

Lecture 10 CH102 A1 (MWF 9:05 am) Spring 2019

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[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?

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



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Wednesday, February 13, 2019

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

Next: Effect of temperature on solubility; Review: Colligative properties; begin ch13: Dynamic chemical equilibrium



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



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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.



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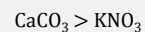
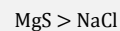
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Lattice enthalpy, $\Delta_{\text{latt}}H$

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

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

The **larger** charges the **greater** lattice enthalpy



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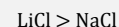
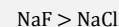
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Lattice enthalpy, $\Delta_{\text{latt}}H$

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

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

The **smaller** ion size, the smaller the **separation** and so ...
the **greater** lattice enthalpy



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

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



Response Counter



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

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



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Enthalpy of aqutation, $\Delta_{\text{aq}}H$

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

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



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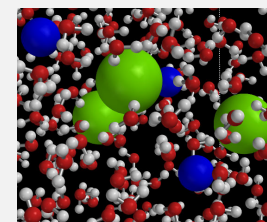
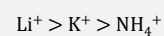
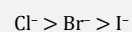
Enthalpy of aqutation, $\Delta_{\text{aq}}H$

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

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

The **smaller** the ion size, ...

the **smaller the distance** to water and so ...
the **greater** enthalpy of aqutation



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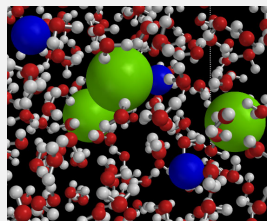
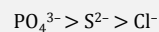
Enthalpy of aqutation, $\Delta_{\text{aq}}H$

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

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

The **larger** the **ion charge** ...

the **greater** enthalpy of aqutation



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

When $\text{KF}(s)$ is dissolved in water in a beaker, the beaker **becomes warm**. What happens when $\text{KCl}(s)$ is dissolved in water?

	Lattice	Aqutation	Solution
KF	+821	-837	-16 (warmer)
KCl			



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

When $\text{KF}(s)$ is dissolved in water in a beaker, the beaker **becomes warm**. What happens when $\text{KCl}(s)$ 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, $\Delta_{\text{sol}}H$

When $\text{KF}(s)$ is dissolved in water in a beaker, the beaker **becomes warm**. What happens when $\text{KCl}(s)$ 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, $\Delta_{\text{sol}}H$

When $\text{KF}(s)$ is dissolved in water in a beaker, the beaker **becomes warm**. What happens when $\text{KCl}(s)$ is dissolved in water?

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

Could we have predicted that when $\text{KCl}(s)$ 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, $|\Delta_{\text{aq}}H|$?

- 0% 1. LiCl
- 0% 2. NaCl
- 0% 3. KCl
- 0% 4. Further information required



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

- 0% 1. MgS
- 0% 2. MgCO_3
- 0% 3. Further information required



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

- 0% 1. MgCO_3
- 0% 2. MgS
- 0% 3. More information needed



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Summary

$\Delta_{\text{latt}}H$ and $\Delta_{\text{aq}}H$ reflect **ion size** and **ion charge**

$\Delta_{\text{sol}}H$ reflects **competition** between $\Delta_{\text{latt}}H$ and $\Delta_{\text{aq}}H$

In general, we **cannot predict sign** of $\Delta_{\text{sol}}H$



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