CAIE Chemistry A-level

Topic 23 - Chemical Energetics

(A-level only)

Flashcards

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Define the standard enthalpy change of atomisation, $\Delta_a H^\theta$

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Define the standard enthalpy change of atomisation, $\Delta_a H^\theta$

The enthalpy change that occurs when one mole of gaseous atoms are formed from an element in its standard state, under standard conditions.

Define the standard enthalpy change of hydration, ΔH_{hyd}^{θ}

Define the standard enthalpy change of hydration, ΔH_{hyd}^{θ}

The enthalpy change that occurs when one mole of gaseous ions are completely hydrated by water to form one mole of aqueous ions, under standard conditions.

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Define the standard enthalpy change of solution, ΔH_{sol}^{θ}

Define the standard enthalpy change of solution, ΔH_{sol}^{θ}

The enthalpy change that occurs when one mole of ionic compound is completely dissolved in water to form aqueous ions, under standard conditions.

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Define first electron affinity

Define first electron affinity

The enthalpy change that takes place when each atom in one mole of gaseous atoms gains an electron to form one mole of gaseous 1- ions under standard conditions.

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What is lattice enthalpy?

What is lattice enthalpy?

The enthalpy change that occurs when one mole of a solid ionic compound is formed from its gaseous ions under standard conditions.

What are two factors that affect the magnitude of lattice enthalpy?

What are two factors that affect the magnitude of lattice enthalpy?

- Ionic charge
- Ionic radius

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Explain how ionic radius affects lattice enthalpy

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Explain how ionic radius affects lattice enthalpy

A smaller ionic radius means the ions are closer together. As a result, the positive and negative ions are more strongly attracted together, making the lattice enthalpy is more exothermic.

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Explain how ionic charge affects lattice enthalpy

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Explain how ionic charge affects lattice enthalpy

A greater ionic charge means greater electrostatic attraction between positive and negative ions. This makes the lattice enthalpy more exothermic.

Calculate the enthalpy change of formation of $C_6H_6(l)$ using the table below

	$\Delta_c H^\theta$ / kJ mol^{-1}
$C_6H_{6(l)}$	-3267
$C_{(s)}$	-394
$H_{2(g)}$	-286

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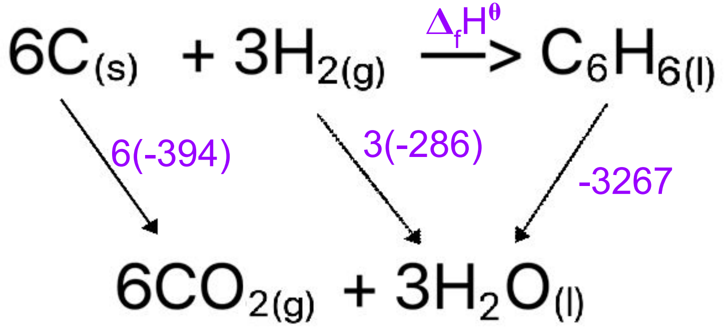
Calculate the enthalpy change of formation of $C_6H_6(l)$



	$\Delta_c H^\theta$ / kJ mol^{-1}
$C_6H_{6(l)}$	-3267
$C_{(s)}$	-394
$H_{2(g)}$	-286

$$\Delta_f H^\theta + (-3267) = 6(-394) + 3(-286)$$

$$\Delta_f H^\theta = 6(-394) + 3(-286) - (-3267)$$

$$= -2364 - 858 + 3267$$

$$= +45 \text{ kJ mol}^{-1}$$

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Calculate the enthalpy change of reaction using the table of bond enthalpies:

$$CO(g) + H_2O(g) \rightarrow CO_2(g) + H_2(g)$$

Bond	Average bond energy / kJ mol^{-1}
C-O	+1077
C=O	+805

Bond	Average bond energy / kJ mol^{-1}
O-H	+464
H-H	+436

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Calculate the enthalpy change of reaction using the table of bond enthalpies: $CO(g) + H_2O(g) \rightarrow CO_2(g) + H_2(g)$

ΔH = total energy needed to break bonds - total energy made when forming bonds

$\Delta H = +1077 + 2(+464) - (+436) - 2(+805)$

$\Delta H = +2005 - (+2046)$

$\Delta H = -41\ kJ\ mol^{-1}$

(May use a Hess' Cycle instead).

Bond	Average bond energy / $kJ\ mol^{-1}$
C-O	+1077
C=O	+805
O-H	+464
H-H	+436

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Draw a Born-Haber cycle for NaCl

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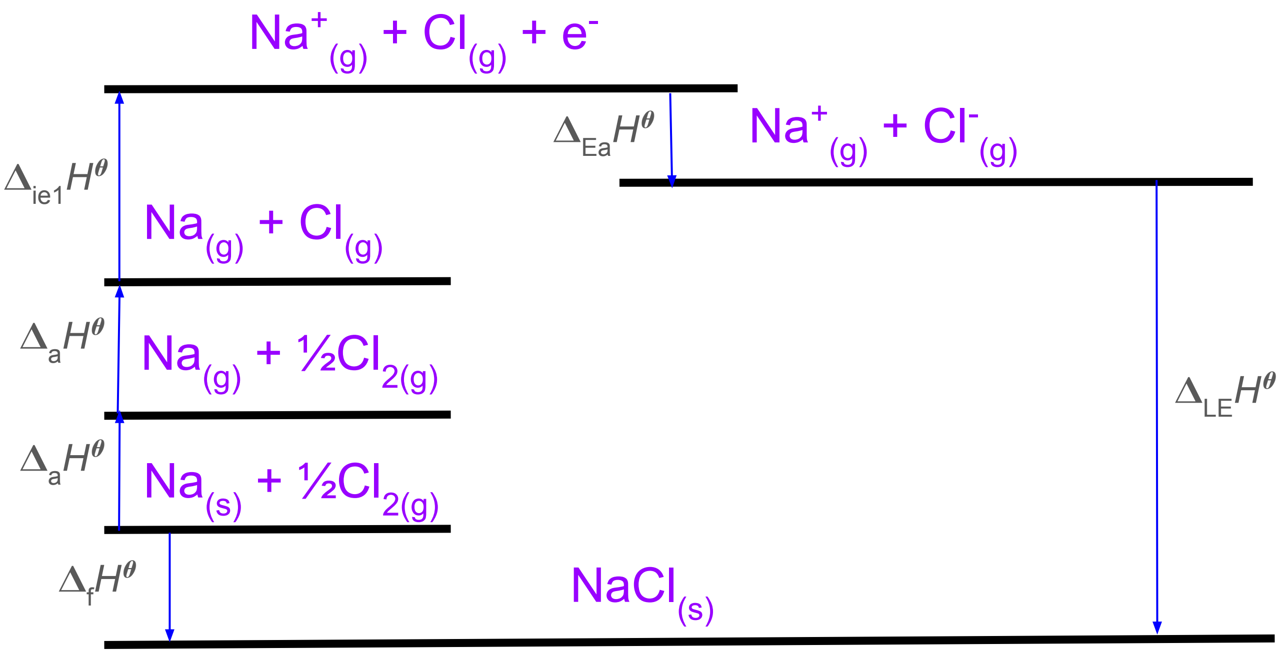
Draw a Born-Haber cycle for NaCl



What is entropy?

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What is entropy?

The measure of disorder of a system.

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In terms of entropy, when is a system more stable?

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In terms of entropy, when is a system more stable?

A system is more stable when its energy is spread out and in a more disordered state. The higher the entropy, the more stable the system.

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How does entropy change when a substance changes state?

How does entropy change when a substance changes state?

Entropy increases from:

Solid → Liquid/Aqueous → Gas.

This occurs because the system becomes more disordered.

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How does entropy change as temperature changes?

How does entropy change as temperature changes?

As temperature increases, the particles in a substance gain kinetic energy and become more disordered. As a result, entropy increases.

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How does entropy change during a reaction in which the number of gas molecules changes?

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How does entropy change during a reaction in which the number of gas molecules changes?

Entropy increases if the number of gas molecules increases. This is because the gaseous state has the highest entropy as there is more disorder in the system.

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How do you calculate the entropy change of the system (given the standard entropies of reactants and products)?

How do you calculate the entropy change of the system (given the standard entropies of reactants and products)?

$$\Delta S = \Sigma S^{\theta}_{products} - \Sigma S^{\theta}_{reactants}$$

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When will ΔS be positive?

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When will ΔS be positive?

When disorder increases, for example:

- State change from solid to liquid or liquid to gas.
- Increase in temperature.
- Increase in the number of gaseous molecules.

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What is Gibbs free energy?

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What is Gibbs free energy?

- The overall change in energy during a reaction is Gibbs free energy, ΔG.
- This energy change consists of entropy change (ΔS) and enthalpy change (ΔH) at a given temperature (T). The units for ΔS must be converted to $kJ\ K^{-1}\ mol^{-1}$.

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

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What does the sign of ΔG say about the feasibility of the reaction?

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What does the sign of ΔG say about the feasibility of the reaction?

ΔG must be zero or negative for the reaction to be feasible/spontaneous.

If ΔG is positive, the reaction is not feasible/spontaneous at the given temperature.

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If ΔH is negative and ΔS is positive, how will changing temperature affect the spontaneity of the reaction?

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If ΔH is negative and ΔS is positive, how will changing temperature affect the spontaneity of the reaction?

ΔG is always negative regardless of temperature so the reaction is spontaneous at all temperatures.

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If ΔH is positive and ΔS is negative, how will changing temperature affect the spontaneity of the reaction?

If ΔH is positive and ΔS is negative, how will changing temperature affect the spontaneity of the reaction?

ΔG is always positive regardless of temperature so the reaction is never spontaneous at any temperatures.

If ΔH and ΔS are positive, how will changing temperature affect the spontaneity of the reaction?

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If ΔH and ΔS are positive, how will changing temperature affect the spontaneity of the reaction?

ΔG is only negative at high temperatures so the reaction will not be spontaneous at low temperatures.

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If ΔH and ΔS are negative, how will changing temperature affect the spontaneity of the reaction?

If ΔH and ΔS are negative, how will changing temperature affect the spontaneity of the reaction?

ΔG is only negative at low temperatures so the reaction will not be spontaneous at high temperatures.