Born-Haber cycles and lattice enthalpy

AQA 7405 · Full A-level

Answer on your own paper. Show your working where needed.

1. Lattice formation and dissociation

Define lattice enthalpy of formation and write the equation for NaCl, with state symbols.

Write the corresponding dissociation equation and relate the two enthalpy changes.

2. Find the lattice enthalpy of KF

Standard enthalpies in kJ mol^{-1}: formation of KF −567, atomisation of K +89 and F +79, first ionisation of K +419, first electron affinity of F −328.

Construct a Born-Haber cycle and use it to calculate the lattice enthalpy of formation of KF.

3. Lattice enthalpy of strontium chloride

For $SrCl_2$, use these enthalpies in kJ mol^{-1}: formation −829, atomisation of Sr +164 and Cl +121, first and second ionisation of Sr +550 and +1064, first electron affinity of Cl −349.

Calculate the lattice enthalpy of formation. State the gaseous ions and their coefficients.

4. Second electron affinity of oxygen

Use the data in kJ mol^{-1} for CaO: formation −635, atomisation of Ca +178 and O +249, first and second ionisation of Ca +590 and +1145, first electron affinity of O −141, lattice formation −3436.

Calculate the second electron affinity of O. Explain its sign.

5. Dissolving potassium bromide

Use these enthalpy changes in kJ mol^{-1}: lattice formation of KBr −671, hydration of K^+ −322, hydration of Br^- −335.

Calculate the enthalpy change of solution. Predict the initial temperature change when KBr dissolves in water in an insulated cup.

6. Hydration of calcium ions

For $CaCl_2$, the lattice enthalpy of formation is −2250 kJ mol^{-1}. The enthalpy change of solution is −81 kJ mol^{-1} and the enthalpy change of hydration of Cl^- is −364 kJ mol^{-1}.

Calculate the enthalpy change of hydration of Ca^{2+}.

7. Compare two oxide lattices

Which has the more exothermic lattice enthalpy of formation, MgO or CaO? Explain your choice.

8. Compare two estimates for silver chloride

For AgCl, a Born-Haber cycle gives a lattice enthalpy of formation of −915 kJ mol^{-1}. A perfectly ionic model gives a lattice enthalpy of dissociation of +770 kJ mol^{-1}.

Compare the two magnitudes. Explain what the difference suggests about bonding in AgCl.

9. Extra challenge · Two models for lithium bromide

For LiBr, the enthalpy of solution is −48 kJ mol^{-1}. The hydration enthalpies of Li^+ and Br^- are −520 and −335 kJ mol^{-1} respectively.

Calculate the lattice enthalpy of dissociation. A perfectly ionic model gives +758 kJ mol^{-1}. Compare the values and explain why there could be a difference.

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