

[TP] Sulfide ion, S^{2-}, is slightly larger than chloride ion, Cl^{-}, since they 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?

33% 1. MgS > NaCl
33% 2. NaCl > MgS
33% 3. Too close to know without additional information.

Response Counter

10

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Lecture 12 CH102 A1 (MWF 9:05 am)

Friday, February 17, 2017

- Complete: Predicting relative values of $\Delta_{latt}H$ and $\Delta_{aq}H$
- Review: Colligative properties

Begin ch13: Equilibrium

- Reaction quotient, Q, spontaneity, and equilibrium

Next: Continue ch13: Reaction quotient, Q, spontaneity, and equilibrium. Predicting direction of change. Q depends on how a reaction is written; disturbing equilibrium (Le Chatelier)

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

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Lattice enthalpy, $\Delta_{\mathrm{latt}}H$

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, $\Delta_{\mathrm{latt}}H$

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, $|\Delta_{\mathrm{latt}}H|$?

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

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

Make a sketch of liquid water at the scale of individual molecules. Represent the molecules as chevrons (/\) in various orientations.

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

Make a sketch of what a 1 M aqueous solution of MgS(*s*) looks like on the scale of your sketch of liquid water.

Represent water molecules as chevrons (/\) in various orientations.

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

Key idea: Electrical attraction (Coulomb's law) between ions and polar water molecules

Energy $\propto \frac{\text{ion charge}}{\text{distance to water}}$

The smaller the ion size, ...

the smaller the distance to water and so ...

the greater enthalpy of aquation

$Cl^- > Br^- > I^-$

$Li^+ > K^+ > NH_4^+$

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

Key idea: Electrical attraction (Coulomb's law) between ions and polar water molecules

Energy $\propto \frac{\text{ion charge}}{\text{distance to water}}$

The larger the ion charge ...

the greater enthalpy of aquation

$PO_4^{3-} > S^{2-} > Cl^-$

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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. What happens when KCl(*s*) is dissolved in water?

	Lattice	Aquation	Solution
KF	+821	–837	–16 (warmer)
KCl			

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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. What happens when KCl(*s*) is dissolved in water?

	Lattice	Aquation	Solution
KF	+821	–837	–16 (warmer)
KCl	+703		

Why is the lattice enthalpy of KCl smaller?

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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. What happens when KCl(*s*) is dissolved in water?

	Lattice	Aquation	Solution
KF	+821	–837	–16 (warmer)
KCl	+703	–700	+3 (colder)

Why is the enthalpy of aquation of KCl smaller?

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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. What happens when KCl(*s*) is dissolved in water?

	Lattice	Aquation	Solution
KF	+821	–837	–16 (warmer)
KCl	+703	–700	+3 (colder)

Could we have predicted that when KCl(*s*) dissolves the solution get colder?

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[TP] Based on Coulomb's law, which of the following has the largest magnitude enthalpy of aquation, $|\Delta_{aq}H|$?

25% 1. LiCl
25% 2. NaCl
25% 3. KCl
25% 4. Further information required

Response Counter 10

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[TP] Based on Coulomb's law, which of the following has the largest magnitude enthalpy of aquation, $|\Delta_{aq}H|$?

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

Response Counter

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[Quiz] Based on Coulomb's law, which of the following has the largest magnitude enthalpy of change of solution, $|\Delta_{sol}H|$?

33% 1. $MgCO_3$
33% 2. MgS
33% 3. More information needed

Response Counter

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Colligative properties review

Non-volatile solute (negligible vapor pressure) ...

- lowers vapor pressure of solvent
- raises boiling point of solvent
- lowers freezing point of solvent

If solute cannot pass through a membrane ...

- the solvent will create an osmotic pressure

Details and practice in lab and in discussion

Begin ch 13

Dynamic chemical equilibrium

Spontaneity of “reactants” → “products”

If products (right side) increase with time, we say ...
the reaction is spontaneous.

If reactants (left side) increase with time, we say ...
the reaction is nonspontaneous.

If the amount of reactants and products do not change with time, we say ...
the reaction is at equilibrium.

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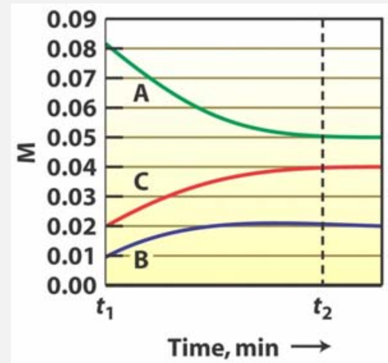
Spontaneous approach to equilibrium: A → B + C



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Reaction quotient Q measures progress

A → B + C

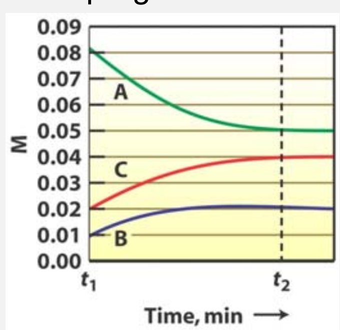
Q = products/reactants = [B][C]/[A]

Q at t_1 is smaller

Q at t_2 is larger

Q thereafter no longer changes

For $t > t_2$, $Q = K$, equilibrium constant



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