Additional Assessment Materials

Summer 2021

Pearson Edexcel GCE in Chemistry 8CH0

Resource Set 2 – Topic Group 4

Topics included:

Topic 8: Energetics I

Topic 9: Kinetics I and Topic 10: Equilibrium I

(Public release version)

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Additional Assessment Materials, Summer 2021

General guidance to Additional Assessment Materials for use in 2021

Context

- Additional Assessment Materials are being produced for GCSE, AS and A levels (with the exception of Art and Design).
- The Additional Assessment Materials presented in this booklet are an **optional** part of the range of evidence teachers may use when deciding on a candidate's grade.
- 2021 Additional Assessment Materials have been drawn from previous examination materials, namely past papers.
- Additional Assessment Materials have come from past papers both published (those materials available publicly) and unpublished (those currently under padlock to our centres) presented in a different format to allow teachers to adapt them for use with candidate.

Purpose

- The purpose of this resource to provide qualification-specific sets/groups of questions covering the knowledge, skills and understanding relevant to this Pearson qualification.
- This document should be used in conjunction with the mapping guidance which will map content and/or skills covered within each set of questions.
- These materials are only intended to support the summer 2021 series.

4 Ethanol, C_2H_5OH, is a member of the homologous series of alcohols.

(a) Calculate the number of molecules in 55.2 kg of ethanol.

[Avogadro Constant = 6.02×10^{23} mol^{-1}]

(2)

(b) Write the equation to represent the standard enthalpy change of formation of ethanol. Include state symbols.

(2)

(c) Ethanol burns completely in excess oxygen.

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

(i) The table shows some mean bond enthalpy data.

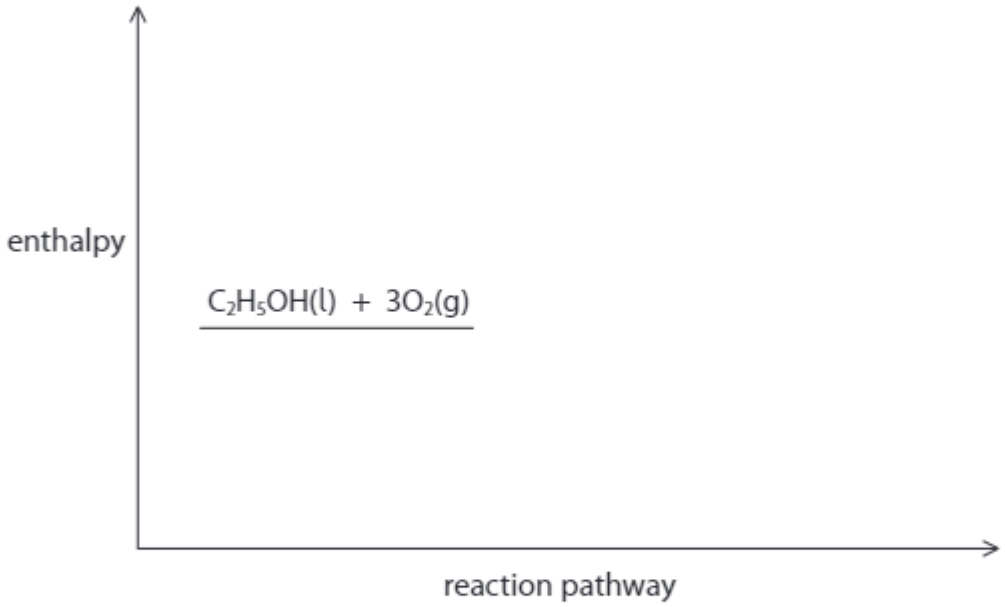
Bond	C—C	C—H	C—O	O—H	O═O	C═O
Mean bond enthalpy / kJ mol^{-1}	347	413	358	464	498	805

Calculate the enthalpy change, in kJ mol^{-1}, for the complete combustion of 1 mol of ethanol.

(3)

(ii) Complete the reaction profile diagram for the combustion of ethanol and fully label the diagram.

(2)



(iii) A data book value for the standard enthalpy change of combustion of ethanol is -1367.3 kJ mol^{-1}.

Give the **main** reason why the value you calculated in (b)(i) is different from this data book value.

(1)

.....

.....

.....

(Total for Question 4 = 10 marks)

8 Compound **X** reacts slowly with water according to the following equation.

$$\mathbf{X}(s) + H_2O(l) \rightarrow \mathbf{Y}(aq) + Z^-(aq) + H^+(aq)$$

The reaction is catalysed by hydrogen ions and eventually goes to completion.

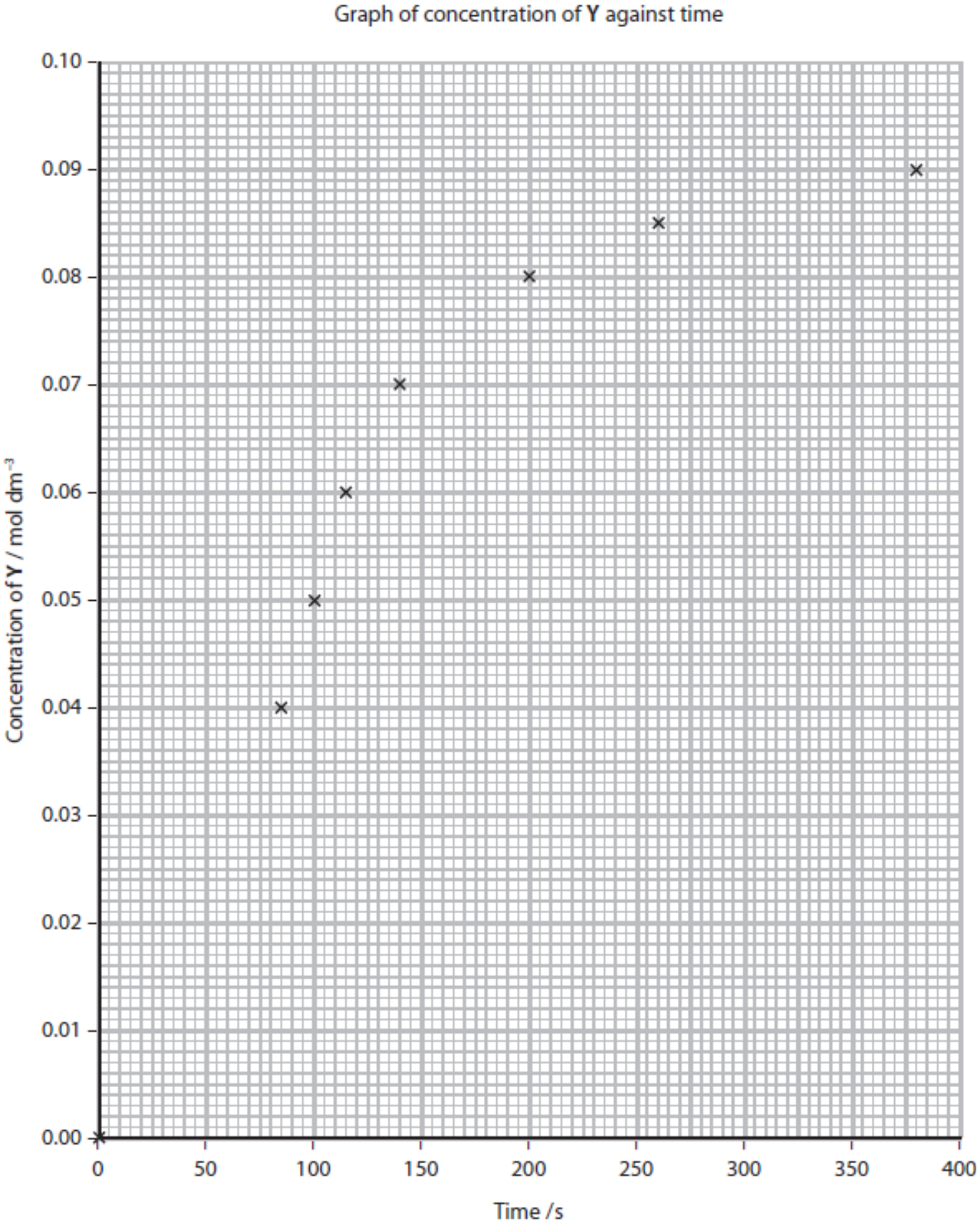
Compound **X** was added to water and the concentration of compound **Y** determined at various times at a constant temperature.

The results of the experiment are shown.

Time / s	Concentration of **Y** / mol dm^{-3}
0	0.000
25	0.002
40	0.005
50	0.010
65	0.020
75	0.030
85	0.040
100	0.050
115	0.060
140	0.070
200	0.080
260	0.085
380	0.090

(a) (i) Complete the graph of concentration against time by adding the six missing points. Draw a line to pass through **all** the points.

(2)


Graph of concentration of Y against time
Concentration of Y / mol dm⁻³
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
0
50
100
150
200
250
300
350
400
Time /s

(ii) Describe how you would find a numerical value for the initial rate of reaction and for the maximum rate of reaction in this experiment from the graph. No actual calculations are required.

(4)

(b) For many reactions, the values of the initial rate and the maximum rate are the same.

Explain why the values of the two reaction rates obtained in this experiment are different from each other.

(2)

(c) Give a reason why the measurement of the initial rate of reaction is likely to be less accurate than the measurement of the maximum rate.

(1)

(Total for Question 8 = 9 marks)

4 Methanol is manufactured from a mixture of carbon monoxide and hydrogen.

$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g) \quad \Delta H = -90.8\,kJ\,mol^{-1}$$

(a) Give **two** characteristics of all reactions at equilibrium.

(2)

(b) (i) How does the equilibrium yield of methanol change if the temperature is increased at constant pressure or the pressure increased at constant temperature?

(1)

	Equilibrium yield when temperature is increased	Equilibrium yield when pressure is increased
☒ **A**	decrease	decrease
☒ **B**	decrease	increase
☒ **C**	increase	decrease
☒ **D**	Increase	increase

(ii) Explain your answer to (b)(i).

(2)

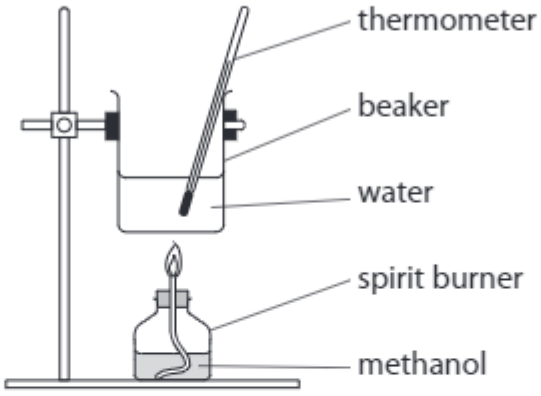
(c) Explain why, in the industrial process involving this reaction, a catalyst is used.

(2)

(Total for Question 4 = 7 marks)

4 Methanol, CH_3OH, is a liquid fuel.

An experiment was carried out to determine the enthalpy change of combustion of liquid methanol.



The energy obtained from burning 2.08 g of methanol was used to heat 75.0 g of water.

The temperature of the water rose from 25.0 °C to 91.0 °C.

[Specific heat capacity of water = 4.18 $J g^{-1} °C^{-1}$]

(a) Use the data to calculate a value for the enthalpy change of combustion of one mole of methanol.

Give your answer to an appropriate number of significant figures and include a sign and units.

(4)

(b) Methanol can be synthesised from methane and steam by a process that occurs in two steps.

Step **1** $CH_4(g) + H_2O(g) \rightleftharpoons 3H_2(g) + CO(g)$ $\Delta H = +206\,kJ\,mol^{-1}$

Step **2** $CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$ $\Delta H = -91\,kJ\,mol^{-1}$

(i) Explain the effects of increasing the pressure on the yield of the products and on the rate of the reaction in Step **1**.

(4)

(ii) Step **2** is carried out at a compromise temperature of 500 K.

Explain why 500 K is considered to be a compromise for Step **2** by considering what would happen at higher and lower temperatures.

(3)

(c) Calculate a value for the standard enthalpy change of combustion of gaseous methanol using the enthalpy change for Step **2** and the standard enthalpy change of combustion of gaseous carbon monoxide and of hydrogen.

Substance	Standard enthalpy change of combustion / kJ mol^{-1}
CO	−283
H_2	−286

(3)

(Total for Question 4 = 14 marks)

Total for Paper = 40 marks