Oxford Cambridge and RSA

Thursday 23 May 2019 – Morning

AS Level Chemistry B (Salters)

H033/02 Chemistry in depth

Time allowed: 1 hour 30 minutes

You must have:
- the Data Sheet for Chemistry B (Salters) (sent with general stationery)

You may use:
- a scientific or graphical calculator

Please write clearly in black ink. **Do not write in the barcodes.**

Centre number | | | | | | Candidate number | | | | |

First name(s) _____

Last name _____

INSTRUCTIONS
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions.
- Where appropriate, your answers should be supported with working. Marks may be given for a correct method even if the answer is incorrect.
- Write your answer to each question in the space provided. If additional space is required, use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.

INFORMATION
- The total mark for this paper is **70**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended responses will be assessed in questions marked with an asterisk (*).
- This document consists of **20** pages.

© OCR 2019 [601/5446/9]
DC (SC/TP) 174343/4
OCR is an exempt Charity

Answer **all** the questions.

1 Catalytic cracking of hydrocarbons is carried out in the petrochemical industry.
Hot vaporised hydrocarbons and a powdered catalyst are fed into the bottom of a tube and forced upwards by steam.

(a) **(i)** Decane, $C_{10}H_{22}$, can be cracked to give an **alkene** with four carbon atoms and another alkane.

Write a chemical equation for this reaction using **molecular** formulae.

[1]

(ii) 2,2,3-Trimethylheptane is an isomer of decane.

Draw the **skeletal formula** of 2,2,3-trimethylheptane.

[1]

© OCR 2019

(b) A student wishes to crack a sample of liquid decane in the laboratory and collect the gaseous products.

Fig. 1.1 shows the apparatus that a student drew before doing this.

What modifications would be required for this apparatus to work?

Explain your answers.

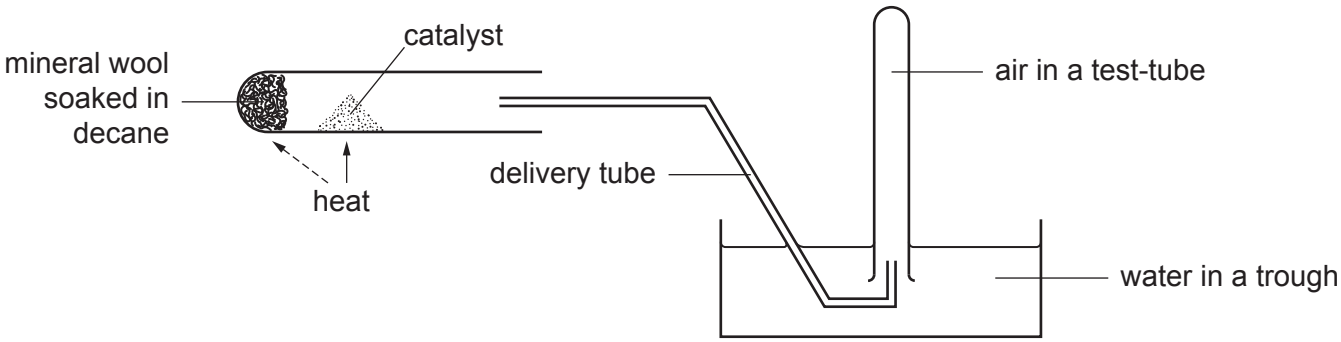


Fig. 1.1

.....

.....

.....

.....

.....

.....

.....

..... **[4]**

(c) Small alkenes produced in cracking can be used for making polymers.

The structure of a polymer chain is shown in **Fig. 1.2**.

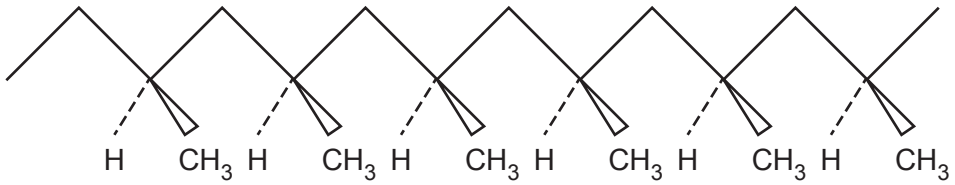


Fig. 1.2

Give the **name** of the monomer that forms the polymer in **Fig. 1.2**.

..... **[1]**

© OCR 2019

(d) Another alkene that can be polymerised is but-2-ene, $CH_3CH{=}CHCH_3$.

Explain why stereoisomerism can occur in but-2-ene.

.....

.....

.....

..... **[2]**

(e) When but-1-ene, $CH_3CH_2CH{=}CH_2$, reacts with ICl the main product is 1-iodo-2-chlorobutane, $CH_3CH_2CHClCH_2I$.

Suggest a mechanism for this reaction.

Show full and partial charges and 'curly arrows'.

[3]

© OCR 2019

(f) Petrol contains hydrocarbons like octane, C_8H_{18}.

Equation 1.1 shows the complete combustion of octane.

$C_8H_{18}(g) + 12\frac{1}{2}O_2(g) \rightarrow 8CO_2(g) + 9H_2O(g)$ **Equation 1.1**

3.42 g of octane are burned per second in a vehicle engine.
The exhaust gases are produced at a temperature of 550 °C and a pressure of 1.50×10^5 Pa.

Calculate the volume of exhaust gases, in dm^3, produced per second.

Assume that carbon dioxide and water vapour are the only gases present in the exhaust.

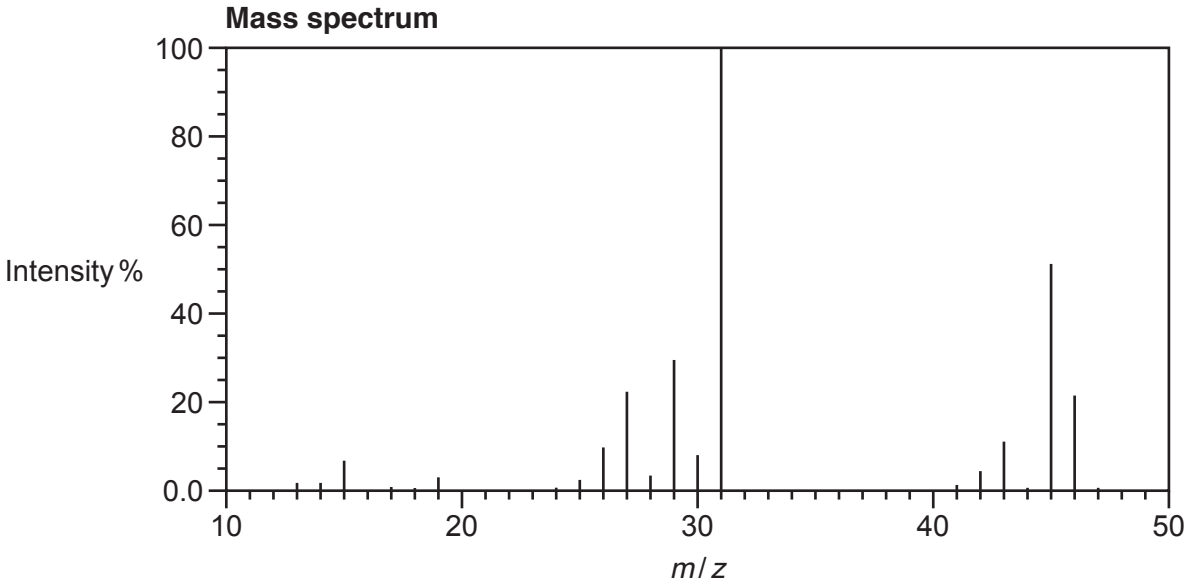
volume of exhaust gases = ... dm^3 **[4]**

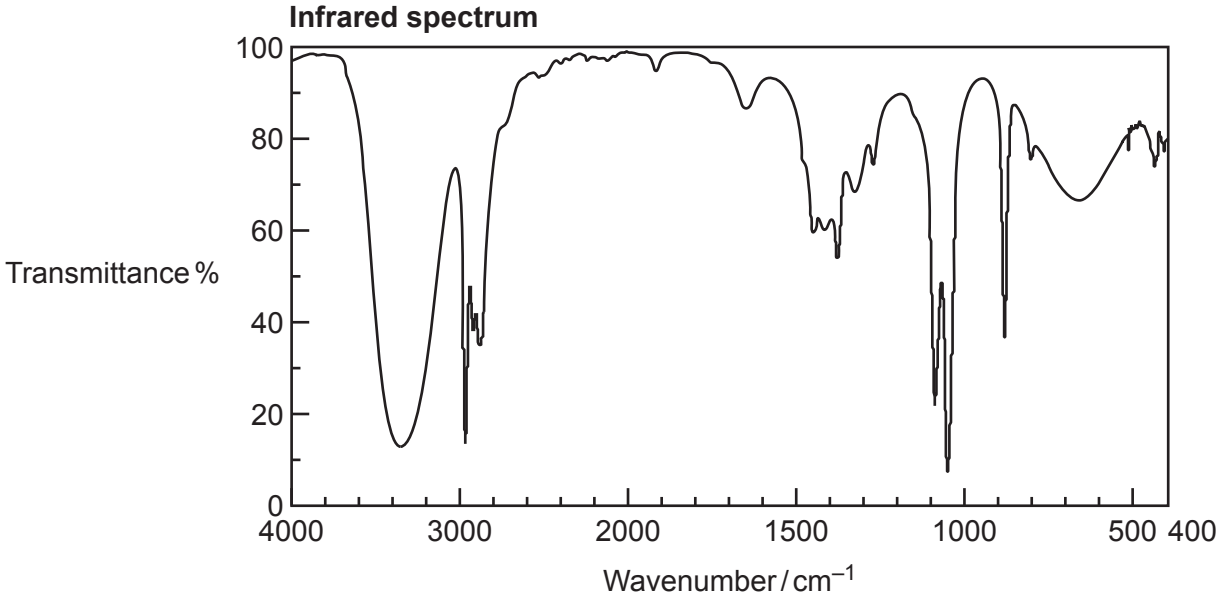
© OCR 2019

(g) Biofuels are increasingly providing alternatives to petrol.

One of the compounds in a biofuel has the following mass spectrum and infrared spectrum.

The biofuel contains carbon, hydrogen and oxygen only.





(i) Identify the biofuel given by the mass spectrum and infrared spectrum.

[1]

© OCR 2019

(ii) Give **one** piece of evidence from the mass spectrum to support your answer to **(g)(i)**.

.....

..... **[1]**

(iii) Give **one** piece of evidence from the infrared spectrum to support your answer to **(g)(i)**.

.....

..... **[1]**

(h)* Discuss the advantages and disadvantages of using biofuels as fuels for cars compared with fossil fuels. **[6]**

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

Additional answer space if required

.....

.....

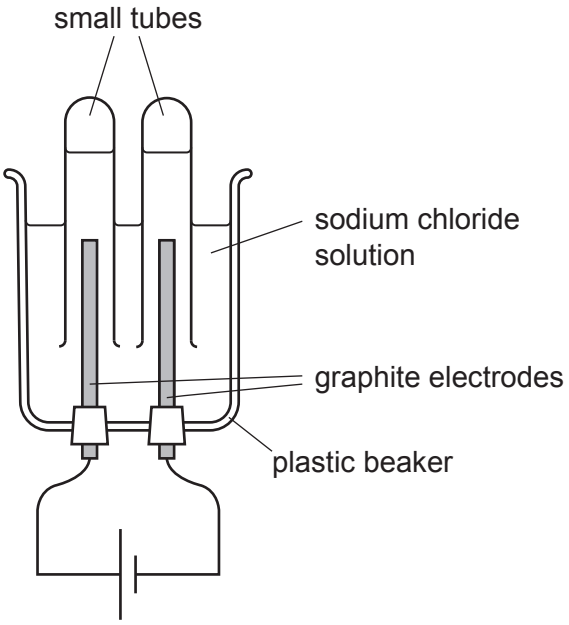
.....

.....

© OCR 2019

2 Chlorine is obtained by the electrolysis of aqueous sodium chloride.

(a) A student investigates the electrolysis of aqueous sodium chloride in the laboratory using the apparatus shown below.



The student observes bubbles of gas at both the anode (+) and the cathode (–).

Write half-equations for the reactions occurring at each electrode.

Anode (+)

Cathode (–)

[2]

(b) One use of chlorine is in water treatment.

Chlorine reacts with water to form chloric(I) acid, HC*l*O, as in **equation 2.1**.

The HC*l*O kills the bacteria that can cause diseases like cholera.

$Cl_2(aq) + H_2O(l) \rightarrow HCl(aq) + HClO(aq)$ **Equation 2.1**

(i) Explain what is meant by the (I) in chloric(I) acid.

..... **[1]**

© OCR 2019

(ii) Chloric(I) acid can also be produced by adding solid calcium chlorate(I) to water.

Suggest a reason why it may be preferable to use calcium chlorate(I) rather than chlorine for treating drinking water.

.....

..... **[2]**

(c) **(i)** Chlorine is also used to sterilise swimming pool water.

An analytical chemist uses a titration to find out the amount of chlorine in a sample of swimming pool water.

The chemist takes a 25.0 cm^3 sample of water and treats it with an excess of potassium iodide solution. The equation for this reaction is shown in **equation 2.2**.

$Cl_2(aq) + 2I^-(aq) \rightarrow I_2(aq) + 2Cl^-(aq)$ **Equation 2.2**

The chemist then titrates the treated sample with 0.000100 mol dm^{-3} sodium thiosulfate solution to find out how much iodine has formed. The equation for this reaction is shown in **equation 2.3**.

$I_2(aq) + 2S_2O_3^{2-}(aq) \rightarrow S_4O_6^{2-}(aq) + 2I^-(aq)$ **Equation 2.3**

The chemist obtains a mean titre of 12.4 cm^3.

Use this information to calculate the concentration of Cl_2, in mol dm^{-3}, in the sample of swimming pool water.

Give your answer to an **appropriate** number of significant figures.

Assume Cl_2 is the only substance in the water that oxidises iodide ions.

concentration of Cl_2 = ... mol dm^{-3} **[4]**

© OCR 2019

(ii) A student is asked to write a detailed plan for the titration carried out by the chemist. The student writes:

1 Use a measuring cylinder to transfer 25 cm^3 of swimming pool water to a 250 cm^3 conical flask.
2 Rinse out a burette with de-ionised water and fill it with the 0.000100 mol dm^{-3} solution of sodium thiosulfate, and ensure that the space below the tap is filled.
3 Record the initial burette reading to the nearest 0.1 cm^3.
4 Add excess potassium iodide solution to the solution in the conical flask.
5 Add a few drops of starch indicator.
6 Titrate until the blue-black colour of the starch indicator just disappears.
7 Repeat until titres agree within 0.1 cm^3.

Identify and correct the mistakes that the student has made.

.....

.....

.....

.....

.....

..... **[3]**

© OCR 2019

(d) Bromine can be extracted from seawater. One method of making bromine involves reacting chlorine gas with acidified seawater that contains bromide ions.

$Cl_2(aq) + 2Br^-(aq) \rightarrow Br_2(aq) + 2Cl^-(aq)$ **Equation 2.4**

The bromine that is produced is then reacted with sulfur dioxide and water.
The reaction that occurs is a redox process.

$Br_2 + SO_2 + 2H_2O \rightarrow 2Br^- + SO_4^{2-} + 4H^+$ **Equation 2.5**

Give the formula of the reducing agent in the reaction shown in **equation 2.5**.

Explain your answer in terms of oxidation states.

Reducing agent .....

Explanation .....
[1]

(e) The solution containing bromide ions is then treated with chlorine and steam before the bromine produced is separated by fractional distillation.

Describe the state and appearance at room temperature of the bromine that is collected at the end of this process.

..... **[1]**

(f) **(i)** A student is given a solution of bromide ions.

The student adds acidified silver nitrate to the solution of bromide ions.

$Ag^+ + Br^- \rightarrow AgBr$

Describe what the student sees.

..... **[1]**

(ii) A solution of sodium bromide has a concentration of 0.0260 mol dm^{-3}.
25.0 cm^3 of this solution are mixed with an excess of silver nitrate solution.
0.118 g of silver bromide is obtained.

Calculate the percentage yield of silver bromide.

percentage yield of AgBr = ... % **[3]**

© OCR 2019

3 Many of the chemical elements found on Earth were produced in nuclear fusion reactions in stars.

(a) Write a nuclear equation to show the fusion of the nuclei of two hydrogen-2 atoms to give a single atom.

[1]

(b) The presence of different elements in stars is shown by absorption or emission atomic spectra.

The diagrams below represent parts of an absorption spectrum and an emission spectrum.

absorption spectrum

emission spectrum

A student says that the absorption and emission spectra are for the same element.

Discuss whether the student is correct, giving the chemical theory.

.....

.....

.....

.....

.....

..... **[3]**

© OCR 2019

(c) The element indium was discovered in 1863 from an emission spectrum.

Indium has two naturally occurring isotopes as shown in the table.

Isotope	Isotopic mass
^{113}In	112.90
^{115}In	114.90

The relative atomic mass, A_r, of indium is 114.82.

Calculate the percentage abundances of the two isotopes.

^{113}In ..... %; ^{115}In ..... % **[2]**

(d) Indium is in Group 13 of the periodic table, the same group as aluminium.

(i) Complete the electronic configuration of indium.

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^{10}\ 5s^2$ ..... **[1]**

(ii) Indium has the same structure and bonding as aluminium.

Explain why indium conducts electricity.

.....

..... **[1]**

(iii) Indium forms an oxide that has a melting point of 1910 °C and conducts electricity in the molten state.

Explain this high melting point in terms of the structure and bonding in the compound.

.....

..... **[1]**

© OCR 2019

(e) A student is asked to predict and explain the shape of an InH_3 molecule.

The student writes, 'Since the formula, InH_3, is similar to ammonia, NH_3, the shape must be the same, so it is trigonal pyramidal with bond angles of about 107°'.

Discuss the student's statements about InH_3.

Give the supporting chemistry.

.....

.....

.....

.....

.....

.....

..... **[3]**

© OCR 2019

4 Halons are halogenated organic compounds.

Halons have been particularly useful in aircraft fire extinguishers.

One halon is Halon–1211, $CBrClF_2$.

In the high temperature of a fire one of the bonds in $CBrClF_2$ breaks and radicals are formed.

(a) A student states that it is a C–F bond that breaks because C–F is the most polar of the three carbon-halogen bonds.

The student's statement is partially correct.

(i) Explain, chemically, the correct part of the statement.

.....

.....

.....

..... **[2]**

(ii) Correct the incorrect part of the statement, giving a reason for the correction.

.....

.....

.....

..... **[2]**

© OCR 2019

(b) An alternative halon that is also used in fire extinguishers has the following composition by mass.

C	Br	F
9.2%	61.5%	29.3%

The M_r of this halon is 259.8.

Deduce the molecular formula of this halon.

molecular formula of halon = ... **[2]**

(c) When halons get into the stratosphere, C–C*l* bonds can be broken by UV radiation from the Sun.

The minimum frequency of radiation needed to break one C–C*l* bond is 8.67×10^{14} Hz.

Calculate the bond enthalpy of the C–C*l* bond, in kJ mol^{-1}.

bond enthalpy = ... kJ mol^{-1} **[3]**

© OCR 2019

(d)* Ozone and nitrogen dioxide are present in both the troposphere and the stratosphere.

Describe the advantages and disadvantages of the presence of ozone and how it can be affected by the presence of nitrogen dioxide in the troposphere and stratosphere.

Give equations where appropriate. **[6]**

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

Additional answer space if required

.....

.....

.....

.....

.....

.....

.....

.....

END OF QUESTION PAPER

© OCR 2019

ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).

© OCR 2019

© OCR 2019

OCR
Oxford Cambridge and RSA

Copyright Information

OCR is committed to seeking permission to reproduce all third-party content that it uses in its assessment materials. OCR has attempted to identify and contact all copyright holders whose work is used in this paper. To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced in the OCR Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download from our public website (www.ocr.org.uk) after the live examination series.

If OCR has unwittingly failed to correctly acknowledge or clear any third-party content in this assessment material, OCR will be happy to correct its mistake at the earliest possible opportunity.

For queries or further information please contact The OCR Copyright Team, The Triangle Building, Shaftesbury Road, Cambridge CB2 8EA.

OCR is part of the Cambridge Assessment Group; Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.

© OCR 2019