

Heat, enthalpy and Hess's law

AP Chemistry · Test

Name: _____ Date: _____ Class: _____ Mark: ____ / 20

This test lasts 45 minutes and covers heat flow, calorimetry, Hess's law, formation enthalpies and bond enthalpies. A calculator is allowed. Use $4.18 \text{ J/(g } ^\circ\text{C)}$ for water. Show all working; the total is 20 marks.

Level: AP Chemistry · **Curriculum:** AP Chem Unit 6

Time: 45 minutes · 8 questions · Total: 20 marks · Calculator allowed

Question 1 Reading the sign (2 marks)

A cold pack contains NH_4NO_3 . When it dissolves, the temperature falls. State whether the process is exothermic or endothermic, and give the sign of ΔH .

Question 2 Calorimetry (3 marks)

In a calorimeter, 150.0 g of water rises from 18.0°C to 31.5°C when 0.0400 mol of a reagent reacts completely ($c = 4.18 \text{ J/(g } ^\circ\text{C)}$).

- Calculate q . (2 marks)
- Calculate ΔH in kJ/mol. (1 mark)

Question 3 Hess's law (3 marks)

(1) $2 \text{ C(s)} + \text{O}_2(\text{g}) \rightarrow 2 \text{ CO(g)}$, $\Delta H = -221 \text{ kJ}$. (2) $2 \text{ CO(g)} + \text{O}_2(\text{g}) \rightarrow 2 \text{ CO}_2(\text{g})$, $\Delta H = -566 \text{ kJ}$. Calculate ΔH for $\text{C(s)} + \text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g})$.

Question 4 Formation enthalpies (3 marks)

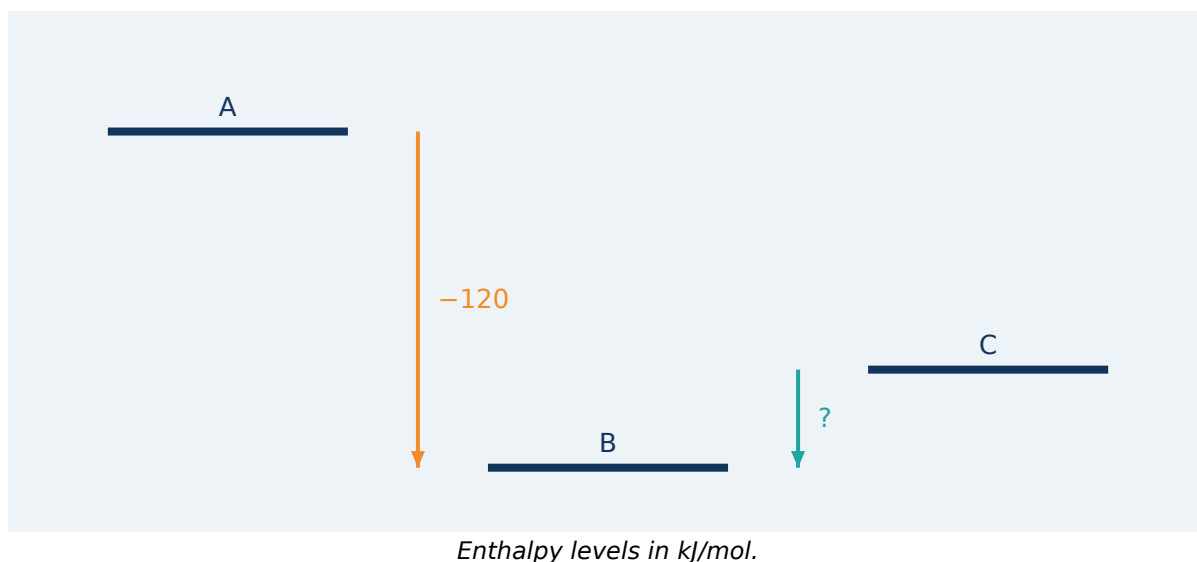
$4 \text{ NH}_3(\text{g}) + 5 \text{ O}_2(\text{g}) \rightarrow 4 \text{ NO(g)} + 6 \text{ H}_2\text{O(g)}$. ΔH°_f (kJ/mol): NH_3 -45.9 , NO $+90.3$, $\text{H}_2\text{O(g)}$ -241.8 . Calculate ΔH° .

Question 5 Bond enthalpies (3 marks)

$\text{CH}_4(\text{g}) + \text{Cl}_2(\text{g}) \rightarrow \text{CH}_3\text{Cl(g)} + \text{HCl(g)}$. Bond enthalpies (kJ/mol): C-H 413, Cl-Cl 243, C-Cl 339, H-Cl 432. Estimate ΔH .

Question 6 Heat loss (2 marks)

A student's calorimetry result for a neutralisation is -53 kJ/mol , while the accepted value is -57 kJ/mol . Explain why heat loss would give a result like this.

Question 7 Enthalpy levels (2 marks)

- State ΔH for $A \rightarrow C$. (1 mark)
- State ΔH for $C \rightarrow B$. (1 mark)

Question 8 Specific heat capacity (2 marks)

A 45.0 g metal sample at 100.0°C is dropped into 100.0 g of water at 20.0°C . The final temperature is 23.5°C . Assuming no heat loss, calculate the specific heat capacity of the metal.