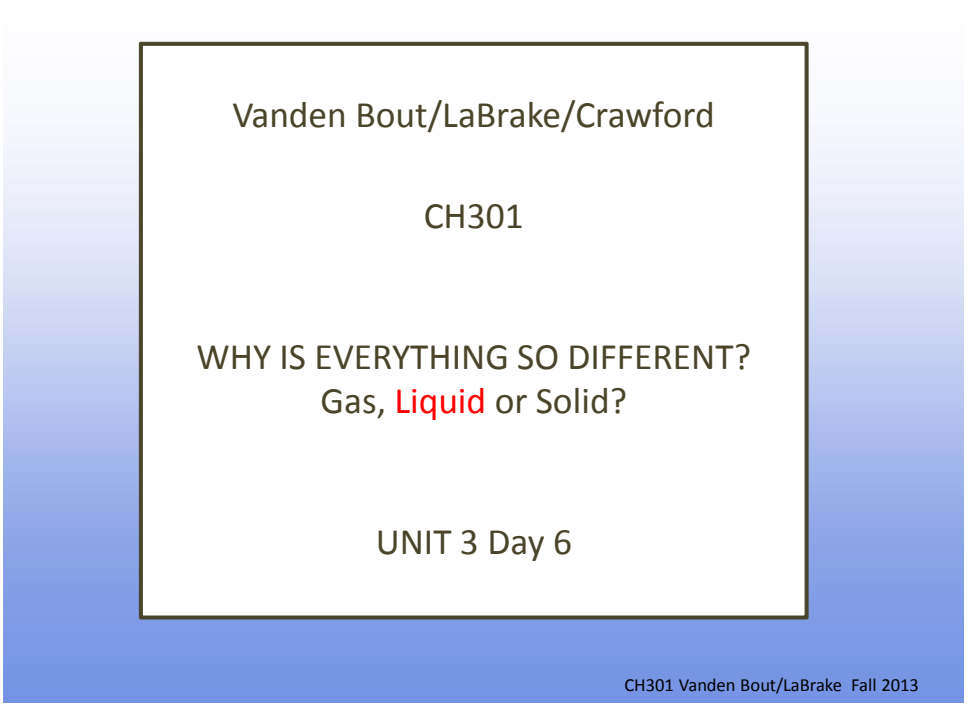
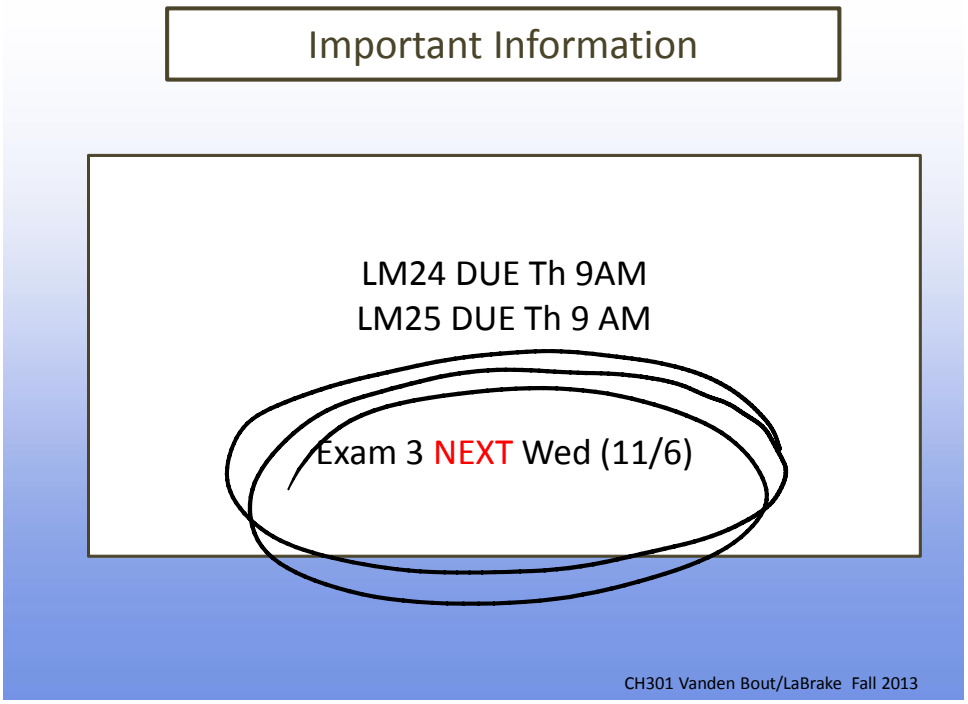
Unit3Day6-Crawford

Monday, October 28, 2013
9:15 AM





What are we going to learn today?

Classify Intermolecular Forces – Recap

Properties of Liquids in context of IMF

QUIZ: iClicker Question 1

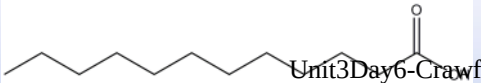
All of the following are terms used to describe the types of intermolecular forces that exist in ALL condensed phases of matter, EXCEPT:

A) Induced dipole – Induced dipole Forces
B) Ion – Ion Forces
C) Dispersion Forces
D) Vander Waals Forces
E) London Forces

QUIZ: iClicker Question 2

Which of the following has a lower boiling point?

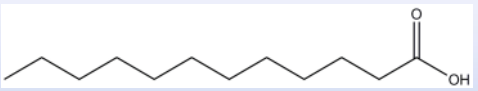
A



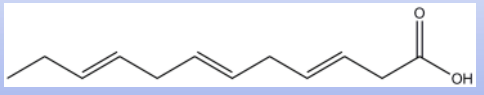
Saturated Fatty Acid

QUIZ: iClicker Question 2

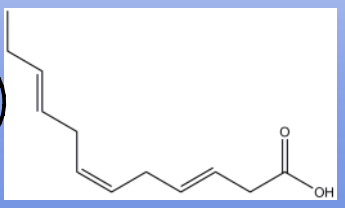
Which of the following has a lower boiling point?

highest **A** 

Saturated Fatty Acid

B 

trans- Unsaturated Fatty Acid

lowest **C** 

cis- Unsaturated Fatty Acid

Intermolecular Forces

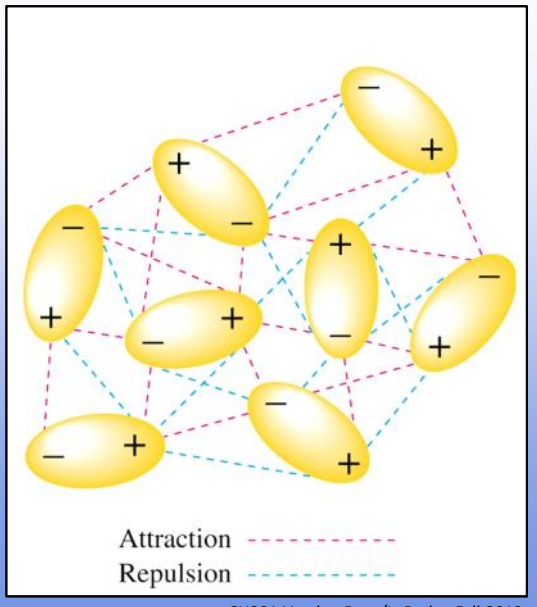
The molecule is in a condensed phase, but not ionic

A molecular condensed phase is a molecular liquid or a molecular solid

IMF
Ion-Ion
Dipole-Dipole
Hydrogen Bonding
Dispersion Forces

Intermolecular Forces: Dipole-Dipole

$$E = \frac{1}{r^3}$$



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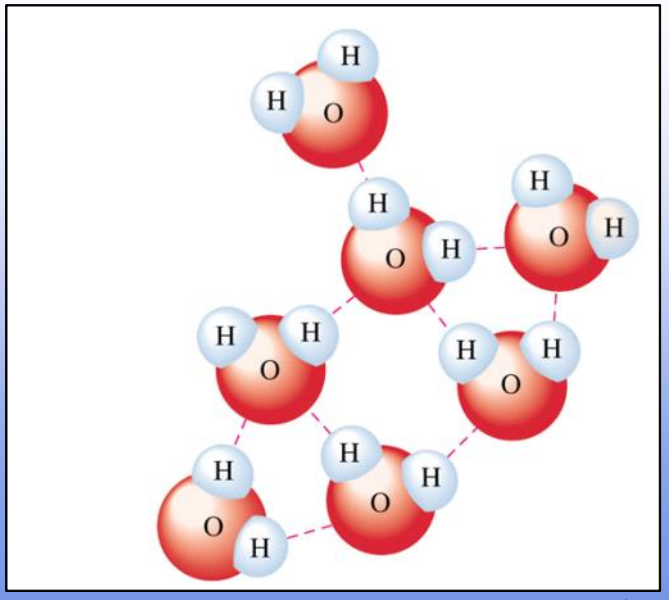
Intermolecular Forces: Hydrogen Bonding



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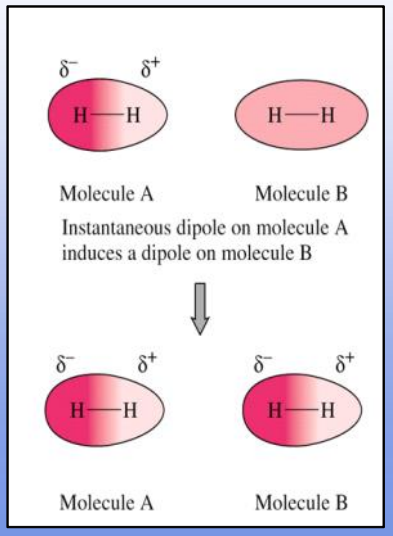
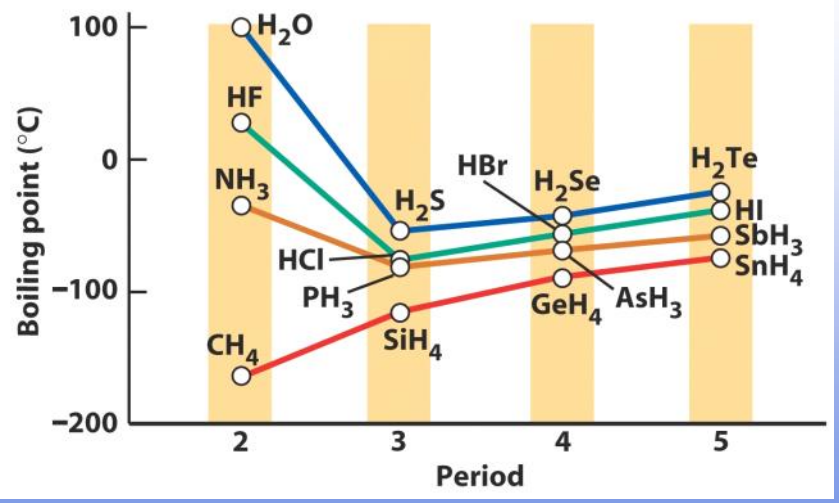
Intermolecular Forces: Induced Dipole-Induced Dipole



Dispersion Forces
London Forces
Van der Waal's Forces
Induced dipole-Induced dipole

$$E = \frac{1}{r^6}$$



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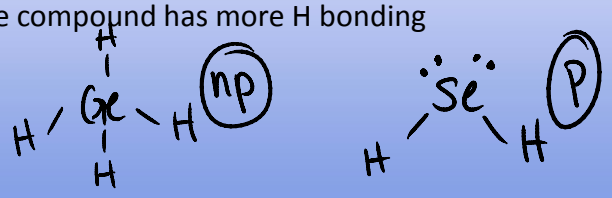
Poll: iClicker Question 3

The BP of GeH_4 is less than the BP of the H_2Se because:

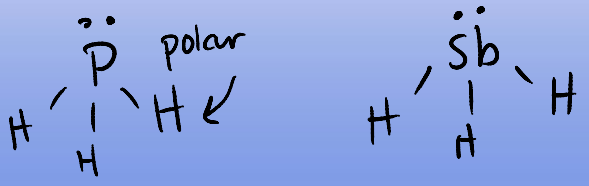
a) The Ge compound has a larger dipole
b) The Ge compound has a smaller dipole
c) The Ge compound is more polarizable
d) The Ge compound is less polarizable
e) The Ge compound has more H bonding



Poll: iClicker Question 4

The BP of PH_3 is less than the BP of the SbH_3 because:

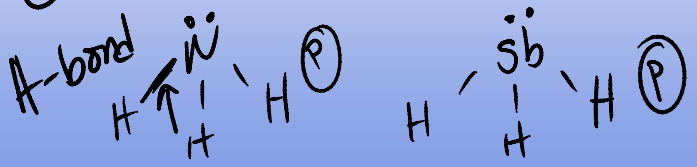
a) The P compound has a larger dipole
b) The P compound has a smaller dipole
c) The P compound is more polarizable
d) The P compound is less polarizable
e) The P compound has more hydrogen bonding



Poll: iClicker Question 5

The BP of NH_3 is higher than the BP of the SbH_3 because:

a) The N compound has a larger dipole
b) The N compound has a smaller dipole
c) The N compound is more polarizable
d) The N compound is less polarizable
e) The N compound has ~~more~~ hydrogen bonding



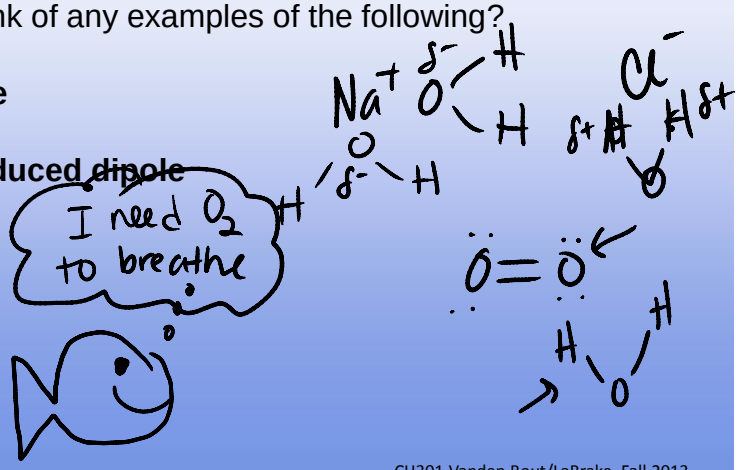
Intermolecular Forces

There are also IMF between different "types" of compounds

Can you think of any examples of the following?

Ion – Dipole

Dipole – Induced ~~dipole~~



Intermolecular Forces

Strength Varies with TYPE

Type of interaction	Typical energy ($kJ \cdot mol^{-1}$)	Interacting species
ion–ion	250	ions only
ion–dipole	15	ions and polar molecules
dipole–dipole	2	stationary polar molecules
	0.3	rotating polar molecules
dipole–induced dipole	2	at least one molecule must be polar
London (dispersion)†	2	all types of molecules
hydrogen bonding	20	molecules containing N, O, F; the link is a shared H atom

Intermolecular Forces

We've focused primarily on gases, but what about condensed phases?

$$PV = nRT$$ Ideal Gas Law — no IMF

$$P(V - nb) = nRT$$ Hard Sphere Model ✓

$$\left(P - \frac{an^2}{V^2}\right)(V - nb) = nRT$$ Van der Waal's Equation ✓

Attractions are very important!!

Size Matters

Poll: iClicker Question 6

Which compound do you think would deviate most from the ideal gas law?

A. H_2O
B. CH_4
C. H_2
D. He

Properties of Liquids

What is Vapor Pressure?

http://www.youtube.com/watch?v=re9r0kzQp_M&feature=mfu_in_order&list=UL

Vapor Pressure is Not Boiling

Demonstration

Liquid Nitrogen in a Bottle

Poll: iClicker Question 7

In a closed container, why does the pressure of the vapor not continue to increase?

a) Because there is insufficient volume for all the liquid to be vapor
b) Because that would blow the lid off the container
c) Because at a certain point the amount of vapor coming out the same as the amount going back in.
d) Because the vapor is becoming a gas.

equilibrium

Poll: iClicker Question 8

Which do you think has the higher vapor pressure?

a) CH_3CH_2OH
b) CH_3OCH_3
c) They would be the same

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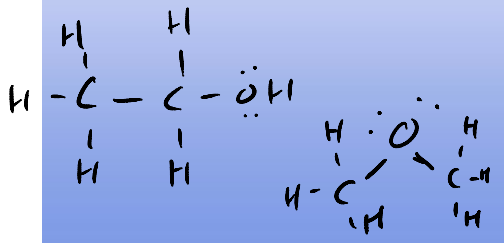


H-Bonding No H-Bonding

Higher IMF Low IMF

Low VP High VP

Vapor Pressure

We've extensively discussed the relationship between boiling point and IMF.

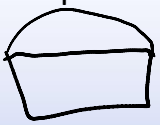
What is the relationship between boiling point and vapor pressure?

↑ BP, ↓ VP strong IMF

↓ BP, ↑ VP weak IMF

Demonstration

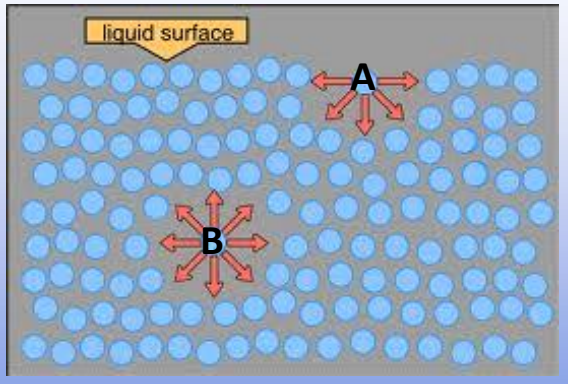
1. Put a few pennies in a cup of Water. Observations?



2. Put a few pennies in a cup of Alcohol. Observations?

3. Put a few pennies in a cup of Acetone. Observations?

Poll: iClicker Question 9



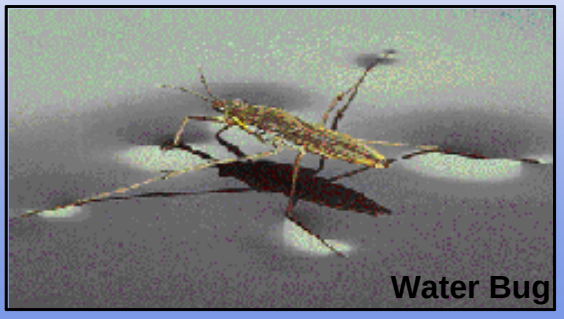
Which has a higher energy?

A) Surface molecule
B) Bulk molecule
C) They are the same.

Surface Tension

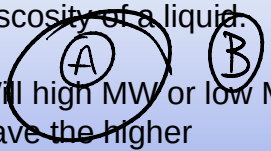
Molecules behave differently at the surface than in bulk.

Surface tension and IMFs are directly related.



Viscosity

Molecular weight and Shape both affect the viscosity of a liquid.



Will high MW or low MW have the higher viscosity?

* Viscosity - resistance to flow

syrup
molasses 10,000cP
honey
H_2O 1cP

What have we learned today?

CLASSIFY INTERMOLECULAR FORCES
ION-ION, DIPOLE-DIPOLE, INDUCED DIPOLE – INDUCED DIPOLE

CONDENDSED PHASES EXIST BECAUSE OF IMFs – ELECTROSTATIC FORCES VARY WITH SHAPE/SIZE/COMPONENTS OF COMPOUND – VARIOUS PHASE TRANSITION TEMPERATURES

PROPERTIES OF LIQUIDS DEPEND ON IMFs
- VAPOR PRESSURE
- VISCOSITY
- SURFACE TENSION

Learning Outcomes

Use a compound's molecular structure to predict the types of IMFs that exist in the condensed phase

Relate the IMFs to liquid properties such as boiling point, vapor pressure, viscosity and surface tension