UNIT5-DAY3-LaB1230pm

Tuesday, January 22, 2013
7:54 AM

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Thinking Like a Chemist About Dissolution

Unit 5 Day 3

CH302 Vanden Bout/LaBrake Spring 2013

What are we going to learn today?

Thinking Like a Chemist in the Context of the Dissolution Process.

- Macro Modeling
- Micro Modeling
- Energy of the change Modeling

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Mathematical Relationship between VP and T

Vapor pressure of a liquid increases with increasing T

Mathematical Relationship between VP and T

Vapor pressure of a liquid increases with increasing T

Piazza!

Clausius-Clapeyron equation

$$ln\left(\frac{P_2}{P_1}\right) = \frac{\Delta H^\circ_{vap}}{R}\left[\frac{1}{T_1} - \frac{1}{T_2}\right]$$

kJ/mol — watch units match ΔH to gas const. J vs. kJ

vapor pressure any pressure unit

gas constant J/K·mol

temp in Kelvin

IMPORTANT INFORMATION

HW1	due TODAY 9AM
LM04 & LM05	due TODAY 9AM
LM06 Solutions	due Th 9AM
LM07 Solutions – Concentrations	due Th 9AM
LM08 Henry's Law	due Th 9AM

LUNCH WITH VDB or LaB?

NOTE: THIS CLASS HAS BEEN DESIGNED TO BE A "HYBRID" OR "BLENDED" STUDENT CENTERED LEARNING EXPERIENCE. THIS MEANS THAT SOME OF THE COURSE INFORMATION WILL BE PRESENTED IN A DIGITAL FORMAT ON THE WWW IN EITHER PRINT OR VIDEO FORMAT. SO LEARNING MODULE INDICATES NEW LEARNING. HOMEWORK INDICATES PRACTICING CONCEPTS/PROBLEM SOLVING THAT HAS BEEN FIRST INTRODUCED EITHER IN CLASS, ON THE WEBSITE OR IN A LEARNING MODULE.

NGLM

14 sol'n & molarity

15 mass % vs density

16 soln dilution $m_1V_1 = m_2V_2$

20 solubility ↳ ALEKS

Quiz: CLICKER QUESTION 1

Which of the following has the highest vapor pressure?

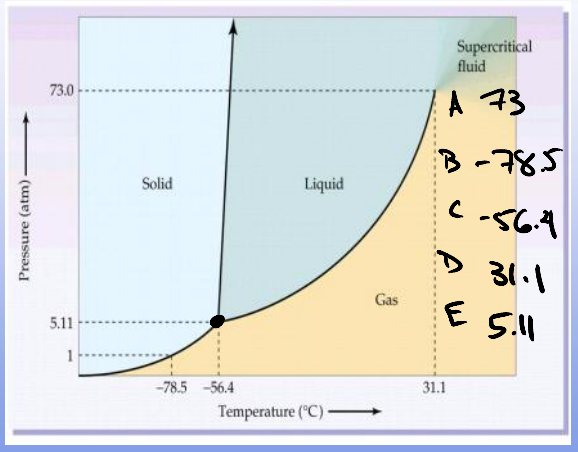
a) CH_3OH

Which of the following has the highest vapor pressure?

a) CH_3OH lowest IMF → ↑ VP dispersion
b) CH_3CH_2OH
c) $CH_3CH_2CH_2OH$
d) $CH_3CH_2CH_2CH_2OH$

Quiz: CLICKER QUESTION 2

What is the temperature at the triple point?



A. 73.0 °C

B. -78.5 °C

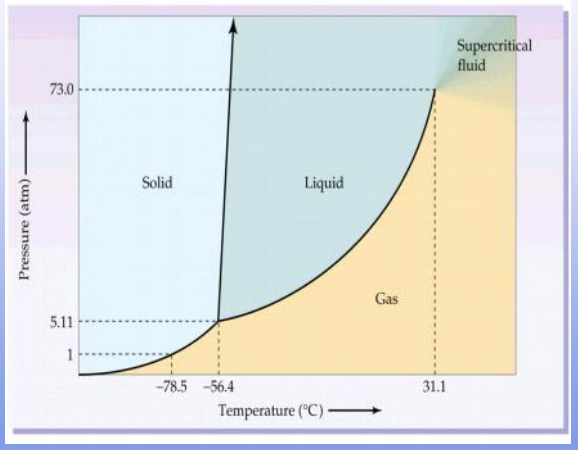
C. -56.4 °C

D. 31.1 °C

E. 5.11 °C

Quiz: CLICKER QUESTION 3

At the triple point solid, liquid, and gas all have the same….



A. number of moles
B. free energy
C. volume
D. density
E. entropy

Solutions: Vocabulary Check!

Look at NGLM if terms are not familar

Solution = Solvent + Solute
greater less

Solubility – how much dissolves
concentration

Dissolution process of making solution, dissolving

Homogeneous Solution described by components and concentrations of those components!

LM will instruct concentration units.

Get to work on the worksheet!

MACROSCOPIC DESCRIPTION OF DISSOLUTION

Get to work on the worksheet!

MACROSCOPIC DESCRIPTION OF DISSOLUTION

white solid/crystal dissolves
"vanishes" in liquid
no temperature change

Polling: Clicker Question 4

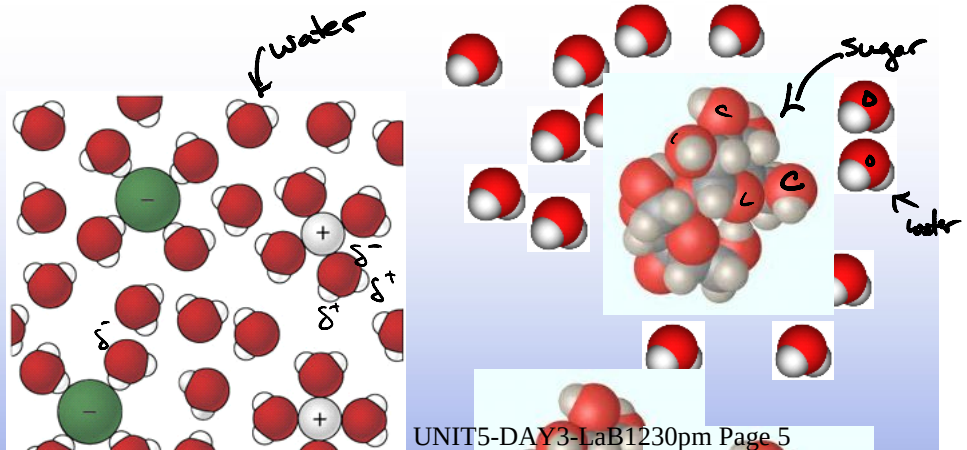
A nice micro view of the dissolution of a(n):

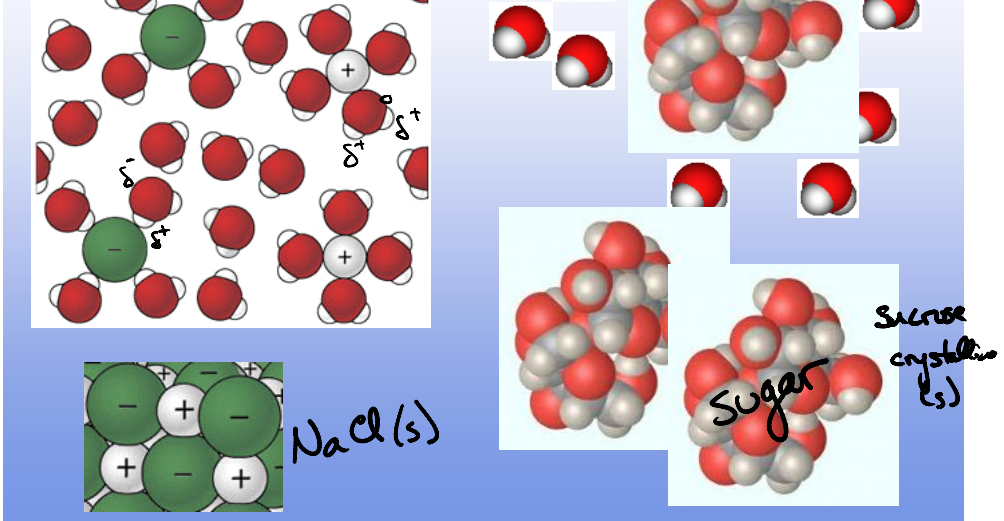
A. ionic solid

B. molecular solid

C. metallic solid

D. covalent solid





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Dissolution Demonstration Observations

Sodium chloride in water

Sucrose in water

Ammonium nitrate in water

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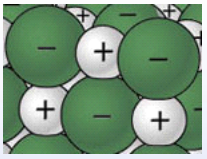
#7

How do we think about this in terms of energy? $\Delta H_{solution}$



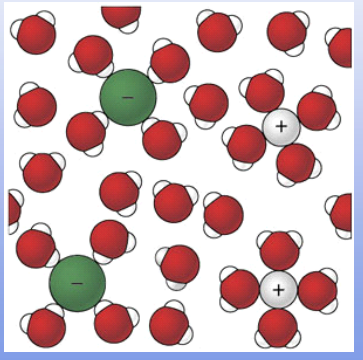
1. break solute
– costs energy – Lattice Energy

$+\Delta H$ endothermic

(ignore break of solvent) → very small

2. form new solute-solvent interactions
- give off energy – Solvation Energy

$-\Delta H$ exothermic



$\Delta H_{solution} = \Delta H_{Lattice\ Energy} + \Delta H_{solvation}$

→ hydration if water

Usually $|\Delta H_{lattice}| > |\Delta H_{solution}|$

so $\Delta H_{solution}$ is typically endothermic

What did we learn just now?

$\Delta H_{solution}$ is hard to predict. Depends on energy needed to separate solute-solute and energy release when new solute-solvent attractions are formed.

$\Delta H_{solution} > 0$

Typical Situation Solute-solvent interactions are weaker than solute-solute (and solvent-solvent)

$\Delta H_{solution} < 0$

Unusual, but possible

Solute-solvent interactions are stronger than solute-solute and solvent-solvent

Exceptions: high charge density (ions), $\Delta H_{solution}$ very high

gas dissolving in liquid is exothermic

gas has no IMFs!

Polling: Clicker Question 5

What is going on with the entropy of dissolution for our example solutions?

→ solid solute

→ general

A. The entropy always increases.
B. The entropy always decreases.

What is going on with the entropy of dissolution for our example solutions?

↳ solid solute

A. The entropy always increases.
B. The entropy always decreases.
C. It depends on the type of solid solute.
D. It depends on the phase of the solute.

in general solids dissolving in liquids increase entropy

↳ gas dissolved in liquid, entropy dec

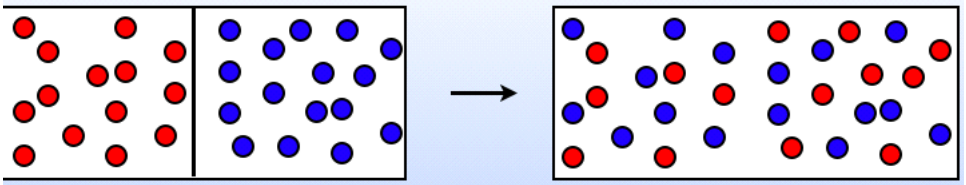
Entropy of Solution $\Delta S_{solution}$
usually easy to predict

Solutions typically have a higher entropy than the unmixed compounds
Therefore $\Delta S_{solution} > 0$
For most cases

Since entropy almost always favors mixing, the differences between different substances are the result of enthalpy (intermolecular forces)

Mixtures

What is different than pure substances?



What is the free energy change for gases mixing?

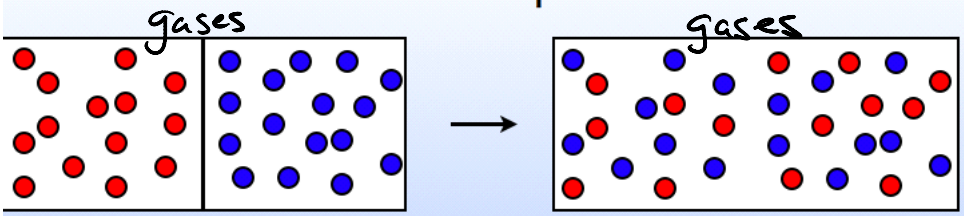
What is the free energy change for gases mixing?

$\Delta G < 0$, spontaneous

POLLING CLICKER QUESTION 6

Mixtures

What is different than pure substances?



Why does the free energy decrease? ($\Delta G = \Delta H - T\Delta S$)

~~A.~~ ΔH is positive, ΔS is zero
B. ΔH is zero, ΔS is positive
C. ΔH is negative, ΔS is positive
~~D.~~ ΔH is negative, ΔS is zero

for gases

ΔH difference in IMFs

gases have no IMFs

POLLING CLICKER QUESTION 7

How can you explain the spontaneous dissolution of the endothermic solution?

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

$- \quad + \quad - \quad (+)$

A. It must be entropically driven

B. It must not really be endothermic

C. It must only occur at very low temperatures, because the solution does get cold

D. It must be driven by the change in enthalpy

E. It must not be as soluble as endothermic solutions

POLLING CLICKER QUESTION 8

What is the sign for the change in Free Energy for the dissolution process in which polystyrene peanuts were place in water?

A. Positive, nonspontaneous

B. Negative

C. $\Delta G = 0$

D. Need values for ΔH and ΔS to determine.

POLLING CLICKER QUESTION 9

What is the sign for the change in Entropy for the dissolution process in which polystyrene peanuts were place in acetone?

A. Positive

B. Negative

were place in acetone?

A. Positive

B. Negative

C. ~~ΔG~~ ΔS = 0

D. Need values for ΔH and ΔS to determine.

POLLING CLICKER QUESTION 10

What is the sign for the change in Enthalpy for the dissolution process in which biodegradable peanuts were place in acetone?

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

$+ \quad ? \quad -(+)$

A. Positive

B. Negative

C. ~~ΔG~~ ΔH = 0

D. Need values for ΔH and ΔS to determine.

POLLING CLICKER QUESTION 11

What is the sign of change in free energy for mixing olive oil with water?

A. Negative
B. Positive
C. 0
D. None of the above

Talk about like dissolves like..

IMFs are same, so

ΔH is near $\emptyset$

What did we learn just now?

When a solute dissolves spontaneously in a solvent, the process is considered spontaneous.

For a spontaneous dissolution process, $\Delta G < 0$

In some cases non-spontaneous dissolution process can become spontaneous upon increasing the temperature.

What did we learn today?

Micro modeling of the dissolution process – noted the difference between molecular solids and ionic solids.

Energy modeling of the dissolution process – noted the changes in enthalpy (solute-solute interactions vs solute-solvent interactions).

Energy modeling of the dissolution process - noted changes in entropy – typically depends on the phase of the solute (solid dissolving in liquid vs gas dissolving in liquid).

Energy modeling of the dissolution process – predict based on sign of ΔG.

Learning Outcomes

Describe the factors that favor the dissolution process in terms of the intermolecular forces and thermodynamics (enthalpies of solution, solvation, lattice energy, entropies of solution, free energy of solution)

Describe how P (Henry's Law) affects solubility of a gas.

Define and perform calculations for common concentration units molarity, molality, and mole fraction.