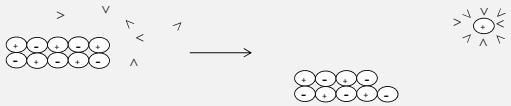
[TP] Do we get the same amount of energy back from making bonds between an ion and water molecules, as it took to break the ionic bonds holding an ion in the solid?



25% 1. The energy is the same
25% 2. More energy to break ion bonds in solid
25% 3. More energy from making ion-water bonds
25% 4. We don't know

Response Counter

10

Lecture 11 CH102 A1 (MWF 9:05 am)

Wednesday, February 14, 2018

Begin ch12: Solutions and their behavior

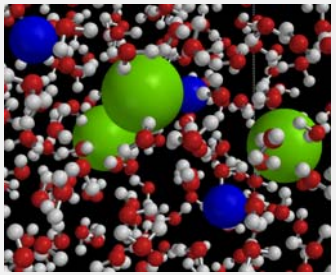
- Enthalpy change of solution: Ionic Solutes
- $\Delta_{latt}H$, $\Delta_{aq}H$ and $\Delta_{soln}H$
- Predicting relative values of $\Delta_{latt}H$ and $\Delta_{aq}H$

Next: Complete ch12: Predicting relative values of $\Delta_{latt}H$ and $\Delta_{aq}H$; review: Colligative properties; begin ch13: Dynamic chemical equilibrium

CH101 lecture 18: About "NaCl(*aq*)", etc.

Ionic solids dissolve by their ions being surrounded by water.

For example, $NaCl(s) \rightarrow Na^+(aq) + Cl^-(aq)$



CH101 lecture 18: About "NaCl(*aq*)", etc.

The collection of hydrated ions is sometimes represented as "salt(aq)".

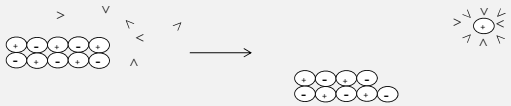
For example, $Na^+(aq) + Cl^-(aq)$ is abbreviated as $NaCl(aq)$

However, this is wrong, since chemically, salt(aq) does not exist.

It is only an abbreviation for the hydrated ions, e.g., $Na^+(aq) + Cl^-(aq)$

Since salt(aq) does not exist, in this course please do not use it!

[TP] Do we get the same amount of energy back from making bonds between an ion and water molecules, as it took to break the ionic bonds holding an ion in the solid?



0% 1. The energy is the same
0% 2. More energy to break ion bonds in solid
0% 3. More energy from making ion-water bonds
0% 4. We don't know

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12

Enthalpy change of solution

When an ionic solid dissolves in water, depending on the ionic solid ...

the solution gets warm or ...

the solution gets cold.

Let's develop a framework with which to analyze such results.

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15

[TP] Lattice enthalpy, $\Delta_{latt}H$, is the enthalpy change required to separate a mole of ionic solid into its individual ions in the gas phase, so that they are so far apart they no longer interact with one another electrically. Lattice enthalpy ...

0% 1. is always positive
0% 2. is always negative
0% 3. can be positive or negative, depending on the ionic solid

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10

16

Lattice enthalpy, $\Delta_{latt}H$

Write the chemical equation whose enthalpy change is the lattice enthalpy of KCl, $\Delta_{latt}H$. Be sure to include the states of all.

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17

Lattice enthalpy, $\Delta_{latt}H$

Create the enthalpy diagram corresponding to the chemical equation whose enthalpy change is the lattice enthalpy of KCl, $\Delta_{latt}H$. Be sure to show visually whether the process is endothermic or exothermic.

[TP] Enthalpy of aquation, $\Delta_{aq}H$, is the enthalpy change when a mole of ion pairs, initially in the gas phase, so far apart they no longer interact with one another electrically, is place in liquid water. Enthalpy of aquation ...

0% 1. is always positive
0% 2. is always negative
0% 3. can be positive or negative, depending on the ionic solid

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10

Enthalpy of aquation, $\Delta_{aq}H$

Write the chemical equation whose enthalpy change is the enthalpy of aquation of KCl, $\Delta_{aq}H$. Be sure to include the states of all species.

Enthalpy of aquation, $\Delta_{aq}H$

Create the enthalpy diagram corresponding to the chemical equation whose enthalpy change is the enthalpy of aquation of KCl, $\Delta_{aq}H$. Be sure to show visually whether the process is endothermic or exothermic.

[TP] Enthalpy change of solution, $\Delta_{sol}H$, is the enthalpy change when a mole of an ionic solid dissolves in water. Enthalpy of solution ...

0% 1. is always positive
0% 2. is always negative
0% 3. can be positive or negative, depending on the ionic solid

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Enthalpy change of solution, $\Delta_{sol}H$

Write the chemical equation whose enthalpy change is the enthalpy change of solution of KCl, $\Delta_{sol}H$. Be sure to include the states of all species.

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Enthalpy change of solution, $\Delta_{sol}H$

Create the enthalpy diagram corresponding to the chemical equation whose enthalpy change is the enthalpy change of solution of KCl, $\Delta_{sol}H$. Be sure to show visually whether the process is endothermic or exothermic.

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Enthalpy change of solution, $\Delta_{sol}H$

Combine the three enthalpy diagrams that you have created to visually related the lattice enthalpy, enthalpy of aquation and the enthalpy change of solution. Be sure to include the states of all species.

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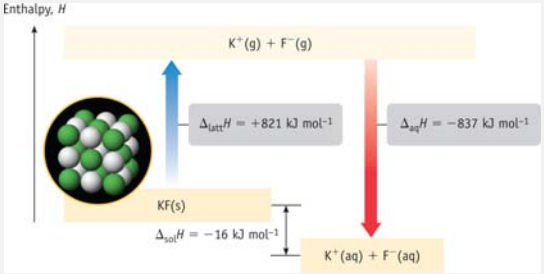
Enthalpy change of solution, $\Delta_{sol}H$

When KF(s) is dissolved in water in a beaker, the beaker becomes warm. Sketch the enthalpy change diagram for $\Delta_{sol}H$ in terms of $\Delta_{latt}H$ and $\Delta_{aq}H$.



[Quiz] When ammonium nitrate dissolves in water in a beaker, the beaker feels cold. The means that, relative to the magnitude of the enthalpy change of aquation, $|\Delta_{aq}H|$, the magnitude of the lattice enthalpy, $|\Delta_{latt}H|$ is …

25% 1. larger
25% 2. the same
25% 3. smaller
25% 4. Further information required

Predicting relative values of $\Delta_{latt}H$ and $\Delta_{aq}H$

[TP] Sulfide ion, S^{2-}, is slightly larger than chloride ion, Cl^{-}; the ions have the same number of electrons but sulfur has one less proton.
See https://en.wikipedia.org/wiki/Ionic_radius
Which has a larger lattice enthalpy?

0% 1. MgS > NaCl
0% 2. NaCl > MgS
0% 3. Too close to know without additional information.

Lattice enthalpy, $\Delta_{latt}H$

Key idea: Electrical attraction (Coulomb's law) between oppositely charged ions in lattice

Energy $\propto \frac{q_+ q_-}{\text{separation}}$

The larger charges the greater lattice enthalpy

MgS > NaCl

$CaCO_3 > KNO_3$

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Lattice enthalpy, $\Delta_{latt}H$

Key idea: Electrical attraction (Coulomb's law) between oppositely charged ions in lattice

Energy $\propto \frac{q_+ q_-}{\text{separation}}$

The smaller ion size, the smaller the separation and so ...

the greater lattice enthalpy

NaF > NaCl

LiCl > NaCl

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[TP] Which of the following has the largest magnitude lattice enthalpy, $|\Delta_{latt}H|$?

33% 1. $MgCO_3$
33% 2. MgS
33% 3. Further information required

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10