BONDING CONCEPTS

Lab: Dimension of a molecule (oleic acid)

8.1 Types of Chemical Bonds

Bond Energy: energy required to break a bond. The system achieves the lowest energy this way.

Types of Bonds:

Ionic: Typically a metal (substance that loses electrons easily, low ionization energy) combines with a non-metal (substance with a high electron affinity, gains electrons easily).

Energy within a pair of ions: $E = 2.31x10^{-19}\,Jnm\left(\frac{Q_1Q_2}{r}\right)$, r is the distance in nm and Q are the numerical ionic charges. Ex. Na^{+1} = +1. An overall negative value gives evidence of an attractive force. That is, the ion pair has lower energy than the separate ions.

Bond length, the distance where the energy is minimal.

Covalent: electrons shred by nuclei.

Polar Covalent: Unequal sharing of electrons. Bond polarity

Ex. δ+ H-F δ-, a partial positive charge on H and a partial negative charge on F. F attracts the electrons more strongly to it.

8.2 Electronegativity

Electronegativity: ability of an atom within a chemical bond to attract electrons to itself.

Linus Pauling (1901 – 1995): 2 unshared Nobel Prizes in Chemistry (work in Electronegativity) and Peace.

A large difference in electronegativities leads to a more ionic component. Small differences have a more covalent characteristic. Trend moves to F with an assigned greatest Electronegativity of 4.0. Across period with (increasing atomic number) e.n. increases. Down family group e.n. decreases.

Ex. Ranking Sample Exercise 8.1:

8.3 Bond Polarity and Dipole Moments

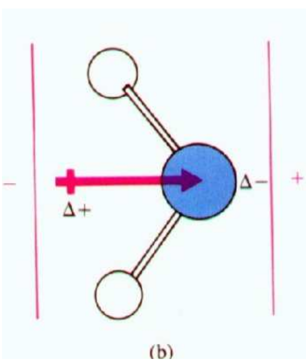
Molecule that has a center of positive charge and a center of negative charge.

Represented by: δ+ ↦ δ- Ex. H-F, H_2O, NH_3

Some molecules have polar bonds but no dipole moment. Ex. CO_2, SO_3, CCl_4 (These molecules do not line up in an electric field because the opposing bond polarities cancel each other out.)

Show the direction of the bond polarities and indicate which ones have a dipole moment.

Show for the above compounds.



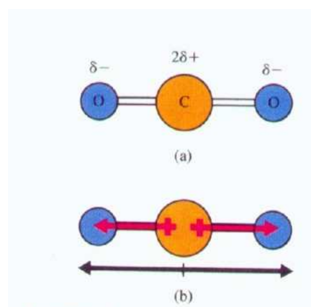


Figure 8.6

(a) The carbon dioxide molecule.
(b) The opposed bond polarities cancel out, and the carbon dioxide molecule has no dipole moment.

8.4 Ions

Electron Configurations and Sizes:

The atoms within a bond are most stable when their electrons are arranged to have a noble gas configuration.

- Two non-metals: React to form a covalent bond, they share electrons in a way that completes the valence of both atoms, i.e. a noble gas configuration.
- Non-metal and a representative group metal react to form a binary ionic compound. The ions form so that the valence electron configuration of the non-metal achieves the electron configuration of the noble gas and the valence orbital of the metal are emptied. Both achieved a noble gas configuration with their electrons.

Predicting Formulas

The solid phase of compacted negative and positive ions the maximizes the opposite charge attractions.
Review predicted ionic charges. Ex., Cl, Mg, O, etc.
Exceptions; Sn^{2+}, Sn^{4+} Pb^{2+},Pb^{4+} Bi^{3+},Bi^{5+} Tl^{+},Tl^{3+}

Size of Ions

(not a perfect value)

Positive ions are smaller than parent atom (lose electrons)
Negative ions are larger than parent atom. (gain electrons)
Consider nuclear charge in comparing Li^{+} with Be^{2+}, same number of electrons but Be has one more proton. Expect Be^{2+} to be smaller than Li^{+}.
S^{2-} > Cl^{-}, Cl has one more proton than S but same number of electrons.

Isoelectronic Ions; same number of electrons. Size decreases as nuclear charge increases.
Sample 4th Period Isoelectronic Series: Rank Se^{2-} , Br^{-}, Rb^{+}, and Sr^{2+} from largest to smallest.

Largest -> Se^{2-} > Br^{-} > Rb^{+} > Sr^{2+} <-smallest

8.5 Partial Ionic Character of Covalent Bonds

There is no perfect, pure ionic bond. Many ambiguities lie in the types of solids formed. Operational definition is that an ionic salt is any compound that conducts an electric current when melted.

Practice Problems for Study: P.382 # 13, 25, 29, 32, 35, 36, 37, 38, 39, 105