Unit5-Day1-LaB

Tuesday, January 14, 2014
8:43 AM

Thinking Like a Chemist

UNIT 5 DAY 1

What are we going to learn today?

Note some important details on the syllabus

Become familiar with the course website

Meet the teaching team

Review the Mechanics of a Learner Centered Course

Review the Concept of Thinking Like a Chemist in the context of a review of some material from last semester –

- Molecular Geometry
- IMFs
- Enthalpy, Entropy, Free Energy

ASSIGNMENTS

LM01 – UNIT 5 LEARNING OUTCOMES

LM02 – THERMODYNAMICS OF PHASE TRANSITIONS

LM03 – REVIEW HEAT CURVE

NOT ON QUEST

Learning Modules are on CANVAS

utexas.instructure.com
(link on course page or UTDirect)

SAME

Canvas.utexas.edu

Polling Question

What class did you take for CH 301?

A. Dr. Sparks class last fall

B. Dr. Vanden Bout, Dr. LaBrake, or Dr. Crawford's class last fall

C. Dr. McCord last fall..

D. Dr. Laude last fall.

E. I tested out of CH 301, took it a while back, took it somewhere else.

Polling Question

What does the phrase "Think Like a Chemist" mean to you?

A. I want to run out of this class now, I'm not a chemistry major, I just need this class for my major.

B. To think like a Chemist

C. Simultaneously make a macroscopic observation, while thinking in terms of the microscopic (molecular) models which can explain said observation.

D. Because you have memorized all the formulas (both chemical and mathematical) that can be used to solve any chemistry problem, you can Think like a General Chemistry teacher type of chemist.

E.This is a trick question, for those of us who did not have these instructors last semester.

What is a Learner Centered Course?

What does the phrase "Think Like a Chemist" mean to you?

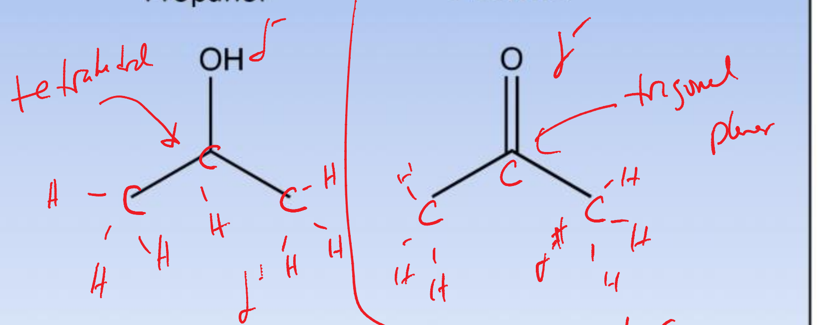
http://www.youtube.com/watch?v=ovbn_J-XqQE

Class Activity

"Thinking Like a Chemist"

Structures

Propanol | Acetone



polar | polar

Dispersion, Dipole/Dipole, H-BONDING ★

Stronger IMF

Dispersion
Dipole-Dipole

NO H-bonding IMF

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Stronger IMF → higher B.P. | NO H-bonds, other IMF similar

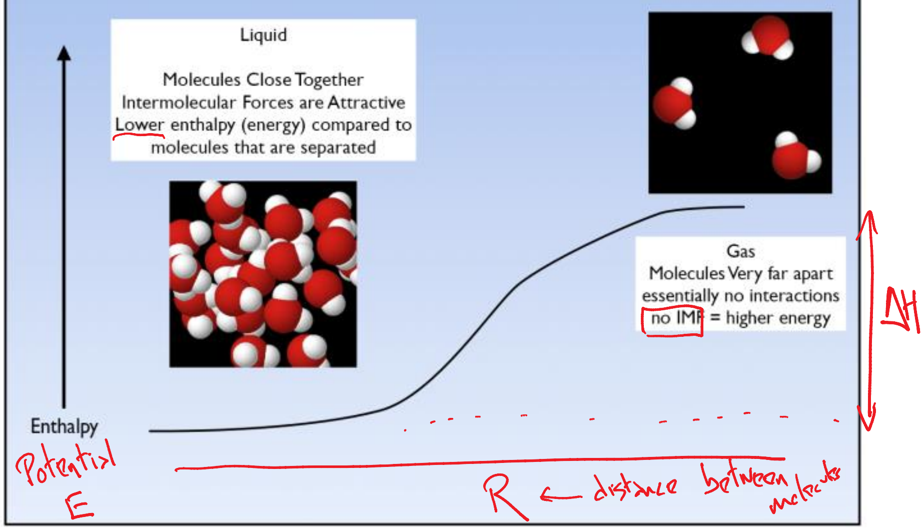
Polling Question

Which has a higher Enthalpy?

A. liquid water
B. gaseous water
C. they are exactly the same
D. it depends on the temperature

$H_2O(l) \rightarrow H_2O(g)$

Why do different phases have different Enthalpies?
Intermolecular Forces (IMF)



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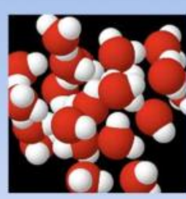
Polling Question

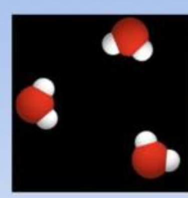
What is the sign for
the enthalpy of vaporization, ΔH_{vap}° ?

A. positive
B. negative
C. zero

$X(l) \rightarrow X(g)$

Comparing the two





Attractive IMF
Lower H

~ No IMF
Higher H

We need to put in energy to overcome
the molecules attractions for each other

$$\Delta H_{vaporization} = H_{gas} - H_{liquid} > 0$$

remember: positive change in enthalpy is energy into the system

Polling Question

Comparing isopropanol and acetone, which has the greater ΔH_{vap}?

A. Impossible to say without some data.
B. isopropanol longer to evaporate ← STRONGER IMF (H-bonding)
C. acetone
D. They are the same.
E. Will vary with temperature

What did we learn just now?

Enthalpy is related to the "energy" of a substance. phase change → potential energy

Liquids have a lower enthalpy (lower energy = more stable) because they are electrostatically attracted to other molecules and thus have a lower energy when they are close together

⇒ The stronger the IMFs, the bigger the difference between the liquid and the gas (which has essentially no potential energy since the "molecules" are so far apart)

BIG IMF → LARGE ΔH

Polling Question

Which has a higher Entropy?

A. liquid water
B. gaseous water
C. they are exactly the same
D. it depends on the temperature

$S_{sol} < S_{liq} < S_{vap}$

A Quick Review of Entropy

The entropy technically depends on the number of equivalent microstates of a system.

How to deal with this qualitatively today?

Entropy increases with:
- Increasing volume $V\uparrow \; S\uparrow$
- Increasing temperature $T\uparrow \; S\uparrow$
- Increasing number of molecules $n\uparrow \; S\uparrow$
- Going from a solid to a liquid to a gas

2nd Law → The Universe tends towards higher entropy

$S_{sol} < S_{liq} < S_{gas}$

Polling Question

Comparing isopropanol and acetone, which has the greater ΔS_{vap}?

A. Impossible to say without some data.
B. isopropanol
C. acetone
D. They are about the same.
E. Will vary with temperature

$X(l) \rightarrow X(g)$

ΔS

BOTH LIQ → GAS

$\Delta S = \frac{\Delta H}{T}$ same?

Bigger T & Bigger ΔH

most $\Delta S_{vap} = 85\ J K^{-1} mol^{-1}$

What did we learn just now?

Gases always have a higher entropy than liquids. This is predominately due to the phase change (not the nature of the molecules).

For almost every compound the difference in entropy between the liquid and the gas is the same.

Polling Question

Which has a lower Gibb's Free Energy?

A. liquid water

B. gaseous water

C. they are exactly the same

D. it depends on the temperature

G = H - TS

Lowest G = most stable

Depends on the TEMPERATURE

Remembering Free Energy

$$\Delta G = \Delta H - T\Delta S$$

$$\Delta H^{o}_{vaporizaiton} > 0$$

$$\Delta S^{o}_{vaporizaiton} > 0$$

therefore

$\Delta G^{o}_{vaporizaiton}$ depends on the temperature

Equilibrium

$$\Delta G = 0$$

same free energy for both phases

when the "reactants" and "products" have the same free energy, the change is not spontaneous in either direction.

This is equilibrium

For a phase change when ΔG=0, then $\Delta H = T\Delta S$!

phase transition TEMP!

Polling Question

Comparing isopropanol and acetone, which has the higher T when $\Delta G^\circ_{vaporization}=0$?

A. Impossible to say without some data.
B. isopropanol
C. acetone
D. They are the same.
E. Will vary depending on the amount of liquid present

ΔH larger ∴ T larger

$\Delta G = 0 \rightarrow \Delta H = T\Delta S$

SAME

What did we learn today?

Differences in enthalpies of vaporization for different compounds depend on their IMF (and thus their molecule structure).

Stronger IMF = larger enthalpies of vaporization

Entropies of vaporization are very similar for most compounds

At equilibrium $\Delta G = 0$, and $\Delta H = T\Delta S$

Therefore, difference in boiling point result from differences in IMF. Stronger IMF = bigger ΔH = higher T.