Chemistry

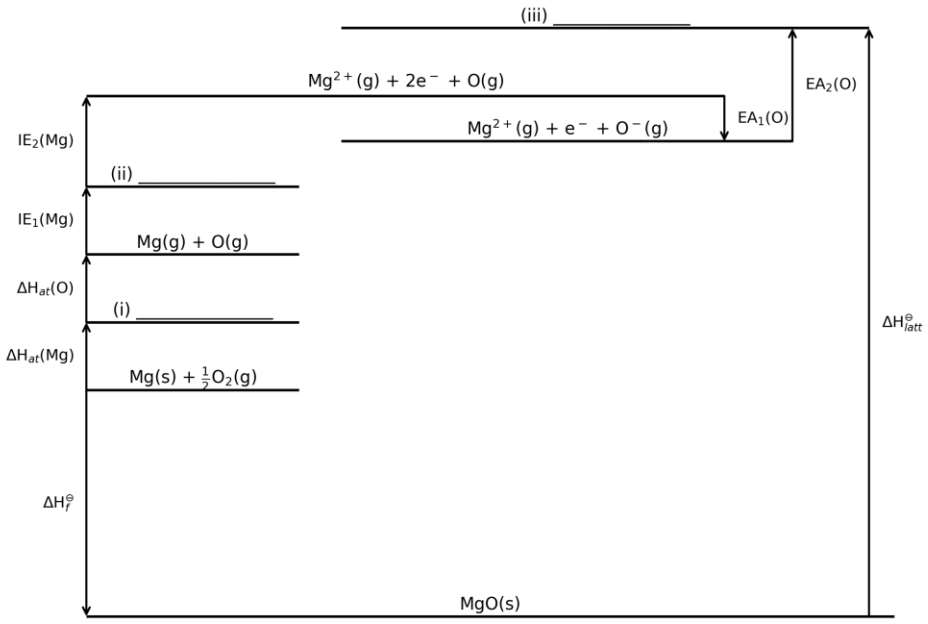
Higher level

Paper 1B

Practice paper

Topic: Thermodynamics

1. The Born-Haber cycle for the formation of magnesium oxide (MgO) is shown below.



(a) Identify the chemical species (including state symbols) represented by labels (i), (ii), and (iii). **[3]**

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(b) State the equation for the lattice enthalpy of dissociation for MgO. **[1]**

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(c) Using the cycle, explain why the formation of MgO is highly exothermic despite requiring large energy inputs for ionization and atomization. **[2]**

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2. The following data are available for potassium chloride, KCl.

$\Delta H^{\ominus}_{latt}$ (KCl) = +711 kJ mol^{-1}

$\Delta H^{\ominus}_{hyd}$ (K^+) = -322 kJ mol^{-1}

$\Delta H^{\ominus}_{hyd}$ (Cl^-) = -364 kJ mol^{-1}

(a) Establish an enthalpy cycle (Born-Haber style or triangle) connecting these values to the enthalpy of solution, ΔH_{sol}. **[2]**

(b) Calculate the enthalpy of solution for KCl in kJ mol^{-1}. **[2]**

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(c) KCl is highly soluble in water even if ΔH_{sol} is endothermic. Explain this in terms of Gibbs free energy and entropy. **[2]**

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3. The standard enthalpy of vaporization for boiling water is +40.7 kJ mol^{-1} at 100 °C.

(a) Calculate the entropy change for the vaporization of one mole of water at its boiling point. **[2]**

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(b) Predict the sign of ΔG at 95 °C for this process. Justify your answer. **[2]**

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4. Two students measured the heat of neutralization using different calorimeters. Student A used a simple polystyrene cup, while Student B used a high-precision vacuum-insulated dewar.

(a) Identify which student will likely obtain a result closer to the literature value. Explain your choice. **[2]**

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(b) Describe the method of 'extrapolation' from a cooling curve used to minimize the error of heat loss in calorimetry. **[2]**

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