Q1.

Sodium hydrogencarbonate can be decomposed to sodium carbonate by heating to about 300 °C.

The equation for the reaction is:

$$2NaHCO_3(s) \rightarrow Na_2CO_3(s) + CO_2(g) + H_2O(l)$$

(a) Give a reason why it is **not** possible to measure the enthalpy change for this reaction directly.

(1)

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(b) (i) State what is meant by the standard enthalpy change of formation.

(2)

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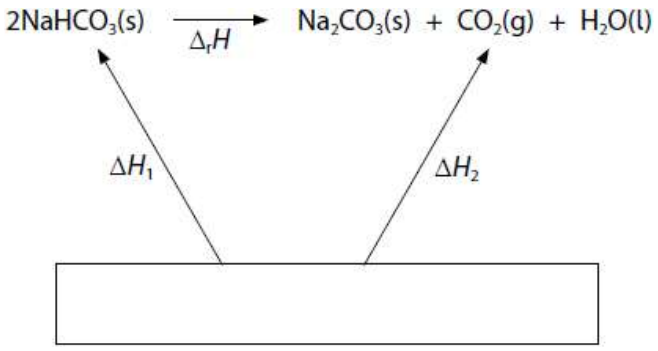
(ii) Complete the Hess cycle that you would use to determine the enthalpy change for this reaction from the standard enthalpy changes of formation.

(2)



(iii) Calculate the standard enthalpy change for the thermal decomposition of sodium hydrogencarbonate, using the information in the table and your completed cycle. Include a sign and units in your answer.

(4)

Compound	Standard enthalpy change of formation, $\Delta_f H^{\ominus}$ / kJ mol^{-1}
$NaHCO_3(s)$	–950.8
$Na_2CO_3(s)$	–1130.7
$CO_2(g)$	–393.5
$H_2O(l)$	–285.8

(iv) Use your answer to (b)(iii) to draw an enthalpy level diagram for this reaction, labelling the axes provided.

(2)

(Total for question = 11 marks)

Q2.

Zinc metal reacts with copper(II) sulfate solution. The equation for the reaction is:

$$Zn(s) + CuSO_4(aq) \rightarrow ZnSO_4(aq) + Cu(s) \qquad \Delta_r H = -210 \text{ kJ mol}^{-1}.$$

(a) What is the temperature rise, in °C, when excess zinc powder is added to 50 cm^3 of copper(II) sulfate solution containing 0.0025 mol of copper(II) ions?

[Assume the specific heat capacity of the solution is 4.2 J g^{-1} $°C^{-1}$].

(1)

☒ **A** 2.5

☒ **B** 10.5

☒ **C** 25.0

☒ **D** 44.1

(b) The reaction of zinc with copper(II) sulfate is best classified as:

(1)

☒ **A** disproportionation

☒ **B** neutralisation

☒ **C** redox

☒ **D** thermal decomposition

(Total for question = 2 marks)