

STARTER FOR 10!!!

10.3. Enthalpy of solution

The tables below give some data on the lattice formation enthalpies for three different salts, and the enthalpies of hydration of the different ions in the salts.

Salt	Lattice formation enthalpy / kJ mol^{-1}
LiCl	-848
NaCl	-780
KCl	-711

Positive ion	Enthalpy of hydration / kJ mol^{-1}
Li^+	-545
Na^+	-418
K^+	-351

Negative ion	Enthalpy of hydration / kJ mol^{-1}
Cl^-	-338
Br^-

1. (a) Describe and explain the trend observed in the enthalpies of hydration of the group one ions.

.....
.....
..... (3 marks)

- (b) The enthalpy of hydration of the bromide ion is not given in the table. Complete the table with a predicted value for the enthalpy of hydration of bromide ions. (1 mark)

2. The enthalpy of solution of a salt can be calculated from its lattice enthalpy and the enthalpies of hydration of the individual ions in the salt.

Use the data in the table above to calculate the enthalpy of solution of each of the following salts. Show full working for your answers. (6 marks)

- (a) LiCl(s)

$$\Delta H_{\text{sol}} = \dots\dots\dots \text{kJ mol}^{-1}$$

- (b) NaCl(s)

$$\Delta H_{\text{sol}} = \dots\dots\dots \text{kJ mol}^{-1}$$

- (c) KCl(s)

$$\Delta H_{\text{sol}} = \dots\dots\dots \text{kJ mol}^{-1}$$



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10. Thermodynamics answers

3. $\Delta H_L(\text{CaO}) = 178 + 590 + 1150 + 249 + (-141) + 844 - (-635)$
 $= 2870 - (-635)$
 $= \underline{3505 \text{ kJ mol}^{-1}}$ (1 mark)

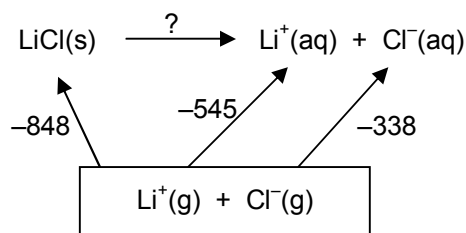
10.3. Enthalpy of solution

1. (a) As the ions increase in size, the enthalpy of hydration decreases. (1 mark)

As the ions increase in size the positive ions are less attractive (lower charge to size ratio) and so the attractions formed between the water molecules of the positive ion are weaker (1 mark) and hence less energy is produced when they form (1 mark).

- (b) As a bromide ion is bigger than a chloride ion, following the trend described above the enthalpy of hydration is smaller (less negative). The actual value is -304 kJ mol^{-1} .

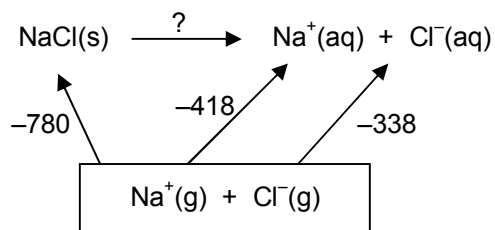
2. (a) $\text{LiCl(s)} \xrightarrow{?} \text{Li}^+(\text{aq}) + \text{Cl}^-(\text{aq})$



$$\Delta H_{\text{sol}}(\text{LiCl}) = -(-848) + -545 + -338 = \underline{-35 \text{ kJ mol}^{-1}}$$

(2 marks)

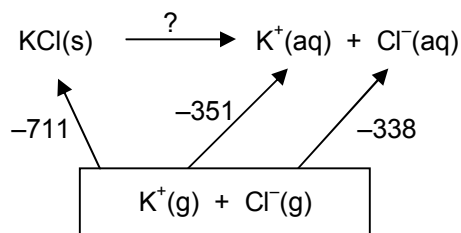
- (b) $\text{NaCl(s)} \xrightarrow{?} \text{Na}^+(\text{aq}) + \text{Cl}^-(\text{aq})$



$$\Delta H_{\text{sol}}(\text{NaCl}) = -(-780) + -418 + -338 = \underline{+24 \text{ kJ mol}^{-1}}$$

(2 marks)

- (c) $\text{KCl(s)} \xrightarrow{?} \text{K}^+(\text{aq}) + \text{Cl}^-(\text{aq})$



$$\Delta H_{\text{sol}}(\text{KCl}) = -(-711) + -351 + -338 = \underline{+22 \text{ kJ mol}^{-1}}$$

(2 marks)

10.4. Entropy

1. (a) The puddle of water (1 mark)
 (b) The firework after it has exploded (1 mark)
2. (a) $\text{H}_2\text{O}_2(\text{l}) \rightarrow \text{H}_2\text{O}(\text{l}) + \text{O}_2(\text{g})$ Positive entropy change (1 mark)
 (b) $2 \text{Fe}_2\text{O}_3(\text{s}) + 3 \text{C}(\text{s}) \rightarrow 4 \text{Fe}(\text{s}) + 3 \text{CO}_2(\text{g})$ Positive entropy change (1 mark)