ENERGETICS Core (SL & HL)

1. An equation for the combustion of pentane is given below:

$$C_5H_{12}(l) + 8O_2(g) \rightarrow 5CO_2(g) + 6H_2O(l)$$

(a) Determine the standard enthalpy change, $\Delta H^{\ominus}$, for this reaction using **section 11** of the data booklet. **Show your working.**

[3]

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(b) Calculate the standard enthalpy change, $\Delta H^{\ominus}$, for this reaction using **section 12** of the data booklet. **Show your working.**

[3]

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(c) State and briefly explain whether the method in (a) or the method in (b) above is likely to be the most accurate determination of $\Delta H^{\ominus}$, for this reaction.

[1]

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2. Copper has a relatively low specific heat capacity. A 50.0g sample of copper rises in temperature by 52.0°C when it absorbs 1000J of energy.

(a) Determine the specific heat capacity of copper in J g^{-1} K^{-1} using section 1 of the data booklet. Give your answer to three significant figures.

[2]

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(b) 0.840g of iron powder was added to 40.0cm^3 of copper sulphate solution in a calorimeter. The copper sulphate was in excess. The maximum temperature rise of the solution was 15.0°C.

$$Fe(s) + CuSO_4(aq) \rightarrow FeSO_4(aq) + Cu(s)$$

(i) Assuming that the heat released was absorbed only by the solution, calculate the enthalpy change, ΔH, for this reaction. Use sections 1 and 2 of the data booklet.

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(ii) State another assumption that you made in (b)(i).

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3. (a) The reaction below is an endothermic reaction.

$$N_2(g) + O_2(g) \rightarrow 2NO(g) \qquad \Delta H = +181kJ$$

(i) Sketch a labelled potential energy profile for this reaction, label the enthalpy change, ΔH.

[2]

(ii) Given that the enthalpy change, ΔH, for the reaction as shown above in (a) is +181kJ, use section 11 of the data booklet to calculate the bond enthalpy of the bond in NO(g).

[2]

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4. Sulfuric acid is produced in the Contact Process. The first two steps are the reactions:

I	$S(s) + O_2(g) \rightarrow SO_2(g)$	$\Delta H^{\ominus} = -297kJ$
II	$SO_2(g) + ½O_2(g) \rightleftharpoons SO_3(g)$	$\Delta H^{\ominus} = -98kJ$

(a) SO_3 is a solid at just below room temperature. If $SO_3(s)$ was the product in reaction II, instead of $SO_3(g)$, would the ΔH for reaction II be more or less negative? Explain your answer.

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(b) Write the equation for the standard enthalpy of formation of $SO_3(g)$.

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(c) Using the $\Delta H^{\ominus}$ values given for reactions I and II above, calculate the $\Delta H^{\ominus}$ for the standard enthalpy of formation of $SO_3(g)$.

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5. Given the enthalpy changes below, and average bond enthalpy for Cl–Cl bond of +242kJ mol^{-1}, calculate the average bond enthalpy for the C–Cl bond. **Show your working.**

$C(s) + 2Cl_2(g) \rightarrow CCl_4(g)$ $\Delta H^{\ominus} = -96kJ\ mol^{-1}$

$C(s) \rightarrow C(g)$ $\Delta H^{\ominus} = +715kJ\ mol^{-1}$

[3]

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Total Marks 26 (39 minutes)