

**Chemical Energetics – 2016**

1. 9701/21/O/N/16/No.2

For many compounds the enthalpy change of formation cannot be calculated directly. An indirect method based on enthalpy changes of combustion can be used.

The enthalpy change of combustion can be found by a calorimetry experiment in which the heat energy given off during combustion is used to heat a known mass of water and the temperature change recorded.

(a) (i) Explain the meaning of the term *standard enthalpy change of combustion*.

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..... [3]

(ii) Write the equation for the complete combustion of ethanol, C<sub>2</sub>H<sub>5</sub>OH.

..... [1]

(b) In an experiment to determine the enthalpy change of combustion of ethanol, 0.23 g of ethanol was burned and the heat given off raised the temperature of 100 g of water by 16.3 °C.

(i) Calculate the heat energy change, *q*, during the combustion of 0.23 g of ethanol.

$q = \dots\dots\dots \text{ J [1]}$

(ii) Calculate the enthalpy change on burning 1 mole of ethanol. Include a sign in your answer.

$\Delta H = \dots\dots\dots \text{ kJ mol}^{-1} [1]$

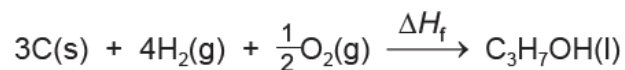
(iii) Suggest **two** reasons why the value for the enthalpy change of combustion of ethanol determined by a simple laboratory calorimetry experiment is likely to be lower than the true value.

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..... [2]

(c) The table gives some enthalpy change of combustion values.

substance	enthalpy change of combustion / kJ mol <sup>-1</sup>
C(s)	-393.5
H <sub>2</sub> (g)	-285.8
C <sub>3</sub> H <sub>7</sub> OH(l)	-2021.0

(i) Construct a labelled energy cycle to show how these values could be used to calculate the enthalpy change of formation of C<sub>3</sub>H<sub>7</sub>OH(l),  $\Delta H_f$ .



[3]

(ii) Calculate the enthalpy change of formation,  $\Delta H_f$ , of C<sub>3</sub>H<sub>7</sub>OH(l).

$\Delta H_f = \dots\dots\dots$  kJ mol<sup>-1</sup> [2]

[Total: 13]