ENERGETICS(A & AS LEVEL)

NOTE-

FOLLOW THE NUMBERING GIVEN IN THE QUESTIONS

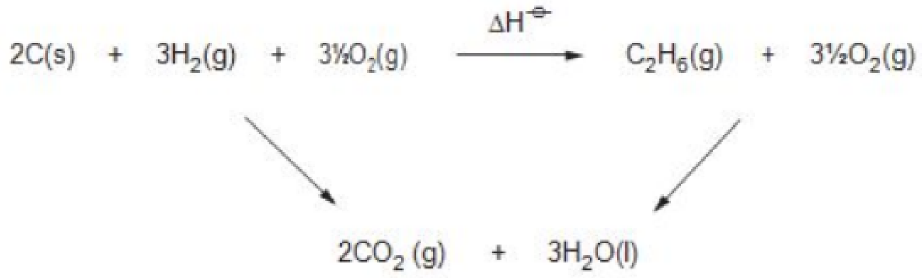
DON'T DO YOUR OWN NUMBERING.

TRY ATTEMPTING IN ORDER.

TIME – 40MIN

MAX. MARKS – 34

1. Study the following energy cycle.



Use the values in the table below to calculate the enthalpy change of reaction, ΔH⦵. [2]

Substance	Enthalpy change of combustion, $\Delta H_c^{\ominus}$ / kJ mol^{-1}
carbon	−394
hydrogen	−286
ethane	−1560

ΔH⦵ = ... kJ mol^{-1}

2.

(a) Ethanol, C_2H_5OH, is a liquid at room temperature. It is being increasingly used as a fuel.

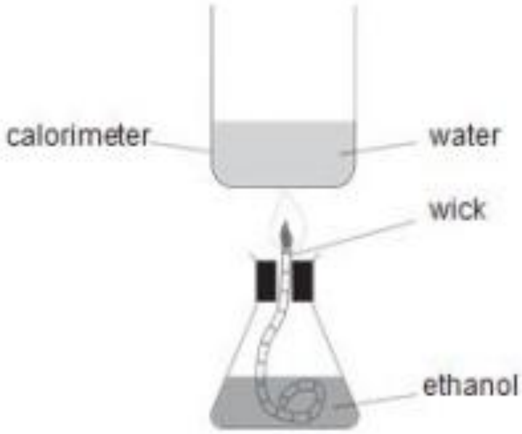
(i) Write the equation that represents the standard molar enthalpy change of formation (ΔH_f) of ethanol. [1]

(ii) Suggest why this enthalpy change cannot be measured directly. [1]

(b) Enthalpy changes of combustion can often be measured directly. The equation for the reaction which represents the enthalpy change of combustion (ΔH_c) of ethanol is as follows.

$$C_2H_5OH(l) + 3O_2(g) \longrightarrow 2CO_2(g) + 3H_2O(l)$$

A student used the apparatus below to determine the enthalpy change of combustion of ethanol.



The student obtained the following results.

Mass of spirit burner + ethanol at start	= 72.27 g
Mass of spirit burner + ethanol after combustion	= 71.46 g
Temperature of water at start	= 21.5 °C
Temperature of water after combustion	= 75.5 °C
Volume of water in calorimeter	= 100 cm^3

The energy released in the experiment can be calculated using the formula

energy released = $mc\Delta T$

where m = mass of the water in grams (assume 1 cm^3 has a mass of 1 g)
c = 4.2 J g^{-1} °C^{-1}
ΔT = change in temperature of the water

(i) Calculate the energy released in the experiment

[1]

Energy released = ... J

(ii) The enthalpy change of combustion of ethanol is defined as the energy change per mol of ethanol burned.

Use your answer to (i) to calculate the enthalpy change of combustion of ethanol.

Give your answer in kJ mol^{-1} and correct to **3 significant figures**. Include the sign.

[3]

(c) Another student did not carry out an experiment to find ΔH_c of ethanol. He looked up the literature value on a respected internet site.

How would you expect the numerical values obtained by the two students to differ? Explain your answer.

You may assume that both values were found under the same conditions of temperature and pressure.

[2]

7. The reaction of an acid with a base to give a salt is an exothermic reaction. In an experiment to determine the enthalpy of neutralisation of hydrochloric acid with sodium hydroxide, 50.0cm^3 of 1.00 mol dm^{-3} HCl was mixed with 50.0 cm^3 of 1.10 mol dm^{-3} NaOH. The temperature rise obtained was 6.90 °C.

(a) Define the term **enthalpy of neutralisation**.

....

....

(1)

(b) Assuming that the density of the final solution is 1.00 g cm^{-3} and that its heat capacity is 4.18 J K^{-1} g^{-1}, calculate the heat evolved during the reaction.

(3)

(c) 0.0500 mol of acid was neutralised in this reaction; calculate $\Delta H_{neutralisation}$ in kJ mol^{-1}.

(2)

8. (a) (i) Define the term **standard enthalpy of combustion**.

....

....

....

....

(3)

(ii) The values for the standard enthalpy of combustion of graphite and carbon monoxide are given below:

	$\Delta H_c^{\ominus}$/kJ mol^{-1}
C (graphite)	–394
CO(g)	–283

Use these data to find the standard enthalpy change of formation of carbon monoxide using a Hess's law cycle.

$$C(graphite) + \frac{1}{2}O_2(g) \rightarrow CO(g)$$

(3)

(iii) Suggest why it is not possible to find the enthalpy of formation of carbon monoxide directly.

....

....

(1)

(iv) Draw an enthalpy level diagram below for the formation of carbon monoxide from graphite.

(1)

17. This question is about a self-heating can of coffee.

The bottom of the can has a compartment containing copper(II) nitrate solution. When a button on the bottom of the can is pressed, magnesium powder is released into the compartment where it reacts with the copper(II) nitrate solution.

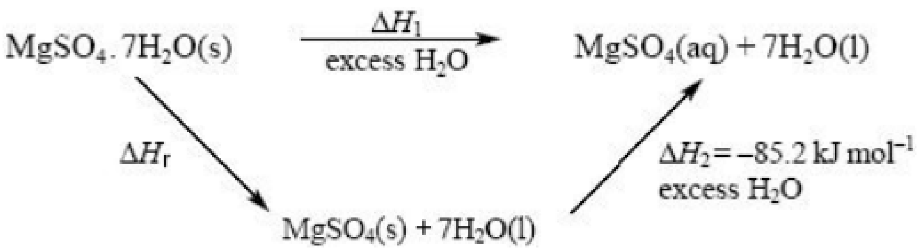
(a) (i) Write an ionic equation for the reaction between magnesium powder and copper(II) ions. Include state symbols, but omit any spectator ions.

(2)

(ii) Show how the standard enthalpy change for this reaction could be calculated from the standard enthalpies of formation of copper(II) ions and magnesium ions. You should include a Hess cycle in your answer.

(3)

18



(i) Use the cycle to write an expression for ΔH_r using ΔH_1 and ΔH_2.

(1)

(e) Methane is the feedstock in the manufacture of hydrogen according to the equation:

$$CH_4(g) + 2H_2O(g) \rightarrow CO_2(g) + 4H_2(g)$$

Given the enthalpy of formation data below, draw a **labelled** Hess's law cycle and use it to calculate the enthalpy change of this reaction.

Substance	Enthalpy of formation/kJ mol^{-1}
$CH_4(g)$	–75
$CO_2(g)$	–394
$H_2O(g)$	–242

(4)