InkChemistry

QUESTION WORKBOOK

Hess's law and enthalpy cycles

Energetics · Unit C04

AQA 3.1.4.3 · OCR A 3.2.1

16 questions · 51 marks

NAVY SCREEN EDITION

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SECTION A · Short, 1 to 2 marks

A1 HSL-Q1 State Hess's law, including the condition under which it applies. [2]

A2 HSL-Q12 Identify the three species in this list whose standard enthalpy of formation is zero: $O_2(g)$, $O_3(g)$, $Br_2(g)$, $Br_2(l)$, C(diamond), C(graphite). [2]

A3 HSL-Q13 Suggest why enthalpies of combustion, rather than enthalpies of formation, are used to find $\Delta_r H^\circ$ for reactions of organic compounds. [2]

SECTION B · Standard, 3 to 5 marks

B1 HSL-Q11 Draw the enthalpy cycle that uses enthalpies of combustion to find the standard enthalpy of formation of propane, and use it to calculate $\Delta_f H^\circ(C_3H_8, g)$. $\Delta_c H^\circ$ / kJ mol^{-1}: C(s) −394, $H_2(g)$ −286, $C_3H_8(g)$ −2220. [5]

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B2 HSL-Q17 Calculate ΔH for $2KHCO_3(s) \rightarrow K_2CO_3(s) + CO_2(g) + H_2O(l)$ from the enthalpy changes for reaction with excess hydrochloric acid, $KHCO_3(s)$ +27.0 kJ mol^{-1} and $K_2CO_3(s)$ -34.0 kJ mol^{-1}, explaining why the first of these is multiplied by two in the cycle. [5]

B3 HSL-Q3 Calculate the standard enthalpy change for $4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(g)$, the first step in making nitric acid. ΔfH° / kJ mol^{-1}: $NH_3(g)$ -46, $NO(g)$ +90, $H_2O(g)$ -242. [4]

B4 HSL-Q5 Calculate the standard enthalpy of formation of ethanol, $2C(s) + 3H_2(g) + \frac{1}{2}O_2(g) \rightarrow C_2H_5OH(l)$, from these enthalpies of combustion / kJ mol^{-1}: $C(s)$ -394, $H_2(g)$ -286, $C_2H_5OH(l)$ -1367. [4]

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B5 HSL-Q2 Calculate the standard enthalpy change for $C_2H_5OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l)$. ΔfH° / kJ mol^{-1}: $C_2H_5OH(l)$ −277, $CO_2(g)$ −394, $H_2O(l)$ −286. [3]

B6 HSL-Q6 Calculate ΔrH° for the hydrogenation of ethene, $C_2H_4(g) + H_2(g) \rightarrow C_2H_6(g)$. ΔcH° / kJ mol^{-1}: $C_2H_4(g)$ −1411, $H_2(g)$ −286, $C_2H_6(g)$ −1560. [3]

B7 HSL-Q8 Explain why the standard enthalpy of formation of carbon monoxide cannot be measured directly, and how Hess's law is used to find it. [3]

B8 HSL-Q9 Explain why the enthalpy change for the hydration of anhydrous copper(II) sulfate cannot be measured directly in a calorimeter. [3]

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B9 HSL-Q10 Explain why Hess's law must be true, using the law of conservation of energy. [3]

B10 HSL-Q14 Suggest how heat lost to the surroundings while anhydrous copper(II) sulfate dissolves would affect the value calculated for its enthalpy of hydration. [3]

B11 HSL-Q15 Compare an enthalpy cycle drawn with enthalpies of formation with one drawn with enthalpies of combustion. [3]

B12 HSL-Q16 Evaluate this working for $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$, using $\Delta_f H^\circ$ / kJ mol^{-1} CH_4 −75, CO_2 −394, $H_2O(l)$ −286: $\Delta_r H^\circ = (-394 + -286) - (-75) = -605$ kJ mol^{-1}. [3]

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B13
HSL-Q19

Suggest why the enthalpy change of decomposition of potassium hydrogencarbonate found from its reaction and that of potassium carbonate with acid, in polystyrene cups, comes out less endothermic than the value from enthalpies of formation. [3]

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