ATOMIC STRUCTURE AND INTERATOMIC BONDING

1) (a) Cite two important quantum mechanical concepts associated with the Bohr model of the atom
   
   (b) Cite two important additional refinements that resulted from the wave-mechanical atomic model

2) Allowed values for the quantum numbers of electrons are as follows:

   \( n = 1, 2, 3, \ldots \) (K,L,M,...shells)

   \( l = 0, 1, 2, 3, \ldots (n-1) \) (subshell, e.g. \( l=1 \) corresponds to p-subshell)

   \( m_l = 0, 1, 2, 3 \ldots (2l+1) \)

   \( m_s = \pm \frac{1}{2} \)

   (a) Write the four quantum numbers for all of the electrons in the L shell in the form of \( 'nlm_l m_s' \) and note which corresponds to the s,p,d subshell

   (b) List the different ways to write the 4 quantum numbers of a 3p orbitals

3) (a) Give the electron configurations of Fe;Fe\(^{3+}\), Al;Al\(^{3+}\), Cu;Cu\(^+\), S\(^2-\), Mn;Mn\(^{2+}\)

   (b) Calcium oxide (CaO) exhibits predominantly ionic bonding. The Ca\(^{2+}\) and O\(^{2-}\) ions have electron structures that are identical to which inert gases?

      (Atomic numbers (Z): Fe=26, Al=13, Cu=29, S=16, Mn=25, Ca=20, O=8)

4) The net potential energy between two adjacent ions, \( E_N \), may be represented by:

   \[ E_N = -\left( \frac{A}{r} \right) + \frac{B}{r^n} \]

   a) Determine the equilibrium interionic spacing

   b) Determine the expression for \( E_O \)
5) Briefly cite the main differences between ionic, covalent and metallic bonding

6) The percent ionic character of a bond between elements A and B (A being the most electronegative) may be approximated by the expression;

\[ \%_{\text{ionic character}} = (1 - e^{-(0.25)(X_A - X_B)^2}) \times 100 \]

\( X_A \) and \( X_B \) are the electronegativities for the respective elements.

Compute the percent ionic character of the interatomic bonds for the following compounds: FeO and CsF

7) Determine the number of the covalent bonds that are possible for atoms of the following elements: Si, Ni, S, Br

8) (a) What type of bonding would be expected for each of the following materials and compounds:

Rubber: \((\text{CH}_2: \text{C(Ch}_3\text{)CH: CH}_2)\), Solid xenon, bronze, nylon(n\text{HOOC-(CH}_2\text{)4-COOH}+n\text{H}_2\text{N-(CH}_2\text{)6-NH}_2\text{--} \rightarrow [-\text{OC-(CH}_2\text{)4-CO-NH-(CH}_2\text{)6-NH-}] n+2n\text{H}_2\text{O and the part --CO-NH- will stick together}), \text{BaS, AlP, MgO, LiF, KCl, H}_2\text{O, CO}_2, \text{HCl}

(a) What type of intermolecular bonding would be expected for each of the compounds:

HF, HCl, H2O