

Paper Reference(s) 8CH0/02

Pearson Edexcel GCE

Chemistry

Advanced Subsidiary

Paper 2: Core Organic and Physical Chemistry

Thursday 23 May 2019 – Morning

Time: 1 hour 30 minutes plus your additional time allowance

INSTRUCTIONS TO CANDIDATES

Write your centre number, candidate number, surname, other names and your signature in the boxes below. Check that you have the correct question paper.

Centre No.					
Candidate No.					
Surname					
Other names					
Signature					
Paper Reference	8	C	H	0	/ 0 2



- Use **BLACK** ink or **BLACK** ball-point pen.
- Answer **ALL** questions.
- Answer the questions in the spaces provided
– there may be more space than you need.

MATERIALS REQUIRED FOR EXAMINATION

Scientific calculator, Data booklet, ruler

ITEMS INCLUDED WITH QUESTION PAPERS

Separate sheet for use with Question 8

Periodic Table

INFORMATION FOR CANDIDATES

- The total mark for this paper is 80.
- The marks for **EACH** question are shown in brackets
– use this as a guide as to how much time to spend on each question.
- For the question marked with an **ASTERISK (*)**, marks will be awarded for your ability to structure your answer logically showing the points that you make are related or follow on from each other where appropriate.
- A Periodic Table is provided.

ADVICE TO CANDIDATES

- Read each question carefully before you start to answer it.
- Show all your working in calculations and include units where appropriate.
- Check your answers if you have time at the end.

(Turn over)

Answer ALL questions.

Some questions must be answered with a cross in a box ☐. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☐.

- 1 Some alkanes are used as fuels for transport. Crude oil, which is a mixture of hydrocarbons, is the major source of these alkanes. Crude oil is processed by fractional distillation, cracking and reforming.**
- (a) Fractional distillation produces fractions which contain molecules of a similar boiling temperature. Molecules containing six carbon atoms are found in both the petrol fraction and the higher boiling kerosene fraction.**
- (i) Identify, by name or structural formula, the unbranched alkane with six carbon atoms found in kerosene. (1 mark)**
-

(Question continues on next page)

(Turn over)

(ii) Explain why ISOMERS of the alkane in (a)(i) have lower boiling temperatures and so are found in the petrol fraction. (3 marks)

[illegible]

(Continue your answer on next page)

(Turn over)

(Question continues on next page)

- (b) During cracking, carbon to carbon bonds are broken.

Explain the TWO major reasons for cracking hydrocarbons. (3 marks)

(Continue your answer on next page)

(Turn over)

(Question continues on next page)

- (c) Which of the following changes to the proportions of organic molecules within a fraction results from the reforming process? (1 mark)

	Proportion of branched chain alkanes	Proportion of cyclic hydrocarbons
<input type="checkbox"/> A	decrease	decrease
<input type="checkbox"/> B	decrease	increase
<input type="checkbox"/> C	increase	decrease
<input type="checkbox"/> D	increase	increase

(TOTAL FOR QUESTION 1 = 8 MARKS)

(Questions continue on next page)

(Turn over)

2 This question is about organic compounds.

(a) Organic compounds can be grouped together in homologous series.

(i) Describe TWO characteristics of a homologous series. (2 marks)

(ii) Name the homologous series to which propene belongs. (1 mark)

(Question continues on next page)

(Turn over)

(b) Propene can be converted into a mixture of 1-chloropropane and 2-chloropropane, in which 2-chloropropane is the major product.

**(i) Give the reagent required for this reaction.
(1 mark)**

(ii) What is the type and mechanism of the reaction in (b)(i)? (1 mark)

- ☐ **A electrophilic addition**
- ☐ **B nucleophilic addition**
- ☐ **C electrophilic substitution**
- ☐ **D nucleophilic substitution**

(Question continues on next page)

(c) 1-chloropropane and 2-chloropropane can be converted into compounds containing the nitrile functional group.

(i) Under appropriate conditions, 1-chloropropane can be converted into butanenitrile, $\text{CH}_3\text{CH}_2\text{CH}_2\text{CN}$.

Which is the reagent for this conversion?
(1 mark)

- ☐ A ammonia
- ☐ B nitric acid
- ☐ C potassium cyanide
- ☐ D silver nitrate

(Question continues on next page)

- (ii) Under appropriate conditions, 2-chloropropane can be converted into a structural isomer of butanenitrile.

State what is meant by the term 'structural isomer'. (2 marks)

(Question continues on next page)

- (iii) Give the displayed formula AND systematic name of the isomer of butanenitrile formed in (c)(ii). You must show ALL the bonds.
(2 marks)

Displayed formula

Name

(TOTAL FOR QUESTION 2 = 10 MARKS)

(Questions continue on next page)

(Turn over)

3 This question is about enthalpy changes.

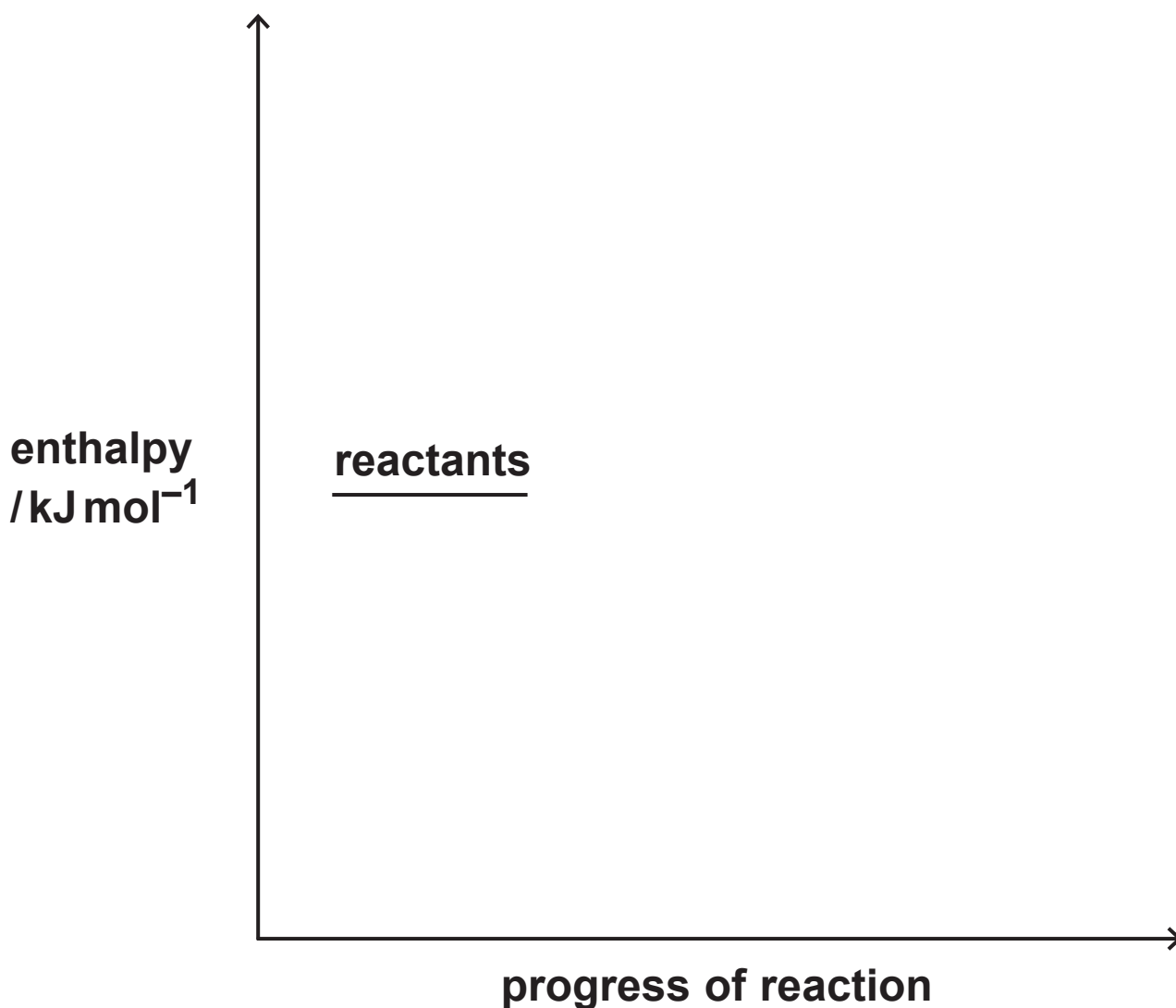
- (a) (i) State what is meant by the term ‘standard enthalpy change of combustion’. (2 marks)**

- (ii) Write the equation, including state symbols, for the reaction that occurs when the standard enthalpy change of combustion of octane, $\text{C}_8\text{H}_{18}(\text{l})$, is measured. (2 marks)**

- (iii) The standard enthalpy change of combustion of octane is $-5470 \text{ kJ mol}^{-1}$.

Complete the reaction profile diagram for the combustion of octane.

Include labels showing the standard enthalpy change of combustion, $\Delta_c H^\ominus$, and the activation energy, E_a . (2 marks)



(Question continues on next page)

(Turn over)

- (b) Enthalpy changes of reactions which cannot be measured directly can be calculated using standard enthalpy changes of combustion.

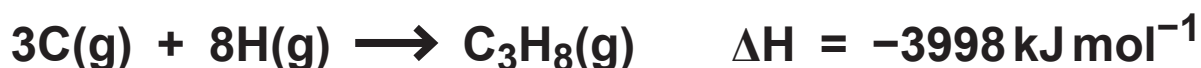
The table shows some of these values.

Substance	$\Delta_c H^\ominus / \text{kJ mol}^{-1}$
C(s)	-394
H ₂ (g)	-286
CH ₄ (g)	-890

Complete the Hess cycle and use it to calculate the standard enthalpy change for the following reaction. (4 marks)



- (c) The equations for the combination of gaseous atoms of carbon and hydrogen to form methane, CH_4 , and propane, C_3H_8 , are



Calculate:

- (i) the mean bond enthalpy of a C—H bond.
(1 mark)

(Question continues on next page)

(Turn over)

- (ii) the mean bond enthalpy of a C—C bond.
(2 marks)

(TOTAL FOR QUESTION 3 = 13 MARKS)

(Questions continue on next page)

(Turn over)

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



- (a) Give TWO characteristics of all reactions at equilibrium. (2 marks)

(Question continues on next page)

(Turn over)

- (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 mark)

	Equilibrium yield when temperature is increased	Equilibrium yield when pressure is increased
<input type="checkbox"/> A	decrease	decrease
<input type="checkbox"/> B	decrease	increase
<input type="checkbox"/> C	increase	decrease
<input type="checkbox"/> D	Increase	increase

(Question continues on next page)

(ii) Explain your answer to (b)(i). (2 marks)

[illegible]

(c) Explain why, in the industrial process involving this reaction, a catalyst is used. (2 marks)

(TOTAL FOR QUESTION 4 = 7 MARKS)

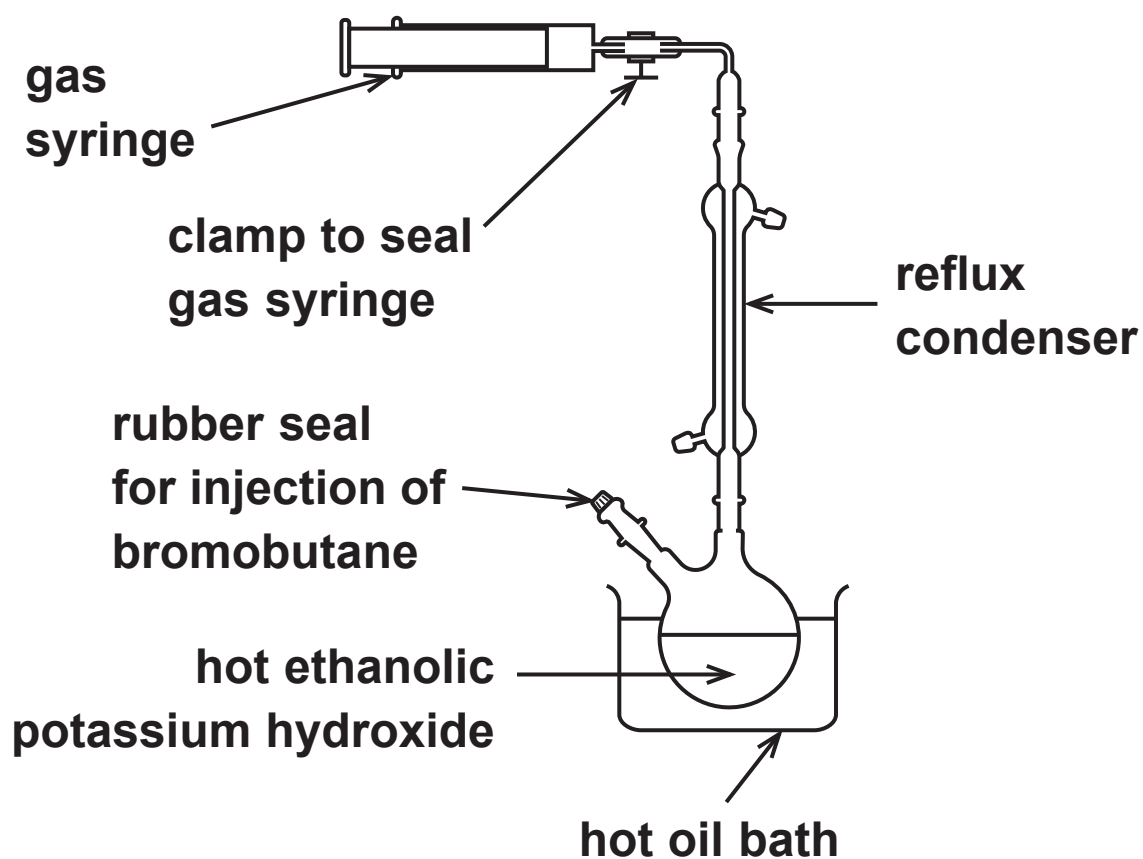
(Questions continue on next page)

(Turn over)

- 5 Bromobutanes react with hot ethanolic potassium hydroxide solution to produce gaseous butenes.



Apparatus



(Question continues on next page)

Procedure

- 0.0080 mol of liquid 1-bromobutane was injected into a round bottom flask containing hot ethanolic potassium hydroxide.
- After the reaction, the syringe was sealed using a clamp.
- The syringe was then removed from the apparatus and allowed to cool to room temperature (298 K).

Result

The final volume of but-1-ene collected was 22.0 cm³.

(a) State the purpose of the condenser. (1 mark)

(Question continues on next page)

(Turn over)

(b) Describe a chemical test on the gas in the syringe to identify its functional group.

Include the expected result. (2 marks)

(Question continues on next page)

(Turn over)

- (c) Calculate the percentage of 1-bromobutane which was converted to but-1-ene. (2 marks)

[Molar volume of a gas at r.t.p. = $24\,000\text{ cm}^3\text{ mol}^{-1}$]

- (d) Before cooling, the volume of but-1-ene in the gas syringe was 24.0 cm^3 .

Calculate the temperature of the gas in the syringe before it cooled. (2 marks)

[Assume no loss from the gas syringe during cooling, and a constant pressure]

- (e) (i) Another compound formed from 1-bromobutane under these conditions is butan-1-ol.

Identify the type of reaction taking place to form butan-1-ol. (1 mark)

- (ii) The functional group in butan-1-ol can be confirmed using a single chemical test.

What is the single chemical test and expected observation? (1 mark)

	Chemical test reagent	Observation
<input type="checkbox"/> A	sodium carbonate solution	effervescence
<input type="checkbox"/> B	aqueous silver nitrate	cream precipitate
<input type="checkbox"/> C	Fehling's solution	red precipitate
<input type="checkbox"/> D	phosphorus(V) chloride	steamy fumes

(Question continues on next page)

- (iii) Draw the mechanism for the reaction of 1-bromobutane with hydroxide ions to form butan-1-ol.

Include curly arrows, and any appropriate lone pairs and dipoles. (3 marks)

- (f) Alkene molecules are formed by elimination from 2-bromobutane.

How many isomeric alkene products will be formed in this reaction? (1 mark)

☐ A 1

☐ B 2

☐ C 3

☐ D 4

(TOTAL FOR QUESTION 5 = 13 MARKS)

(Questions continue on next page)

(Turn over)

6 Wine and gin are aqueous solutions of ethanol with traces of other organic compounds which give these drinks their characteristic flavours and aromas.

(a) When a bottle of wine is opened, oxidation of the ethanol in the wine produces ethanoic acid.

An experiment was carried out to determine the percentage of the ethanol that had been oxidised.

- A bottle of white wine, with an ethanol concentration of 2.50 mol dm^{-3} , was opened and left to stand at room temperature for three weeks.**
- A 25.0 cm^3 sample of the wine was transferred to a conical flask and phenolphthalein indicator added.**
- Aqueous sodium hydroxide of concentration $0.235 \text{ mol dm}^{-3}$ was added from a burette until the colour of the indicator permanently changed.**
- The titration was repeated and the titre values, in cm^3 , were 27.90, 26.75 and 26.85.**

(Question continues on next page)

(Turn over)

The equation for the neutralisation reaction is



- (i) Name the piece of apparatus used to measure 25.0 cm^3 of wine. (1 mark)

-
- (ii) To improve the accuracy, the burette should be rinsed.

State what should be used. (1 mark)

(Question continues on next page)

(Turn over)

**(iii) What is the colour change at the end-point?
(1 mark)**

- ☐ **A from orange to yellow**
- ☐ **B from red to orange**
- ☐ **C from colourless to pink**
- ☐ **D from pink to colourless**

**(iv) State what is meant by the term ‘concordant results’ as applied to a titration experiment.
(1 mark)**

(Question continues on next page)

- (v) Calculate the percentage of ethanol that has oxidised, given that one mole of ethanol forms one mole of ethanoic acid.

Give your answer to an appropriate number of significant figures. (5 marks)

- (vi) Deduce why this method would NOT be effective for the analysis of the acid content of a red wine. (1 mark)

- (b) The ethanol content of alcoholic drinks is usually measured as the percentage of alcohol by volume (ABV).

$$\text{ABV} = \frac{\text{Volume of ethanol in a solution}}{\text{Total volume of the solution}} \times 100$$

The ABV values of four different brands of gin are shown.

Brand of gin	ABV (%)
A	40
B	42
C	44
D	46

A sample of one of these gins was found to contain an ethanol concentration of 7.50 mol dm^{-3} .

By calculating the percentage of ethanol by volume (ABV) of this sample, deduce the brand of this gin. (3 marks)

[Assume the density of ethanol,
 $\text{C}_2\text{H}_5\text{OH} = 0.79 \text{ g cm}^{-3}$]

(TOTAL FOR QUESTION 6 = 13 MARKS)

(Questions continue on next page)

(Turn over)

7 This question is about compounds with the molecular formula $\text{C}_4\text{H}_8\text{O}$.

(a) What is the percentage by mass of each element in $\text{C}_4\text{H}_8\text{O}$? (1 mark)

	Percentage carbon	Percentage hydrogen	Percentage oxygen
<input type="checkbox"/> A	66.67	11.11	22.22
<input type="checkbox"/> B	60.00	20.00	20.00
<input type="checkbox"/> C	41.38	3.45	55.17
<input type="checkbox"/> D	30.77	61.54	7.69

*(b) Three different compounds, A, B and C, have the molecular formula $\text{C}_4\text{H}_8\text{O}$.

Information about these three compounds includes:

- all three compounds have infrared absorptions at about 3500 cm^{-1}
- the infrared spectra of A and B each contain a peak at about 1650 cm^{-1} , while that of C does not
- only A has a branched carbon chain
- B is the E-isomer of a pair of stereoisomers.

(Question continues on next page)

(Turn over)

Deduce a possible DISPLAYED formula for each of the compounds A, B and C.

**You must use ALL the information and the Data Booklet to fully justify each of your structures.
(6 marks)**

(Turn over)

(Turn over)

(TOTAL FOR QUESTION 7 = 7 MARKS)

(Questions continue on next page)

(Turn over)

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



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.

(Question continues on next page)

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) On the separate sheet provided, complete the graph of concentration against time by adding the six missing points.
Draw a line to pass through ALL the points.
(2 marks)

(Question continues on next page)

(Turn over)

- (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 marks)

- (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 marks)

(Question continues on next page)

- (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 mark)

(TOTAL FOR QUESTION 8 = 9 MARKS)

TOTAL FOR PAPER = 80 MARKS
END