Chemistry 102 Winter 2010

Today

1. Brief review of bonding.
2. Intermolecular forces.

Announcements

1. DROP deadline today.
2. CSULA closure on Jan. 15 (furlough).
3. CSULA closure on Jan. 18 (holiday).
4. ADD deadline on Jan. 19, Tuesday.
5. First midterm exam on Jan. 25, Monday.
6. Bring textbook and calculator to each lecture.

Bonding: covalent and ionic (and metallic)

Examples:
Cl_2

HCl

NaCl

Bond classification scheme
Pure covalent: no difference in electronegativity.
Polar covalent: moderate difference.
Ionic: large difference.

Really a continuum (Fig. 8.7)

Electronegativity: χ ("chi"), the ability of an element to attract bonding electrons to itself, the ability of an element to pull electrons in a bond toward itself. See Fig. 8.6.

The type of bonding plays a major role in the properties of all substances. (discrete Cl_2 molecules vs. a lattice of NaCl, see Fig. 3.3)

Polar bonds also play a role.

Why is CH_4 a gas but CH_3I a liquid at room temperature?

dipole moment: a net separation of partial charges, a measure of the polarity of a bond or molecule.

A polar bond has a permanent dipole moment. HCl, Fig. 9.14. HCl is a polar molecule with a dipole moment.

The dipole (two poles) of one molecule is attracted to the dipole of another molecule.

dipole-dipole forces: attractions between two or more polar molecules (dipolar forces, permanent dipole forces)

The negative end of one molecule will be attracted to the positive end of the other molecule.

What about CH_4 and CH_3I?

Identify polar bonds and use VSEPR shape to determine if the molecule is polar.

Practice: Identify polar bonds and VSEPR shape

CH_4

CH_3I

Intermolecular Forces

Intermolecular forces (IMF's): the forces between two or more molecules, noncovalent interactions between molecules, usually weaker than chemical bonds.

What do intermolecular forces do?

Molecules attract each other and stick to each other.

Example: Gecko lizards

http://www.sciencenewsforkids.org/articles/20031119/Feature1.asp

Other examples of the effects of IMF's.

1. Some substances are a liquid or solid at room temperature, while others are a gas.
2. Some substances are very hard to boil.
3. Like substances can dissolve like substances ("like dissolves like").
4. Soaps can work.
5. Cell membranes can form.

Intermolecular forces are weaker than chemical bonds, but they are still important when explaining the behavior of molecules.

Four main types of IMF's

1. Dipole-dipole forces (dipolar forces, permanent dipole forces)

2. London forces (dispersion forces, induced dipole forces, temporary dipole forces)

3. Hydrogen bonds

4. Ion-dipole forces (hydration in Ch 14, pp. 511-512)

Dispersion forces

(London forces, induced dipole forces, temporary dipole forces)

Dispersion forces are dipolar forces that come from temporary charge imbalances (temporary dipoles), rather than a permanent dipole moment on a polar molecule.

The electron cloud of one molecule is temporarily distorted for a moment. At the same time, the electron cloud of another molecule is temporarily distorted.

The distortions allow the electron cloud of one molecule to be attracted to the nucleus of the other molecule.

All molecules have dispersion forces because all molecules have electron clouds.

polarizability: the ability of an electron cloud to distort and allow the molecule to become momentarily polar.

Larger electron clouds (larger n, less tightly held, more diffuse) are easier to distort than smaller (smaller n, more tightly held, more compact) electron clouds.

X_2	total v. e.	orbital size (n)	at room T
Cl_2	14	3	Gas
Br_2	14	4	Liquid
I_2	14	5	Solid

Looking at the phase at room T, which compound has the largest dispersion forces?

Looking at orbital size, which compound has the largest electron cloud?

Larger molecules have larger electron clouds simply because there are more electrons.

Hydrocarbons: compounds containing mostly hydrogen and carbon (C_xH_y…).

# of carbons	Example	at room T
1-4	C_3H_8 (propane)	Gas
6-12	Gasoline	Liquid
16-24	Engine lubricant	Viscous liquid
20 and above	Asphalt, wax	Solid

The larger the molecule (longer carbon chain), the more dispersion forces, the more the molecules stick together, and the more likely the substances is a condensed phase at room T.

Hydrogen bonding

hydrogen bond: the attraction between an extremely electron deficient hydrogen of one molecule and a very electron rich and electronegative atom (F, O, or N with lone pairs) of another molecule; this attraction is strong but not as strong as an actual bond between atoms.

1. F-H bond (p. 333)

2. -O-H bond

water: Fig. 9-21, and http://www.northland.cc.mn.us/biology/Biology1111/animations/hydrogenbonds.html

3. -N-H bonds also

General observations:
1. The *greater the magnitude* of the intermolecular forces, the higher the melting temperature and boiling temperature.

2. The *more types* of intermolecular forces, the higher the melting temperature and boiling temperature.

3. Substances with similar intermolecular forces attract each other more strongly and can mix more easily. "Like dissolves like"
(vs. "opposites attract" for electrical charges and magnetic poles)

Why are the small molecules CO_2 and H_2 gases at room temperature but H_2O is a liquid?

Although hazardous, mechanics in the past often used gasoline to wash away oil from their hands. Why?

Why do salad dressings containing oil and vinegar need to be shaken?

Ion-dipole forces

(hydration example Ch. 14, p. Fig. 10-34)

The negative ends of several polar molecules surround the positive ion (cation) and dissolve it.

The positive ends of several polar molecules surround the negative ion (anion) and dissolve it.

Example: Water dissolves NaCl.

http://www.chem.iastate.edu/group/Greenbowe/sections/projectfolder/flashfiles/thermochem/solutionSalt.html

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Before next class,

1. Study Chapter 9 and work on OWL HW.
3. Read Chapter 10.1-10.4, especially 10.3-10.4.