Announcements – 12/1/00

- **Final Exam:** Monday, 12/11, 8 am
  - Info page is now online!
- **EXTRA Review/Problem Sessions**
  - Thursday (12/7): noon - 2 pm, B112
  - Sunday (12/10): 4:15 - 6:00 pm, B112
- **Last Quiz: Today!**

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London Dispersion Forces

- These are usually very weak interactions
  (0.05 - 2 kJ/mol)
- Energy drops of as $1/r^6$
- ALL atoms and molecules will experience *London Dispersion Forces*
- **Magnitude** of force will depend upon how easy it is to distort the electron cloud (*polarize):*
  - favors atoms and molecules that are **LARGE** and have the **greatest surface area**

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Boiling Point Trends

- The enthalpy change associated with vaporization is due to the ***disruption*** of these intermolecular forces
- The magnitude of ΔH^{o}_{vap} is reflected in the *boiling point temperature* (T_b) for a compound
- For *polar* molecules:

Substance	Molecular Weight (amu)	Dipole Moment, μ (D)	Boiling Point (K)
Propane, $CH_3CH_2CH_3$	44	0.1	231
Dimethyl ether, CH_3OCH_3	46	1.3	248
Methyl chloride, CH_3Cl	50	1.9	249
Acetaldehyde, CH_3CHO	44	2.7	294
Acetonitrile, CH_3CN	41	3.9	355

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More BP Trends

- For **NONPOLAR** species:

Halogen	Molecular Weight (amu)	Boiling Point (K)	Noble Gas	Molecular Weight (amu)	Boiling Point (K)
F_2	38.0	85.1	He	4.0	4.6
Cl_2	71.0	238.6	Ne	20.2	27.3
Br_2	159.8	332.0	Ar	39.9	87.5
I_2	253.8	457.6	Kr	83.8	120.9
			Xe	131.3	166.1

increased molar mass = *greater polarizability*

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Hydride Boiling Points

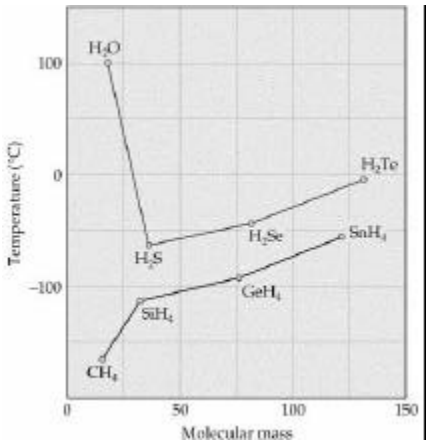
- Something strange in the B.P. of some hydrides:

  -unusually high B.P. for water

  -same effect observed with other 2nd Period hydrides:

  - $T_b(HF) > T_b(HCl)$
  - $T_b(NH_3) > T_b(PH_3)$

What's going on here?



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Hydrogen Bonding

- Why is there an unusually strong intermolecular attraction between 2nd Period hydrides?
  - Hydrogen is unusual: its *only* electron is its *valence electron*

    -so, if bound to a *very electronegative* element, the unshielded hydrogen nucleus has a significant positive charge

    -the hydrogen is, thus, attracted to the *lone pair electrons* on the *very electronegative* atom of an adjacent molecule

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More Hydrogen Bonding

- Why only with Group 5, 6 and 7 hydrides?

  -the most significant dipole will occur if the atom is both *very electronegative* as well as ***small***

  -so, **N and O and F** hydrides experience this unusually strong *dipole-dipole* interaction

- Hydrogen "bonds" are the *strongest* intermolecular interaction
  - typically: 20 - 40 kJ/mol

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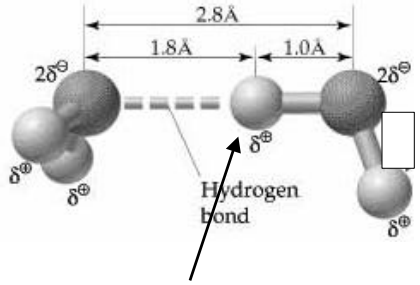
H-bonding in Water

- Hydrogen bonding in water is very significant
- Without H-bonding, we would expect water to have a B.P. of about -123 ^{o}C



Hydrogen acts as a *bridge* to facilitate electron-sharing between the oxygen atoms on adjacent molecules

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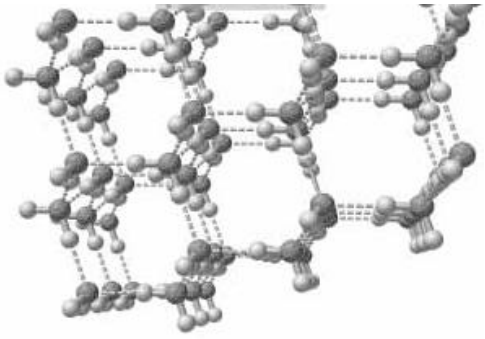
Structure of Water

- Each oxygen can accommodate interactions with *four* hydrogen atoms (2 bonding, 2 H-bonding)

  -gives a *hexagonal structure* in solid phase

  -more open space than liquid phase, so solid water is *less dense* than liquid water



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