is the <u>electronic configuration</u> of Co^{3+} ? (Show how you derived your answer using an orbital diagram; do not use any abbreviations such as [Ar]) **(4 pt)** What is the <u>valence electronic configuration</u>? **(4 pt)** What is the <u>valence shell</u> (K, L, etc)? **(3 pt)**

Notes:
- An orbital diagram not depicted in the key but is required for full credit (or – 3 points). Easiest to construct the Co neutral atom orbital diagram and then remove electrons per the order prescribed. The orbital diagram is NOT a substitute for *stating* the "configuration".

- Co (Z = 27 so 27 electrons): electronic configuration = $1s^22s^22p^63s^23p^63d^74s^2$ and its valence electronic configuration = $3d^74s^2$

- **Thus, electronic Configuration of Co^{3+}: $1s^22s^22p^63s^23p^63d^6$ (4 pt)**
  (From a neutral Co atom, lost two ns electrons first, then one (n-1)d electrons).

- **Valence Electronic Configuration of Co^{3+}: $3s^23p^63d^6$ (4 pt)**

- Since valence n = 3, **M shell** (must be capital letter) **(3 pt)**

2. **(11 pts)** What is the electronic configuration of Ti^{3+} ? (Show how you derived your answer using an orbital diagram; do not use any abbreviations such as [Ar]) **(4 pt)** What is the valence electronic configuration? **(4 pt)** What is the valence shell (K, L, etc)? **(3 pt)**

Notes:
- orbital diagram not depicted in the key but is required for full credit (or – 3 points). Easiest to construct the Ti neutral atom orbital diagram and then remove electrons per the order prescribed. The orbital diagram is NOT a substitute for *stating* the "configuration".

- Ti (Z = 22 so 22 electrons): Filling up: $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^2$ → after filling → $1s^2 2s^2 2p^6 3s^2 3p^6 \underline{3d^2 4s^2}$

- **Thus, electronic configuration of Ti^{3+}: $1s^2 2s^2 2p^6 3s^2 3p^6 3d^1$ (4 pt)**
  (Note: From a neutral Ti atom, lost two ns electrons first, then one (n-1)d electrons).

- **Valence Electronic Configuration of Ti^{3+}: $3s^2 3p^6 3d^1$ (4 pt)**
  (Note: Write the entire n =3 shell now that no electrons in 4s)

- Since valence n = 3, **M shell** (must be capital letter) **(3 pt)**

3. **(8 pts)** What is the electronic configuration of O^{2-}? (*Show* how you derived your answer using an *orbital diagram*) **(3 pt)** What is the valence electronic configuration?**(3 pt)** O^{2-} has the same electronic configuration as what neutral atom? **(2 pt)**

O: Z = 8 so 8+2 = 10 electrons:

O^{2-}: **$1s^2 2s^2 2p^6$** (4 pt)

O^{2-}: **$2s^2 2p^6$** (3 pt)

Neon (Ne) (2 pt)

4. **(4 pts)** Briefly describe London (dispersion) forces *including* their origin (i.e. why they occur).

Weak attractive forces (1 pt) between molecules due to **instantaneous dipoles** (1 pt) that occur because of **varying positions of electrons during motion** about nuclei (1 pt)

5. **(6 pts)** Calculate the volume of unit cell of nickel (Ni) in cubic meters. Refer to Table 3.1 in your book.

Nickel has FCC crystal structure

Nickel: R = 0.1246 nm = 0.1246×10^{-9} m

$V_c = 16R^3\sqrt{2} = (16)(0.1246 \times 10^{-9}\ m)^3(\sqrt{2}) = \mathbf{4.38 \times 10^{-29}\ m^3}$

(minus 1 if wrong unit)

6. **(6 pts)** Calculate the theoretical density (g/cm^3) of tungsten (W). Refer to Table 3.1 in your book.

Tungsten: BCC crystal structure so 2 atoms per unit cell
Atomic radius (R) = 0.1371 nm = 0.1371×10^{-7} cm
Atomic weight = 183.85 g/mol
$a = 4R/\sqrt{3}$ = 0.3166 nm = 0.3166×10^{-7} cm
$V_c = a^3 = (4R/\sqrt{3})^3 = (0.3166 \times 10^{-7}\ cm)^3 = 3.17 \times 10^{-23}\ cm^3$

$$\text{Density } (p) = \frac{(n)(A)}{(V_c)(N_A)}$$

$$\text{Density } (p) = \frac{(2\ \text{atoms})(183.85\ \text{g/mol})}{(3.17 \times 10^{-23}\ cm^3)(6.023 \times 10^{23}\ \text{atoms/mol})}$$

19.24 g/cm^3

Note: From Table B.1 in book, density = 19.3 g/cm^3