Lecture 21

Outline of Last Lecture

- To understand the quantum-mechanical model of an atom, we have to know about electromagnetic radiation.
- Section 7.2: Light behaves as a wave. It has a frequency (ν) and a wavelength (λ) that are related by its speed. It refracts and diffracts
- It undergoes constructive and destructive interference.

  Vλ = C

  c=2.99792458x10^8m/s
- Section 7.4: But light also behaves like a particle. The photoelectron effect (pp 319-321), in particular, was best explained if light consisted of small "packets" of energy (photons). The energy of a photon is related to its frequency.

  E= v . h

  h= 6.62606931x10^-34J.s

Outline of Current Lecture

- The H atom is one proton and one electron.
- The energy of an orbital is determined solely by n.
- All orbitals in a shell have the same energy.

Current Lecture

-An electron will preferentially occupy the lowest energy orbital available. The single electron in a hydrogen atom occupies the orbital with n=1, l=0, m=0 (the 1s orbital)

-The lowest energy state for an atom, ion, or molecule, is to have all the electrons in the lowest energy orbitals possible. This is called the ground state.

-Any other configuration of the electrons would be an excited state.

-ground state electron configuration for H:

H 1s^1

-ground state orbital diagram for H:

H 1

-Write an electron configuration for an excited state of H:

1s 2s

-In the helium atom, a second electron also occupies the 1s orbital.

Pauli exclusion principle: two electrons can occupy the same orbital if they have opposite spins.

-This requires a fourth quantum number: m , the spin quantum number ms can have values of +½ and -½.

-No two electrons in an atom can have the same set of four quantum numbers.

- In helium:

  electron "A" n = 1, l = 0, m = 0, m = ½

  electron "B" n = 1, l = 0, m = 0, m = -½

-The presence of more than one electron also affects the energy levels of the orbitals: The energy is now dependant upon the values of both n and l. (shell and subshell).

Q: Write the full electron configuration for the ground state of:

Silicon

Si 1s^1 2S^2 2P^6 3S^2 3P^2

Manganese

Mn 1S^2 2S^2 2P^6 3S^2 3P^6 4S^2 3d^5

Q: Draw orbital diagrams for the ground state of:

carbon

1s 2s 2p

iron

[Ar] 2s 3d

Q: What are the quantum numbers that specify the highest energy electrons in Si, Mn, C, and Fe?

Si n=3 , l=1 , me= -1

Mn n=3 , l=2, me= -2

C n=2 , l=1, me= -1