Announcements – 11/29/00

- **Exam #3: *Take Home Addendum***
  -***due by Friday at start of class (NO EXCEPTIONS)***
  -download (PDF file) or pickup hardcopy after class today
- **Friday: The Last Quiz**
- **Schedule for the remaining classes:**
  -Chapter 9 (readings and problems posted)
  -Chapter 11 (readings and problems TBA)
- **Final Exam:** Monday, 12/11, 8 am
  -Info page will be available by Friday
  -Review/Problem Sessions? Thurs (12/7) & Sun (12/10)?

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Where do CFC's go?

- **Unforeseen problem:** CFC's are so *unreactive* that they do not decompose in the lower atmosphere
- After 2-5 years, CFC's drift into the stratosphere (upper atmosphere) where they *photodissociate:*

$$CCl_3F + hn\ (UV) \rightarrow CCl_2F\bullet + Cl\bullet$$

- Cl• reacts with O_3:

$$Cl\bullet + O_3 \rightarrow ClO\bullet + O_2$$
$$ClO\bullet + O\bullet \rightarrow O_2 + Cl\bullet$$

-this cycle can repeat as many as 100,000 times before terminating and forming HCl or $ClONO_2$

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Environmental Implications

- As CFC levels have increased, O_3 levels have decreased (with the expected time delay)
- Effect is not disputed (scientifically)
  - resulted in a Nobel Prize for the scientists (Rowland and Mollina) who first proposed this
- Decreased O_3 levels allows more UV to reach the Earth's surface
  - 10% increase in UV causes about 10% increase in skin cancer (equiv. to living 200 km closer to the equator)

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Solutions?

- CFC use has been phased out
- New "ozone layer friendly" compounds (HFC's - ***hydro***fluorocarbons) have been developed which perform similarly but do not have the same reactive properties which result in O_3 destruction
- <u>BUT:</u> it will be about a ***century*** before CFC levels drop back to levels which do not have a significant impact on the ozone layer

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Is there a "Global Warming" and "Ozone Depletion" connection?

- Commonly used *interchangeably* by the media, there ***are*** some connections:

  -CFC's *also* contribute to the "greenhouse effect" by effectively trapping IR

    -CO_2 accounts for a little more than half of global warming effects (CFC's contribute about 25%)

  -increased UV levels inhibits plant growth

    -could result in decreased CO_2 uptake by plants, increasing CO_2 levels

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Intermolecular Forces

- What happens to gas phase molecules when subjected to *increased pressure?*
  - Volume occupied by gas *decreases (IGL)*
  - At higher pressures: get *negative deviations from IGL*
    - -due to intermolecular attraction (*Van deWaals Equation*)
  - At a high enough pressure:

ABRUPT decrease (100x or more) in volume

Phase Transition: *Gas* ® **Liquid**

- due to *intermolecular attractive forces*

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Electrostatic Attraction

- All based on *electrostatic* attraction, but not strong enough to be considered a **chemical bond**
- Recall: **Ionic Bonds**

  -electrostatic attraction between two ions:

  Na^+ Cl^-

  Bond strength varies with: -charge on ions
  -distance (r) separating ions

  -force varies with $1/r^2$

  -bond *energy* (force acting over a distance r) then varies with ***1/r***

  -ionic bond energies: very large (300 - 600 kJ/mol)

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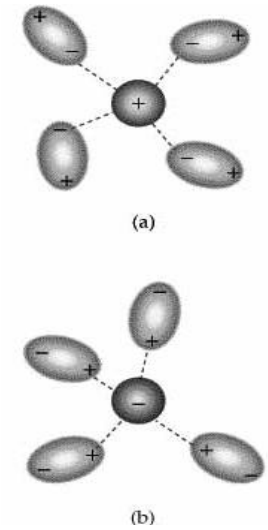
Ion-Dipole Interactions

- Ions can have electrostatic interactions with *polar molecules:*



Both *attractive* and **repulsive** forces are operative here

-**lower energy interaction** *(10 - 20 kJ/mol)*

-energy drops off as ***1/r²***

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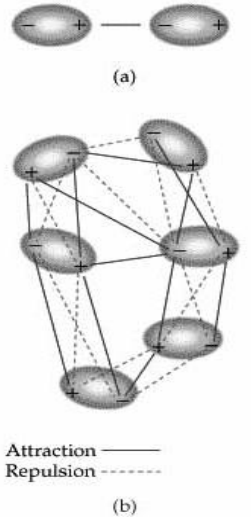
Dipole-Dipole Interactions

- Polar molecules can have *electrostatic interactions* with *other* polar molecules:

Again, both *attractive* and **repulsive** forces are operative here

-even **lower energy interaction** *(1 - 5 kJ/mol)*

-energy drops off as $\boldsymbol{1/r^3}$



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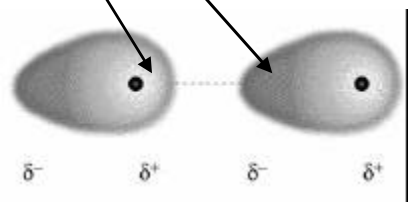
London Dispersion Force

- How, then, can there be *intermolecular attraction* between **nonpolar molecules?**
  - nonpolar ~~species (including ALL atoms)~~ can have an *instantaneous* or *momentary* dipole
  - This can then *induce* a dipole on an adjacent species, resulting in an *electrostatic interaction:*



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