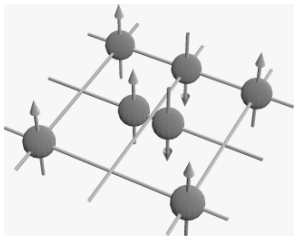
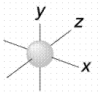
Chemistry of Life….

Is the chemistry of electron-electron interactions



Electron Orbitals



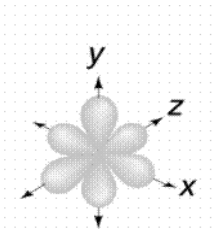
- e- were shown in the Bohr model as planets spinning about a central sun
- In reality it is not possible to truly locate an e- position….only its probability of being somewhere
- The likely position in space for an e- is described as e- orbitals

Niels Bohr
1885-1962
Copenhagen, Denmark

Electron Orbitals

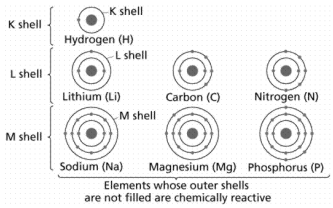
Or: e- Position in space

- Lie in discrete regions at different distances from the center
- Range from spherical to dumbbell-shaped
- Only 2 e- may exist in any orbital
- Text pg. 20



Energy Levels Or e- Shells

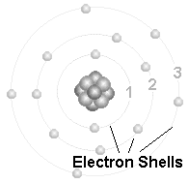
- e- posses potential energy (PE)
- like an apple held above the floor…
- e- orbitals exist in discrete energy levels (or shells)
- Shells further away with more PE
- e- shells termed K, L, M…
- Text pg. 21



e- Shells

- e- don't just cram into any available shell….
- There is order in the universe!
- Atomic theory predicts that the maximum number of e- in any shell follows a formula…

$2n^2$



$2n^2$

- Where n = the Shell number
- K=1
- L=2
- M=3
- ….. And so on...

Shell Number	Maximum Number of Electrons in the Shell
1	2 x 1 = 2
2	2 x 4 = 8
3	2 x 9 = 18
4	2 x 16 = 32
5	2 x 25 = 50

Quiz

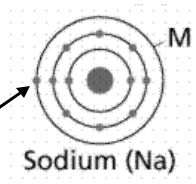
- How many e- will fit into each of the first three e- Shells
- Draw the e- shells for the first 8 elements….
- Draw the e- shells for the element Magnesium

Biological Chemistry is the Chemistry of e- interactions

- Which e- are most important?
- The outermost ones!
- These are termed the valence e-
- Atoms '*desire*' to have their outermost e- shell filled
- If not filled completely, they 'like' the number 8
- Text pg. 21

Atoms will 'strive' to fill their outer orbitals

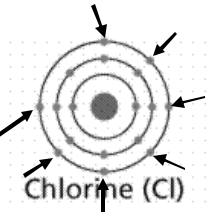
- If an atom has 1 valence e-, it's 'happy' to give it away
- Example: Sodium (text pg. 24)



1 valence e-

Atoms will 'strive' to fill their outer orbitals

AND…If an atom has 7 valence e-, it's 'happy' to pick up one
Ex. Chlorine (text pg. 24)



7 valence e-

Oxidation/Reduction

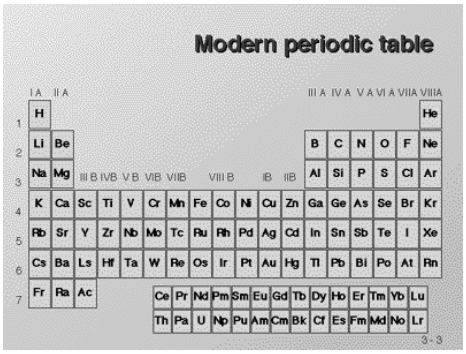
- Atoms which give up an e- are now oxidized
- Atoms which pick up an e- are now reduced
- These are known as Red/Ox reactions

Biological Chemistry is dependent on valence e-

- What if the outer shell is filled?
- Example: He with 2 e- in K shell
- Ne with 2, 8 e-
- Ar with 2,8,8 e-
- These are the non-reactive (inert) elements
- Text pg. 21

The Periodic Table

- The Russian chemist, Mendeleev
- A pattern of chemical properties that tends to repeat in groups of 8 elements
- Table arranged so that horizontal rows increase by At. No.,
- vertical rows arranged by similar chemical properties
- Text pg.18

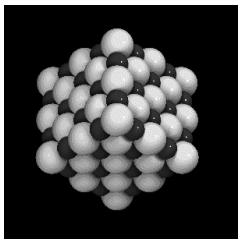


Chemical Bonds

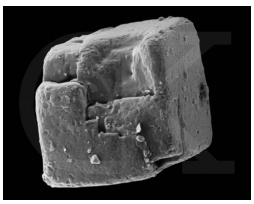
- The transferring or sharing of e- between 2 atoms
- Two or more elements involved in this relationship form a molecule
- ….Molecules are formed by chemical bonds

Chemical Bonds: Ionic Bonds

- Formed by the electrical attraction between (+) and (-) charged atoms
- Example $Na^{+}Cl^{-}$ Text pg. 25
- Indicated by + and – signs on each element



$Na^{+}Cl^{-}$



Quiz

- Which of the following elements is Na most likely to form ionic bonds with?

  K

  S

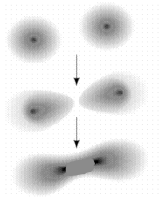
  Br

  Mg

- Why ???

Covalent Bonds

- Two atoms may *agree* to share e- rather than give them away…
- Consider Hydrogen
- With 1 valence e-, H would like another (Why?)
- 2 H's can each share 1 e-
- Text pg. 22
- End result is a stable molecule of H_2 gas
- Covalent bonds are strong!



Review

- Ionic bonds occur when e- are shared in a +/- arrangement
- Covalent bonds exist when one atom shares 1 or more e- with another atom.
- One covalent bond means 2 e- are involved. *Always involves a pair of e-*

Multiple Covalent Bonds

- Two elements may share more than 1 pair of e-
- If 2 pair are shared…. A double bond
- If 3 pair…a triple bond

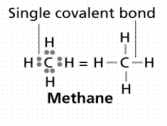
Covalent Bonds

- A single covalent bond is indicated by a single line joining two elements

  C-C

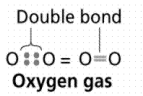
  H-H

  O-O



- A double covalent bond by two lines

  C=C



Quiz

- How many e- are involved in the following covalent bond: C-H
- How many in the following: N≡N
- Which of the following elements is more likely to form double bonds. Why?

  Si

  Li

  O

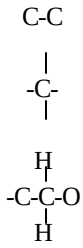
  P

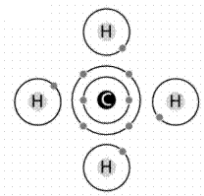
- How many covalent bonds do you think Carbon atoms commonly form? >

Covalent Bonds

- If an atom 'desires' 2, 3, or 4 e- to fill its valence shell, it will commonly form that many covalent bonds with 1-several other atoms.
- C would 'like' to have 4 more e- to complete its L shell
- C typically forms 4 covalent bonds

Carbon: 4 covalent Bonds

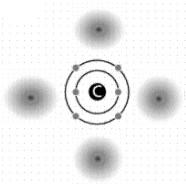




Carbon

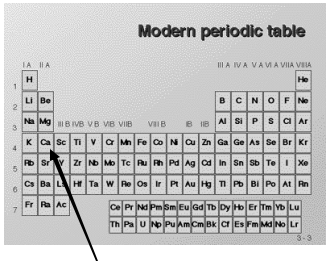
- The versatility of C to form 4 covalent bonds is so important to life…
- C can bond with many other atoms..

  i.e. C, O, N, P



The Atoms of Life

- Of the 92 natural elements in the universe only few (~11) are found in living organisms in more than trace amounts.
- All 11 have At. No. less than 21
- Life is mostly composed of low molecular weight elements!



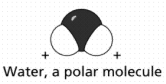
Atomic Number 20 = Calcium

The Atoms of Life

- In fact, only 4 elements make up 96% of living things….

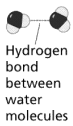
P. COHN

Chemistry of Water



Water, a polar molecule

Amazing stuff!!!
Should not be a liquid at room temp…
Why so unusual?
Text pg. 26-28
Highly Polar molecule.


Hydrogen bond between water molecules