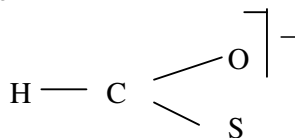


CHEM 245 Fall 2009
PROBLEM SET-I

- Determine the de Broglie wavelength of:
 - An electron moving at one-tenth the speed of light.
 - A 400 g Frisbee moving at 10 km/h.
- The transitions from the $n = 7$ to the $n = 2$ level of the hydrogen atom is accompanied by the emission of light slightly beyond the range of human perception, in the UV region of the spectrum. Determine the energy and wavelength of this light.
- What does the term Bohr radius mean?
- For the $3p_z$ and $4d_{xz}$ hydrogen-like atomic orbitals, sketch the following:
 - The radial function R .
 - Radial probability function $a_0 r^2 R^2$.
- What does it mean by a node? Angular, radial and spherical nodes?
- For $3p_z$ and $4d_{xz}$ hydrogen-like atomic orbitals:
 - How many radial nodes do each orbital have?
 - How many angular nodes do each orbital have?
- Find the possible values for the l and m_l quantum numbers for a $5d$ electron, a $4f$ electron and a $7g$ electron.
 - Find the possible values for all four quantum numbers for a $3d$ electron.
- Using Slater's Rule determine the Z_{eff} for:
 - [2.15.(d)] A $4f$ electron in Ce:
 - [2.15.(b)] A $2p$ electron in O^{2-} :
 - [2.15.(b)] A $2p$ electron in Na^+ :
- Select the better choice in each of the following and briefly explain it.
 - Higher ionization energy: Ca or Ga
 - Higher ionization energy: Mg or Ca
 - Higher electron affinity: Si or P
 - More likely configuration for Mn^{2+} : $[Ar] 4s^2 3d^3$ or $[Ar] 3d^5$
- On the basis of electron configurations, explain why:
 - Sulfur has a lower electron affinity than chlorine.
 - Iodine has a lower electron affinity than bromine.
 - Boron has a lower ionization energy than beryllium.
 - Sulfur has a lower ionization energy than phosphorus.
 - Chlorine has a lower ionization energy than fluorine.
- Predict the largest and smallest in each series:
 - Se^{2-} Br^- Rb^+ Sr^{2+}
 - Y^{3+} Zr^{4+} Nb^{5+}
 - Co^{4+} Co^{3+} Co^{2+} Co

12. Several resonance structures are possible for each of the following ions. For each, draw these resonance structures, assign formal charges and select the best resonance structure for the ion.

- a) Selenocyanate ion, SeCN^-
- b) Thioformate ion



- c) Dithiocarbonate, $[\text{S}_2\text{CO}]^{2-}$ (C is central)

13. Draw the resonance structures for the isoelectronic ions NSO^- and SNO^- . Assign formal charges. Which ion is more likely to be stable?

14. From each set given below, select the molecule or ion with the smallest bond angle, and briefly explain your choice:

- a) NH_3 , PH_3 or AsH_3
- b) O_3^+ , O_3 or O_3^-
- c) SOCl_2 or SOF_2 (halogen-S-halogen angle)
- d) NO_2^- or O_3
- e) ClO_3^- or BrO_3^-

15. Determine the EPG and the shape of the following:

- a) ICl_2^- b) H_3PO_3 c) IO_4^- d) SOCl_2 e) ClOF_4^- f) XeO_2F_2

16. The bond angles at the nitrogen atom are indicated in parentheses for the following species: NH_3 (106.6°), $\text{N}(\text{CH}_3)_3$ (110.9°), $\text{N}(\text{SiH}_3)_3$ (120°), $\text{N}(\text{GeH}_3)_3$ (120°). Explain this trend.

17. In the following bond, which atom is more electronegative? Try to put them in order of increasing polarity:

- a) C-N b) N-O c) C-I d) O-Cl

18. The dipole moment of the gaseous HCl molecule is 0.827 D. Determine the charge distribution in this diatomic molecule if the bond distance is 141.5 pm.