# Atomic Structure

Bohr Theory

1. The distance between two ions $A^+$ and $B^-$ is 10 $A^o$
   a. If the distance is decreased to 2 $A^o$, the attractive force _____ (increases/decreases) by a factor of _____.
   b. If the charge on A is increased by 2+ and the charge on B is increased to 2-, then the attractive force _____ (increases/decreases) by a factor of _____ (distance between the ions is 2 $A^o$)
2. The blue line in the absorption spectrum of hydrogen has a wavelength of 4340 angstrom $A^o$
   a. Calculate the frequency of radiation producing this line.

   b. Calculate the energy of the photons giving rise to this line in
      (i) ergs

      (ii) kJ

      (iii) electron volts

Conversion factors:
$1A^o = 1 \times 10^{-8}$ cm
$1A^o = 1 \times 10^{-10}$m
$1nm = 4.18 \times 10^{-9}$m
1 kcal = $4.18 \times 10^{10}$ ergs
1kcal = 4.18 kJ
1 ev = $1.60 \times 10^{-12}$ergs
1 ev = $1.60 \times 10^{-19}$Joules

3. Given $E_n = -13.6/n^2$ev, calculate the energies of the K,L and M shell electrons of the hydrogen atom in ev.

4. Calculate the frequency of radiation require to promote an electron from the ground state to the second excited state in the hydrogen atom (work in ev). The first excited state is n = 2, second excited state n = 3 and the ground state n = 3 and the ground state is n = 1.

5. Calculate the wavelengths of the first 4 lines in the Balmer emission spectrum of hydrogen. Work in ev units for energy. Refer your answers to the colour as demonstrated in the line spectra.
   (1)

   (2)

(3)

(4)

6. Calculate the frequency of the spectral line rep0resenting the transition n = 2 to n = 1. To which spectral series does it belong? In what region of the electromagnetic spectrum does this series belong?

7. Given that $\frac{2\ \pi^2 m e^4 Z^2}{E^2 n^2 h^2}$= 1066.5 kcal for n = 1 for sodium. Calculate the first ionization energy potential for the element sodium.

Quantum Mechanics

1. What is the relationship between the Bohr shells K,L,M,N etc. and the principle quantum number 'n' in quantum mechanics?

2. For each of the following principle quantum numbers 'n' show the type (letter) and number of orbital's allowed at that level.
   (a) n = 1 (b) n = 2

   (c) n = 3 (d) n = 4

3. (a) Define the term degenerate orbital's

   (b) How does the orbital energy diagram of hydrogen differ from any of the other multi-electron atoms?

4. Identify the elements whose neutral atoms have the electron configurations:
   (a) $1s^2\ 2s^2$ _____
   (b) $1s^2 2s^2 2p^2 3s^1$_____
   (c) $1s^2 2s^2 2p^3$_____
   (d) $1s^2 2s^2 2p^6 3p^3$_____
   (e) $1s^2 2s^2 2p^2 3s^2 3p^6 3d^5 4s^1$_____

5. Draw the electron configuration diagrams of the following elements (Check for the exceptions)
   (a) nitrogen
   (b) strontium
   (c) copper
   (d) tungsten

6. Which of the following represents the electron configuration of an excited atom?
   (a) $1s^2 2s^2 2p^6$ (b) $1s^2 2s^1 3s^1$ (c) $1s^2 2s^2 2p^2 3s^1$ (d) $1s^2 2s^2 4d^1$

   Which is likely to give off the photon with the greatest energy on returning to the ground state?

7. Explain why orbital's replace orbits in the modern atomic theory. (Hint: Heisenberg's Uncertainty principle)

8. Using an electron energy level diagram for carbon, explain the meaning of Hund's Rule.

9. What is an orbital?

10. Explain using orbital theory why $PCl_5$ can exist while $NCl_5$ can't.

11. Sketch the shapes of the's', 'p' and'd' orbital's show all possibilities.

12. Which orbital's are represented by the following sets of quantum numbers.
    (a) 1,0,0, + ½ _____ (b) 2,1,-1, - ½ _____
    (c) 3,2,+1, + ½ _____ (d)4,3,-2, + ½ _____

13. The maximum number of electrons in any shell is calculated by:

14. Write the electron configuration for an $sp^3$ hybridized carbon atom.

15. When we say that the energy of the electron is quantized, what does that mean?

16. Explain why the Pauli Exclusion Principle only allows two electrons as a maximum in each orbital?