5.1 Energetics

Question Paper

Course	DP IB Chemistry
Section	5. Energetics / Thermochemistry
Topic	5.1 Energetics
Difficulty	Easy

Time allowed: 50

Score: /35

Percentage: /100

Question 1a

a)
Chemical reactions can be exothermic or endothermic. State which type of reaction is indicated by a decrease in temperature.

[1 mark]

Question 1b

b)
State the type of reaction in which the energy of the system decreases.

[1 mark]

Question 1c

c)
The reaction of propane with oxygen is represented by the following equation

$$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O \qquad \Delta H = -2219\ kJ\ mol^{-1}$$

State the classification of the enthalpy change is occurring in this reaction.

[1 mark]

Question 1d

d)
Define the term enthalpy of formation, ΔH_f, and state the standard conditions.

[6 marks]

Question 2a

a)
Define the term enthalpy change of reaction, ΔH_r.

[2 marks]

Question 2b

b)
The equations below can be identified as any of the following enthalpy changes. Identify the enthalpy change for each reaction.

- Enthalpy of reaction, ΔH_r
- Enthalpy of formation, ΔH_f
- Enthalpy of combustion, ΔH_c
- Enthalpy of neutralisation, ΔH_{neut}

$C_2H_5OH\,(l) + O_2\,(g) \rightarrow CO_2\,(g) + H_2O\,(l)$ ……

$CaSO_3\,(s) \rightarrow CaO\,(s) + SO_2\,(g)$ ……

$HCl\,(aq) + NaOH\,(aq) \rightarrow NaCl\,(aq) + H_2O\,(l)$ ……

[3 marks]

Question 2c

c)
Hydrochloric acid, HCl (aq), and sodium hydroxide, NaOH (aq), react as follows

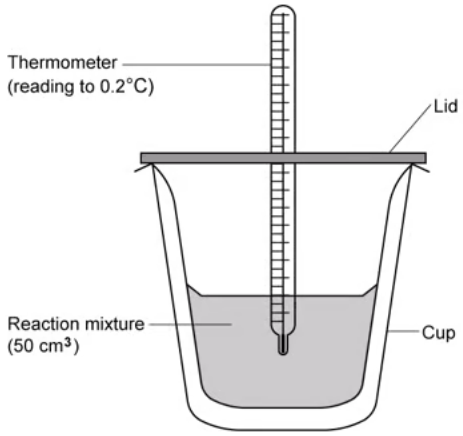
$$HCl\,(aq) + NaOH\,(aq) \rightarrow NaCl\,(aq) + H_2O\,(l) \quad \Delta H_r = -57.9\ kJ\ mol^{-1}$$

Determine the enthalpy change, in kJ, when 25 cm^3 of 0.5 mol dm^{-3} hydrochloric acid reacts with 25 cm^3 of 0.5 mol dm^{-3} sodium hydroxide. Give your answer to 2 decimal places.

[2 marks]

Question 3a

a)
A student set up apparatus for a calorimetry experiment as shown below.
Suggest suitable materials for the lid and cup. Justify your answer.



[3 marks]

Question 3b

b)
The student added excess zinc powder to the cup with 50.0 cm^3 of 1.0 mol dm^{-3} copper(II) sulfate solution in a calorimeter.
The reaction equation was as follows:

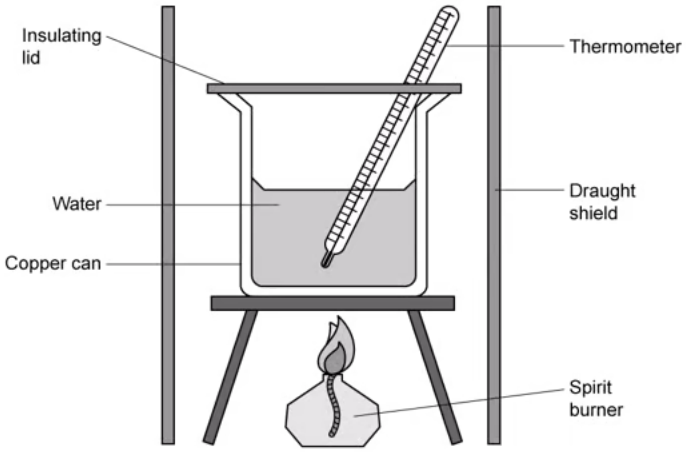
$$Zn(s) + CuSO_4(aq) \rightarrow ZnSO_4(aq) + Cu(s)$$

The maximum temperature rise was 22.6 °C. Using section 1 of the data booklet, determine the enthalpy of reaction, in kJ.
Give your answer to 2 significant figures.
Calculate the energy change, *q* ……
Calculate the number of moles of copper(II) sulfate solution ……
Calculate the enthalpy change of the reaction ……

[3 marks]

Question 3c

c)
Another calorimetry experiment was set up to determine the enthalpy of combustion for ethanol.



Define standard enthalpy of combustion, ΔH_c.

[2 marks]

Question 3d

d)
0.61 g of ethanol, C_2H_5OH, was burned in a spirit burner and used to heat 100 cm^3 of water in a copper calorimeter. The temperature of the water rose by 40 °C.

i)
Using section 1 and 2 in the data booklet determine the energy, in joules, for this reaction.

ii)
Convert your answer to part (i) into kilojoules.

[2 marks]

Question 3e

e)
Calculate the enthalpy change for the combustion of ethanol.

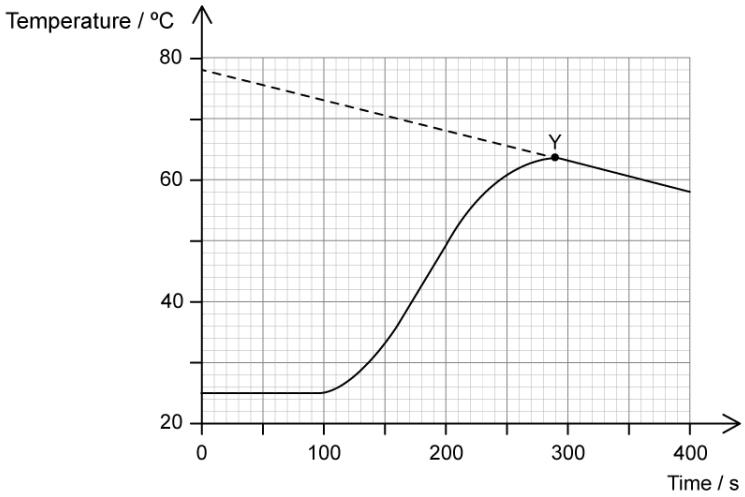
Determine the moles of ethanol ……..
Determine the overall enthalpy change ……..

[3 marks]

Question 4a

a)

4.00 g of powdered iron was reacted with 25.0 cm^3 of 2.00 mol dm^{-3} copper(II) sulfate solution in an insulated beaker. Temperature was plotted against time.



Estimate the time at which the powdered iron was added to the beaker.

[1 mark]

Question 4b

b)

A student added point Y to the graph.

i)

State what point Y indicates on the graph.

ii)

Assuming there is no heat loss in the experiment and the heat change is instantaneous, using the graph, determine the total temperature change.

[3 marks]

Question 4c

c)
Explain why the student has recorded the temperature of the copper sulfate solution for a period of time before adding the iron powder.

[1 mark]

Question 4d

The student used the equation $q = mc\Delta T$ to calculate the enthalpy change for the reaction that took place in the beaker.
State the value that the student should use for m.

[1 mark]