

Please check the examination details below before entering your candidate information

Candidate surname

Other names

Centre Number

Candidate Number

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Pearson Edexcel Level 3 GCE

Tuesday 23 May 2023

Morning (Time: 1 hour 30 minutes)

Paper
reference

8CH0/02

Chemistry

Advanced Subsidiary

PAPER 2: Core Organic and Physical Chemistry

You must have:

Scientific calculator, Data Booklet, ruler

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B).
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
– *there may be more space than you need.*

Information

- 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 printed on the back cover of this paper.

Advice

- 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 ►

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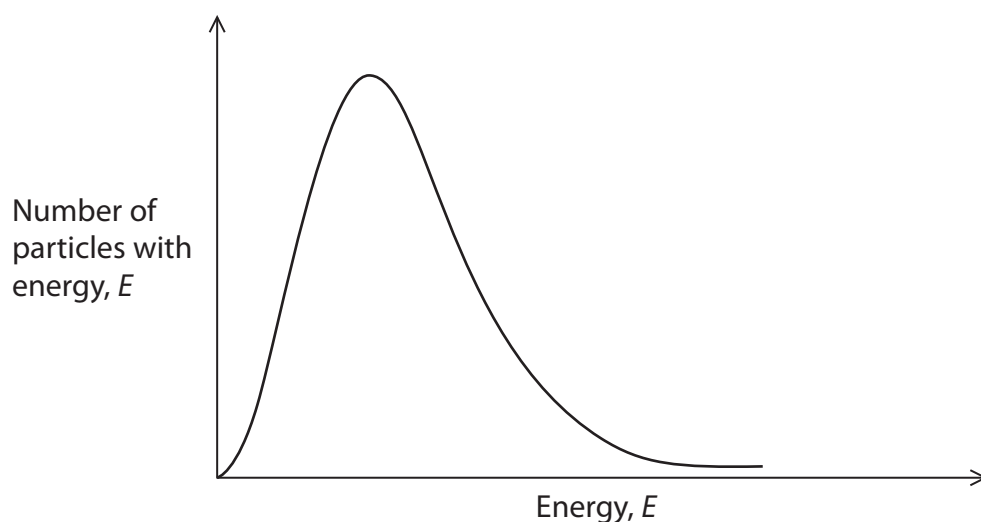
Answer ALL questions.

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 This question is about collision theory.

The Maxwell-Boltzmann distribution of molecular energies for a reaction at a particular temperature is shown in the graph.

Add another line on the graph to represent the same reaction with the same number of particles at a **higher** temperature.



(Total for Question 1 = 2 marks)

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2 This question is about alkanes and some of their reactions.

(a) Hexane is a saturated hydrocarbon.

State what is meant by the term 'saturated hydrocarbon'.

Your answer should refer to both words in the term.

(2)

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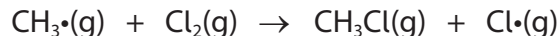
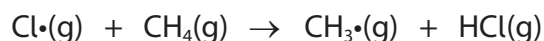
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(b) When methane reacts with gaseous chlorine, the initiation step is bond breaking in the chlorine molecule to form chlorine free radicals.

The equation for this step is shown.



Two equations for the propagation step are shown.



(i) Write the overall equation for this reaction of methane with chlorine.
State symbols are not required.

(1)

(ii) Calculate the maximum **mass**, in grams, of chloromethane produced when 7.00 g of chlorine gas reacts completely with excess methane.

[Molar mass of $\text{CH}_3\text{Cl} = 50.5 \text{ g mol}^{-1}$]

(2)



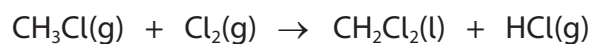
- (iii) Write an equation for a termination step for this reaction.
State symbols are not required.

(1)

- (iv) Further substitution of chloromethane can occur, producing dichloromethane, which is a liquid at room temperature.

Calculate the maximum volume, in cm^3 , of dichloromethane liquid that could be produced from 12.5 g of chloromethane.
Give your answer to an appropriate number of significant figures.

(3)



[Density of dichloromethane, $\text{CH}_2\text{Cl}_2(\text{l}) = 1.32 \text{ g cm}^{-3}$]

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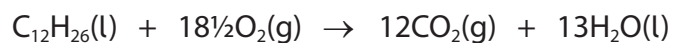
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(c) Commercial diesel fuel is a mixture of hydrocarbons.

One of the components of commercial diesel fuel is a hydrocarbon with the formula $C_{12}H_{26}$.

An equation for the complete combustion of $C_{12}H_{26}$ is shown.



- (i) Calculate the maximum volume, in m^3 , of carbon dioxide gas produced in an engine by the complete combustion of 1.00 **kg** of $C_{12}H_{26}$ at $200^\circ C$, at a pressure of 6.0×10^6 Pa.

[The ideal gas equation is $pV = nRT$
Gas constant, $R = 8.31 \text{ J mol}^{-1} \text{ K}^{-1}$]

(4)

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(ii) Biodiesel is derived from plants and petrodiesel is derived from crude oil. Biodiesel is increasingly widely used, although it is more expensive and provides less energy per kg when burned than petrodiesel.

Give **one** reason why biodiesel is now preferred to petrodiesel.

(1)

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(Total for Question 2 = 14 marks)

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3 This question is about alkenes and some of their reactions.

(a) Alkenes have the same general formula as cycloalkanes.

Explain why this general formula is different from that of alkanes.
Include the general formulae in your answer.

(3)

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(b) Draw the **skeletal** formula of cyclohexene.

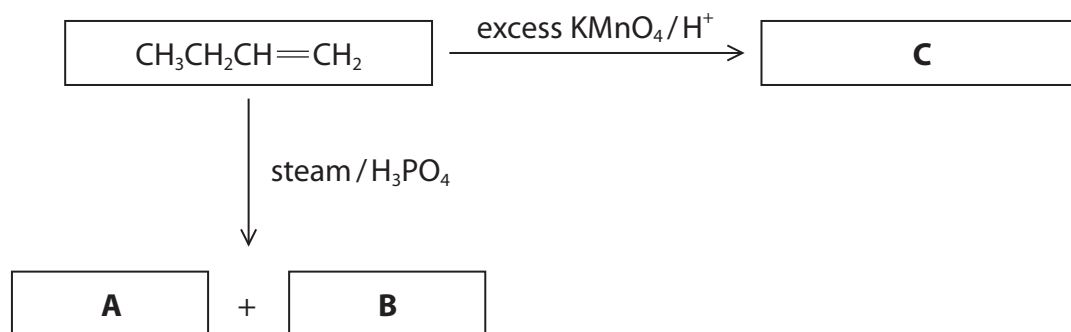
(1)

(c) Draw a diagram of an ethene molecule showing the shape of **all** the bonding electron clouds.
Include labels for all the bond types within the molecule.

(3)



(d) The reaction scheme shows some of the reactions of but-1-ene.



A and **B** are structural isomers. **A** is butan-1-ol.

(i) Draw the fully **displayed** formula of isomer **B**.

(1)

(ii) Draw the **structural** formula of product **C**, which is formed by the reaction of but-1-ene with potassium manganate(VII) in acid conditions.

(1)



- (e) The industrial manufacture of margarine involves the addition of hydrogen to an alkene.

Which catalyst is used for this process?

(1)

- A** iron
- B** nickel
- C** phosphoric acid
- D** sodium hydroxide

- (f) Polymers can be produced by the addition polymerisation of alkenes. Poly(propene) can be made from propene.

Draw the structure of poly(propene), showing **two** repeat units.

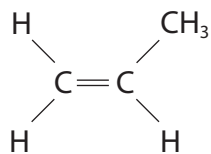
(1)



(g) Propene reacts with hydrogen bromide to form a mixture of products.

- (i) Complete the mechanism of the reaction of propene with hydrogen bromide to form 2-bromopropane.
Include curly arrows and any relevant lone pairs and dipoles.

(4)



- (ii) What is the type and mechanism for the reaction of hydrogen bromide with propene?

(1)

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



4 This question is about halogenoalkanes and some of their reactions.

(a) **X**, **Y** and **Z** are three different halogenoalkanes.

X is 1-chloropropane

Y is 1-bromopropane

Z is 1-iodopropane

An experiment is carried out to compare the rates of hydrolysis of these compounds.

Outline procedure:

1 cm³ of each of the three halogenoalkanes, **X**, **Y** and **Z**, is added to separate test tubes, each containing 5 cm³ of ethanol and 5 cm³ of aqueous silver nitrate solution, in a water bath at 50 °C.

The time taken for a precipitate to form in each test tube is measured.

(i) Give **three** reasons why these reaction **conditions** are specified.

(3)

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(ii) Explain why a precipitate forms.

(2)

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(iii) The three halogenoalkanes were placed in order of **increasing** rate of reaction.

Which is the correct sequence?

(1)

- A X, Y, Z
- B X, Z, Y
- C Y, X, Z
- D Z, Y, X

(b) The results table shows the time taken to produce a precipitate when three bromoalkanes react with aqueous ethanolic silver nitrate solution.

Halogenoalkane	Time to produce a precipitate / s
1-bromobutane	58
2-bromobutane	33
2-bromo-2-methylpropane	2

Give a reason why the times taken to produce a precipitate for these isomeric bromoalkanes are different.

(1)

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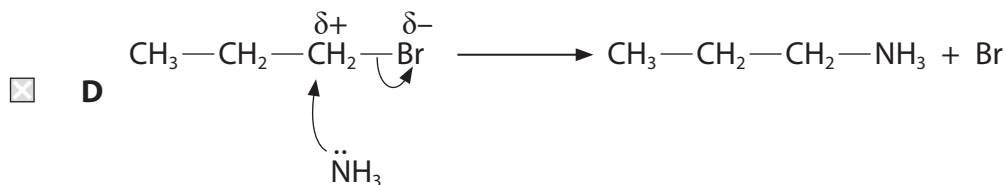
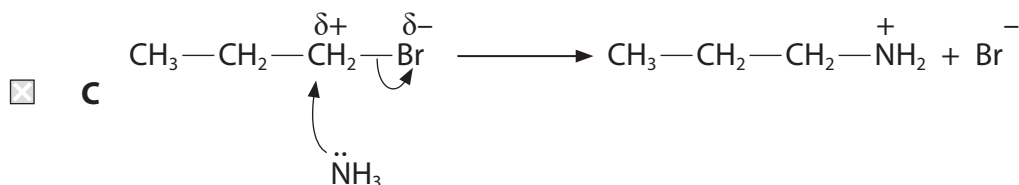
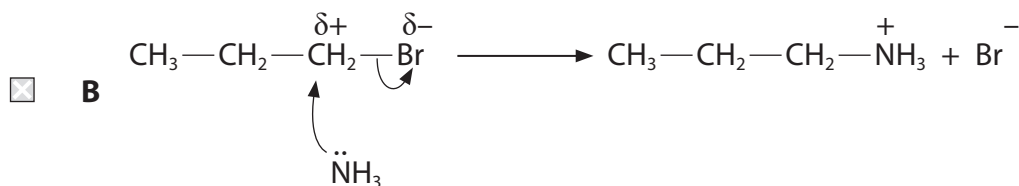
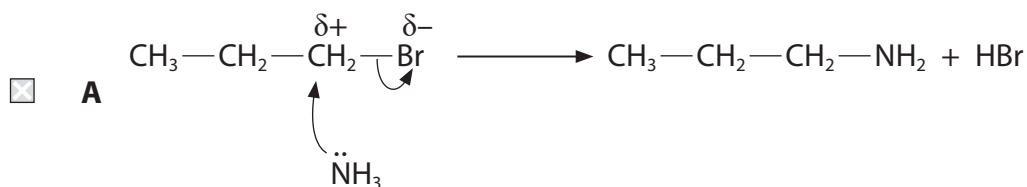
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(c) (i) Which equation shows the first step of the mechanism for the reaction of 1-bromopropane with ammonia?

(1)

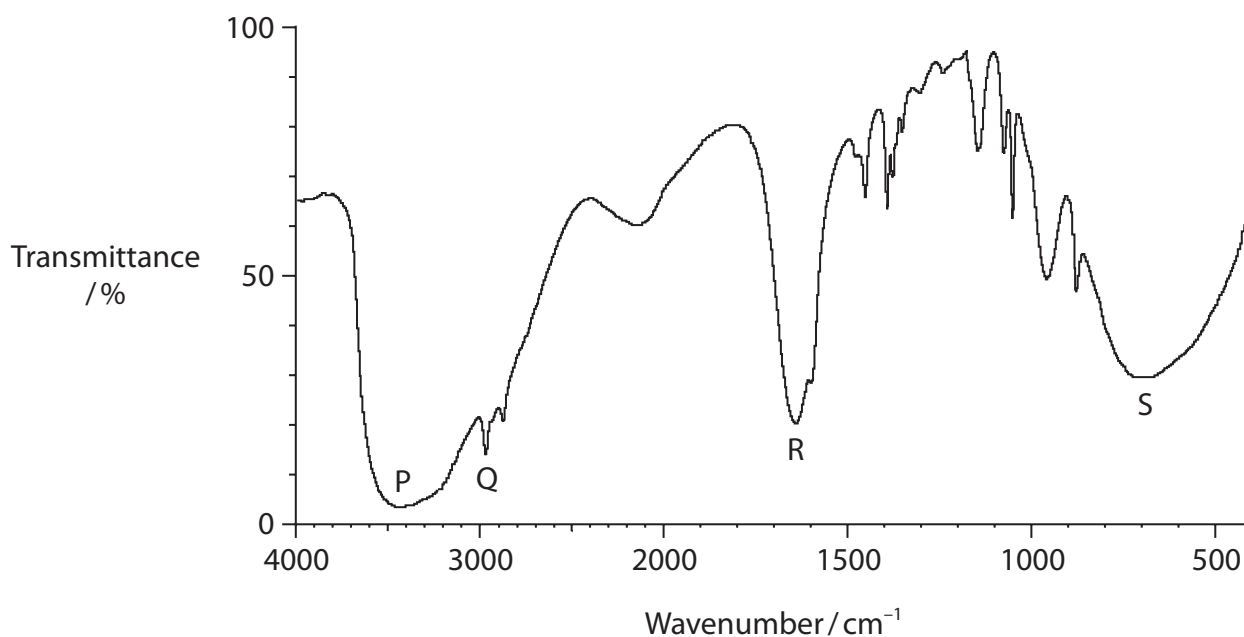


(ii) Write the formula of the final inorganic product of the reaction of 1-bromopropane with **excess** ammonia.

(1)



(iii) The infrared spectrum of ethylamine is shown.



Which absorption peak confirms this as an amine?

(1)

- A absorption P
- B absorption Q
- C absorption R
- D absorption S

(d) 1-bromopropane undergoes reactions when heated with different reagents.

- (i) Give **two** reasons why organic reactions are often heated for a long time but the yield is frequently low.

(2)

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(ii) Give the name or formula of the reagent and the condition, other than heat, used to increase the carbon chain length by one carbon atom, starting from 1-bromopropane.

(2)

(iii) 1-bromopropane, $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{Br}$, can be converted into but-1-ene, $\text{CH}_3\text{CH}_2\text{CH}=\text{CH}_2$.

Give the name or formula of the reagent and the condition, other than heat, used for this reaction.

(2)

(Total for Question 4 = 16 marks)

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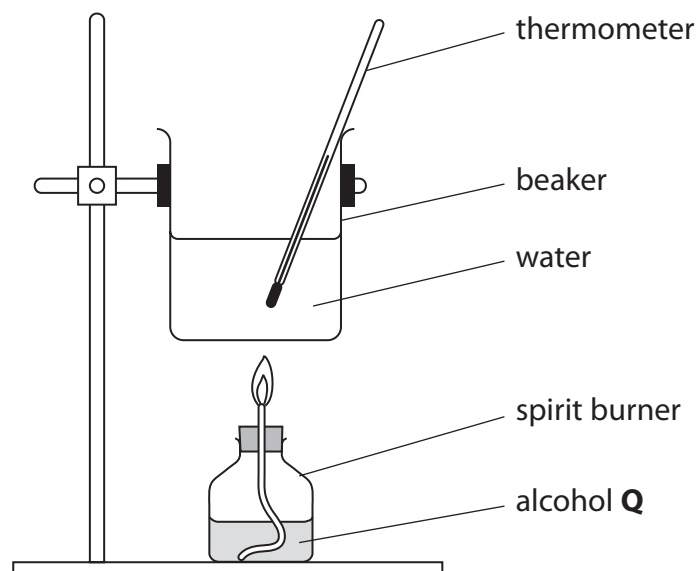


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- 5 A student found a bottle of a colourless liquid that was thought to be an alcohol. However, the label was missing and the identity of the alcohol was unknown.

The student decided to attempt to identify this alcohol (**Q**) by measuring its enthalpy change of combustion, and comparing the result with values in a data book.

The student used the equipment shown in the diagram to determine the enthalpy change of combustion of alcohol **Q**.



Data

Mass of spirit burner + alcohol **Q** before combustion = 20.24 g

Mass of spirit burner + alcohol **Q** after combustion = 19.48 g

Mass of water in the beaker = 500 g

Temperature of the water before the experiment = 17.8 °C

Temperature of the water at the end of the experiment = 28.7 °C

Specific heat capacity of water = 4.18 Jg⁻¹°C⁻¹



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(a) (i) Calculate the enthalpy change, in kJ g^{-1} , when 1.00 g of alcohol **Q** is burned. Include a sign in your final answer.

(3)

(ii) At the end of the experiment there was a black deposit of carbon on the bottom of the beaker.

Explain the effect of formation of the carbon deposit on your answer to (a)(i).

(2)

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(b) Give one theoretical and one practical reason why this procedure is insufficient to identify the alcohol.

(2)

Theoretical reason

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Practical reason

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(c) The student concluded that alcohol **Q** was either propan-1-ol or propan-2-ol because the mass spectrum had the molecular ion peak at $m/z = 60$.

Explain **one** peak that you would expect to be present in the mass spectrum of propan-1-ol but not in the mass spectrum of propan-2-ol.

(2)

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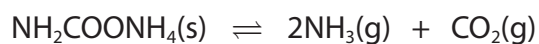
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(Total for Question 5 = 9 marks)



- 6 Ammonium carbamate has the formula $\text{NH}_2\text{COONH}_4$. When a sample of ammonium carbamate is placed in a sealed tube and heated, it partially decomposes to the compounds used to synthesise it.

The equation for this reversible reaction is



Which is the expression for the equilibrium constant, K_c , for this reaction?
All concentration terms are at equilibrium.

- A $\frac{[\text{NH}_3][\text{CO}_2]}{[\text{NH}_2\text{COONH}_4]}$
- B $\frac{[2\text{NH}_3][\text{CO}_2]}{[\text{NH}_2\text{COONH}_4]}$
- C $[\text{NH}_3]^2[\text{CO}_2]$
- D $\frac{[\text{NH}_3]^2[\text{CO}_2]}{[\text{NH}_2\text{COONH}_4]}$

(Total for Question 6 = 1 mark)



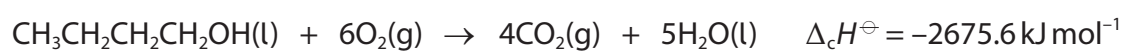
7 This question is about the primary alcohol butan-1-ol.

(a) Which are the intermolecular force(s) between butan-1-ol molecules in the liquid phase?

(1)

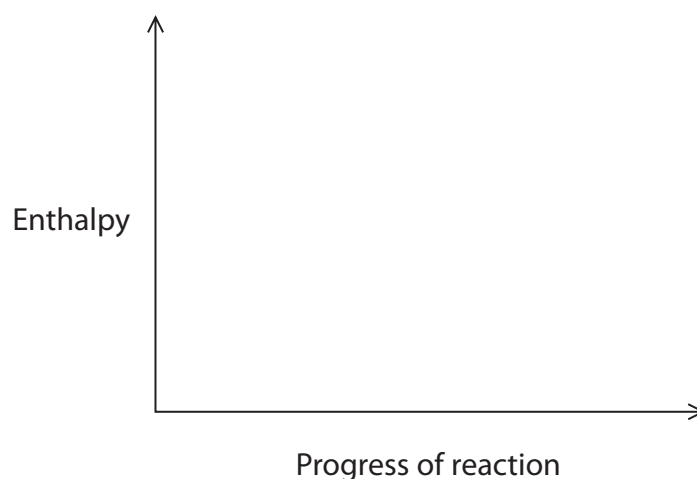
- A hydrogen bonding only
- B hydrogen bonding and permanent dipole-dipole forces only
- C hydrogen bonding, permanent dipole-dipole forces and London forces
- D London forces only

(b) The equation for the complete combustion of butan-1-ol is shown.



Draw a labelled enthalpy level diagram for this reaction, using the axes provided. You may use the labels 'reactants' and 'products' in place of the formulae shown in the equation.

(2)



(c) Butan-1-ol can be oxidised to produce butanal or butanoic acid.

(i) Which is a suitable test and result for butan-1-ol?

(1)

	Test reagent	Observation
<input type="checkbox"/> A	phosphorus(V) chloride $\text{PCl}_5(\text{s})$	white smoke
<input type="checkbox"/> B	phosphorus(V) chloride $\text{PCl}_5(\text{s})$	steamy fumes
<input type="checkbox"/> C	sodium carbonate $\text{Na}_2\text{CO}_3(\text{aq})$	carbon dioxide given off
<input type="checkbox"/> D	sodium carbonate $\text{Na}_2\text{CO}_3(\text{aq})$	effervescence

(ii) State how to produce butanal in high yield when butan-1-ol reacts with acidified potassium dichromate(VI).

(1)

(iii) Describe a chemical test, including the expected results, that would confirm the presence of an aldehyde such as butanal.

(2)



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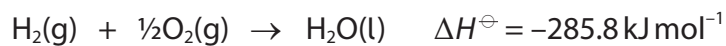
Handwriting practice area with 15 horizontal dotted lines.

(Total for Question 7 = 13 marks)



P 7 1 9 2 7 A 0 2 5 2 8

8 A data book gave the following information.

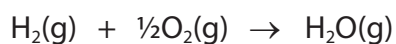


(a) State the **two** conditions denoted by the standard symbol \ominus for this reaction. (2)

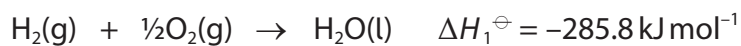
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(b) (i) Draw a Hess's Law cycle that would enable you to use the data provided to calculate the enthalpy change of formation of gaseous water, $\Delta_f H$. (2)



Data:



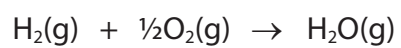
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(ii) Calculate the enthalpy change for the reaction shown.



(3)

(Total for Question 8 = 7 marks)

TOTAL FOR PAPER = 80 MARKS

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The Periodic Table of Elements

1 2 3 4 5 6 7 0 (8) (18)

1.0	H
	hydrogen
	1

Key

relative atomic mass
atomic symbol
name
atomic (proton) number

(1) (2)

6.9	Li	lithium	3
9.0	Be	beryllium	4
23.0	Na	sodium	11
24.3	Mg	magnesium	12

39.1	K	potassium	19
85.5	Rb	rubidium	37
132.9	Cs	caesium	55

45.0	Sc	scandium	21
40.1	Ca	calcium	20
88.9	Y	yttrium	39
138.9	La*	lanthanum	57

47.9	Ti	titanium	22
91.2	Zr	zirconium	40
178.5	Hf	hafnium	72
[261]	Rf	rutherfordium	104

50.9	V	vanadium	23
92.9	Nb	niobium	41
180.9	Ta	tantalum	73
[262]	Db	dubnium	105

52.0	Cr	chromium	24
95.9	Mo	molybdenum	42
183.8	W	tungsten	74
[266]	Sg	seaborgium	106

54.9	Mn	manganese	25
[98]	Tc	technetium	43
186.2	Re	rhenium	75
[264]	Bh	bohrium	107

55.8	Fe	iron	26
101.1	Ru	ruthenium	44
190.2	Os	osmium	76
[277]	Hs	hassium	108

58.9	Co	cobalt	27
102.9	Rh	rhodium	45
192.2	Ir	iridium	77
[268]	Mt	meitnerium	109

58.7	Ni	nickel	28
106.4	Pd	palladium	46
195.1	Pt	platinum	78
[271]	Ds	darmstadtium	110

(3) (4) (5) (6) (7) (8) (9) (10) (11) (12)

63.5	Cu	copper	29
107.9	Ag	silver	47
197.0	Au	gold	79
[272]	Rg	roentgenium	111

65.4	Zn	zinc	30
112.4	Cd	cadmium	48
200.6	Hg	mercury	80

69.7	Ga	gallium	31
114.8	In	indium	49
204.4	Tl	thallium	81

72.6	Ge	germanium	32
118.7	Sn	tin	50
207.2	Pb	lead	82

74.9	As	arsenic	33
121.8	Sb	antimony	51
209.0	Bi	bismuth	83

79.0	Se	selenium	34
127.6	Te	tellurium	52
[209]	Po	polonium	84

79.9	Br	bromine	35
126.9	I	iodine	53
[210]	At	astatine	85

83.8	Kr	krypton	36
131.3	Xe	xenon	54
[222]	Rn	radon	86

(13) (14) (15) (16) (17) (18)

10.8	B	boron	5
12.0	C	carbon	6
14.0	N	nitrogen	7
16.0	O	oxygen	8

14.0	N	nitrogen	7
31.0	P	phosphorus	15
32.1	S	sulfur	16
35.5	Cl	chlorine	17

27.0	Al	aluminium	13
28.1	Si	silicon	14
72.6	Ge	germanium	32

28.1	Si	silicon	14
72.6	Ge	germanium	32
118.7	Sn	tin	50

28.1	Si	silicon	14
72.6	Ge	germanium	32
118.7	Sn	tin	50

28.1	Si	silicon	14
72.6	Ge	germanium	32
118.7	Sn	tin	50

28.1	Si	silicon	14
72.6	Ge	germanium	32
118.7	Sn	tin	50

28.1	Si	silicon	14
72.6	Ge	germanium	32
118.7	Sn	tin	50

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* Lanthanide series

* Actinide series

Elements with atomic numbers 112-116 have been reported but not fully authenticated

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