Oxford Cambridge and RSA

Tuesday 21 May 2024 – 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

You can use:
- a scientific or graphical calculator
- an HB pencil

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. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided. If you need extra space use the lined pages at the end of this booklet. The question numbers must be clearly shown.
- Answer **all** the questions.
- Where appropriate, your answer should be supported with working. Marks might be given for using a correct method, even if your answer is wrong.

INFORMATION
- The total mark for this paper is **70**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended response will be assessed in questions marked with an asterisk (*).
- This document has **16** pages.

ADVICE
- Read each question carefully before you start your answer.

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1 'Lo Salt' is a reduced-sodium alternative to regular table salt. Some of the sodium chloride is replaced by potassium chloride.

(a) Two models of the structure of sodium chloride are shown below in **Fig. 1.1** and **Fig. 1.2**.

Fig. 1.1

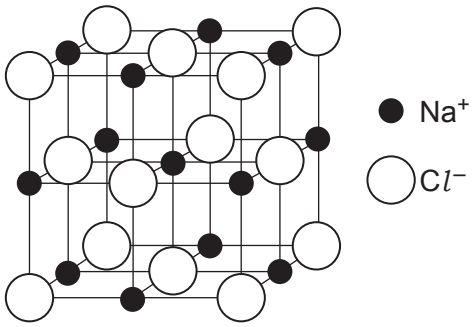
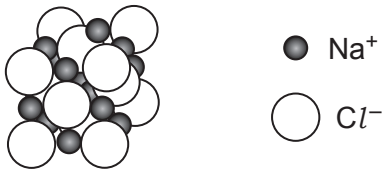


Fig. 1.2



The two models show different features of the structure.

Complete the table with ticks (✓) where a statement is correct for a model.

	Correct for Fig. 1.1	**Correct for Fig. 1.2**
Model shows the relative sizes of ions		
Model shows how the ions pack together		
Model allows all the ions in the model to be seen		

[2]

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(b) Sodium chloride and potassium chloride are both white crystalline solids.

A student wants to distinguish between these two solids.

Name a simple laboratory test the student could use and give the results.

Name of test .....

Results .....

.....

.....
[3]

(c) A student has a solid sample of an unknown ionic chloride.

The student uses the following method to calculate the percentage by mass of chlorine in the solid:

- Weigh out 0.94 g of solid and dissolve in deionised water.
- Add excess silver nitrate solution so $AgCl$ precipitates.
- Collect and dry the precipitate. It weighs 2.29 g.

(i) Calculate the percentage by mass of chlorine in the unknown solid.

percentage by mass of chlorine = ... % **[3]**

(ii) The student fails to dry the $AgCl$ precipitate fully.

What effect would this have on the percentage by mass of chlorine calculated?

Explain your answer.

.....

.....

.....

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

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(d) Give the formula of another aqueous ion (other than Ag^+) that would form a precipitate with chloride ions.

Give the colour of this precipitate.

Ion .....

Colour of precipitate .....
[1]

(e) Some students have a solution of a sodium halide (chloride, bromide or iodide) to identify. They add silver nitrate solution and get an off-white/pale yellow precipitate. This enables them to say that one halide ion is definitely not present.

(i) Which halide ion is definitely **not** present?

Give a reason.

.....

.....

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

(ii) Describe further tests they can do on the precipitate to decide which of the remaining halides is present.

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

(f) A group of students carry out experiments in which they mix halogen solutions with solutions of halides.

(i) The students add aqueous bromine to a solution of a halide. They then shake the resulting solution with hexane which turns purple.

Name the halide ion present, giving your reasons.

.....

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

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(ii) Write an ionic equation for the reaction of bromine with the halide.

[1]

(iii) A student says:

- Mixing solutions of bromine and sodium chloride would not result in a reaction.
- This is because the chloride ion is a stronger reducing agent than the bromide ion.
- The chloride ion has a lower tendency than the bromide ion to lose an electron.

Comment on these statements, giving the correct chemistry where necessary.

.....

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

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2 Ozone in the stratosphere is broken down more rapidly when chlorofluorocarbons (CFC) are present.

(a) The concentration of ozone in part of the atmosphere is 0.000 021%.

Calculate this concentration of ozone in ppm.

concentration = ... ppm **[1]**

(b) Ozone in the stratosphere is exposed to high energy ultraviolet radiation.
This radiation sometimes breaks bonds.

Describe another effect that high energy ultraviolet radiation can have on a molecule.

.....

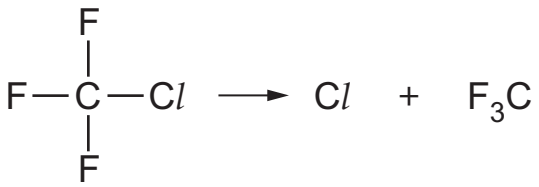
..... **[1]**

(c) Calculate the frequency, in Hz, of ultraviolet radiation with a wavelength of 2.55×10^{-5} cm.

frequency = ... Hz **[2]**

(d) The CFC $CCl F_3$ undergoes homolytic bond fission in the stratosphere.

(i) Add 'half curly arrows' to show how the bond breaks.



[1]

(ii) Explain why the C–C*l* bond breaks in this reaction rather than the C–F bond.

.....

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

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(iii) Chlorine atoms in the stratosphere catalyse the conversion of ozone into oxygen.

Complete the following two equations to show how this happens.

$Cl + O_3 \rightarrow$ ..... $+ O_2$

..... + ... $\rightarrow Cl + O_2$

[1]

(iv) Ozone is also present in the troposphere where it is a pollutant.

Give **one** problem caused by ozone in the troposphere.

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

(e) 0.327 g of a CFC produces 65.0 cm^3 of vapour at a pressure of 101 000 Pa and a temperature of 293 K.

Calculate the M_r of this CFC.

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

M_r = ... **[5]**

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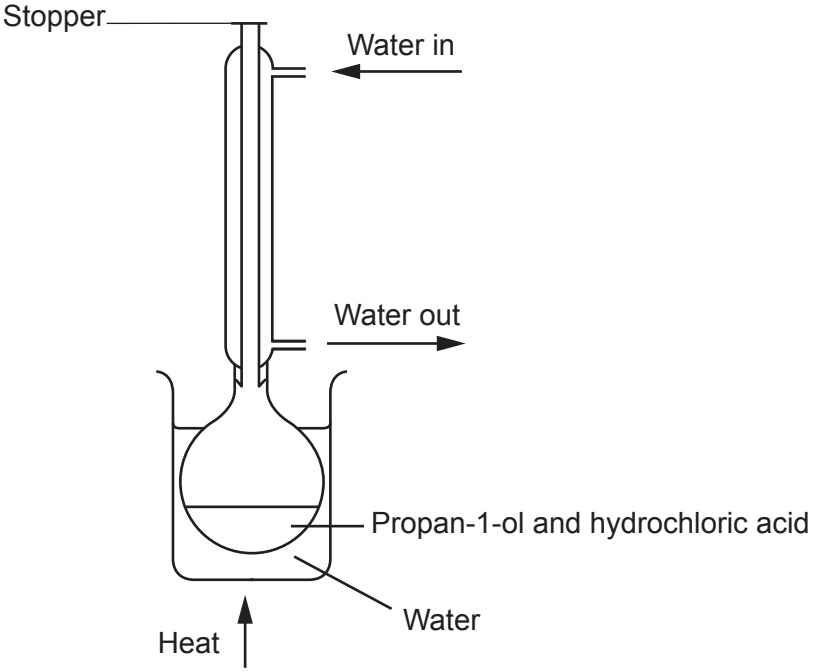
(f) 1-chloropropane, $CH_3CH_2CH_2Cl$, is another organic compound containing chlorine. 1-chloropropane is made by reacting propan-1-ol, $CH_3CH_2CH_2OH$, with concentrated hydrochloric acid.

A student sets up the following apparatus to heat the propan-1-ol and hydrochloric acid under reflux.



Identify **two** mistakes that the student has made in setting up this apparatus.
(Assume that clamps and supports are present.)

Mistake 1: .....

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Mistake 2: .....

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[2]

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3 Most diesel fuel is made from crude oil. However, biodiesel, made from vegetable oils, is increasingly being used.

(a) Diesel fuel made from crude oil often undergoes incomplete combustion in vehicle engines. The pollutants carbon monoxide and carbon particulates are formed.

$C_{12}H_{26}$ is a typical hydrocarbon found in diesel.

Write an equation for the **incomplete** combustion of $C_{12}H_{26}$ to give equal amounts of carbon monoxide and carbon.

[1]

(b) $C_{14}H_{30}$ is another hydrocarbon found in diesel.

2.50 g of $C_{14}H_{30}$ is **completely** burned in oxygen.

Calculate the volume of CO_2 formed (in dm^3) at RTP.

volume of CO_2 = ... dm^3 **[2]**

(c) Biodiesel produces lower emissions of carbon monoxide and carbon.
It also produces less of other pollutants, such as sulfur dioxide, compared with diesel.

How is sulfur dioxide formed in a diesel engine?

.....

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

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(d) A student says that biodiesel is both sustainable and carbon neutral because it is made from vegetable oils.

Comment on the validity of both parts of this statement.

Sustainable .....

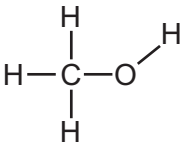
.....

Carbon neutral .....

.....

[2]

(e) Methanol is a reactant in the reaction that produces biodiesel.



methanol

(i) State and explain the C–O–H bond angle in a methanol molecule.

C–O–H bond angle = ...°

Explanation of bond angle.

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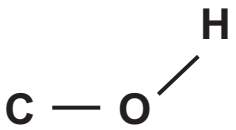
..... **[4]**

(ii) Complete the diagram to show the three-dimensional structure of a methanol molecule.

Use solid and dashed wedges to represent bonds where necessary.



[1]

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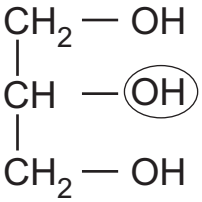
(f) The other product in the reaction to produce biodiesel is propane-1,2,3–triol.

The structure of propane-1,2,3–triol is shown below.



Classify the circled OH group as primary, secondary or tertiary.

Explain your answer.

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

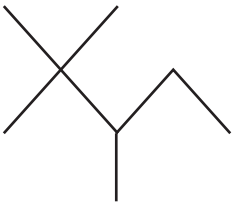
(g) Fuels such as diesel contain many alkanes.

(i) Draw the **skeletal** formula for the molecule shown below.

$CH_3CH_2CH(CH_3)CH_2CH(CH_2CH_3)CH(CH_3)CH_2CH_3$

[1]

(ii) **Name** the molecule shown below.



Name:..... **[1]**

(iii) Alkanes have no double bonds and no benzene rings.

Give words that are used to describe these features of the alkanes.

No double bonds .....

No benzene rings ..... **[1]**

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(h)* An organic compound **A**, has the following composition by mass:

3.7 g of compound **A** contains 1.8 g carbon, 0.3 g of hydrogen, the rest of its mass is oxygen.

The infrared and mass spectra of compound **A** are shown below.

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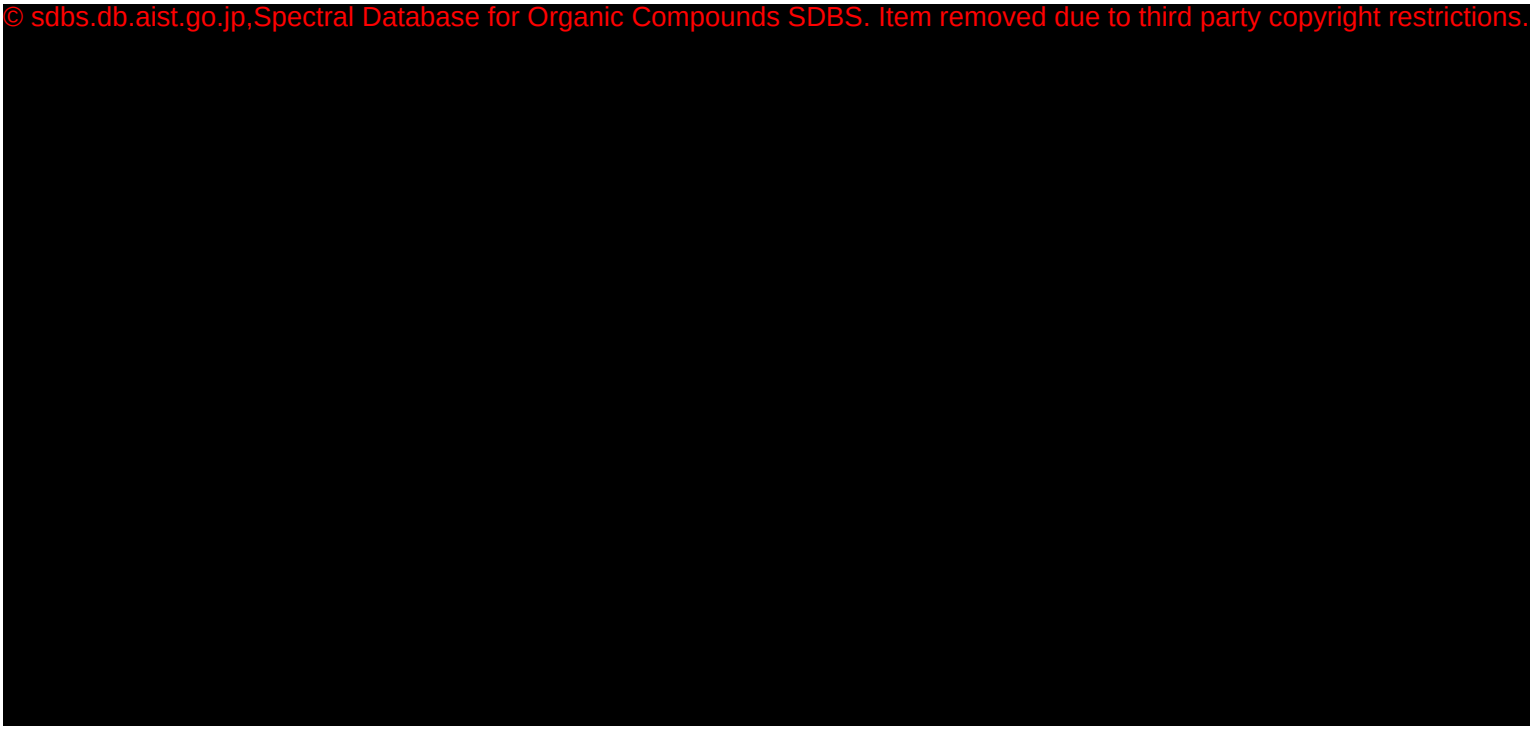

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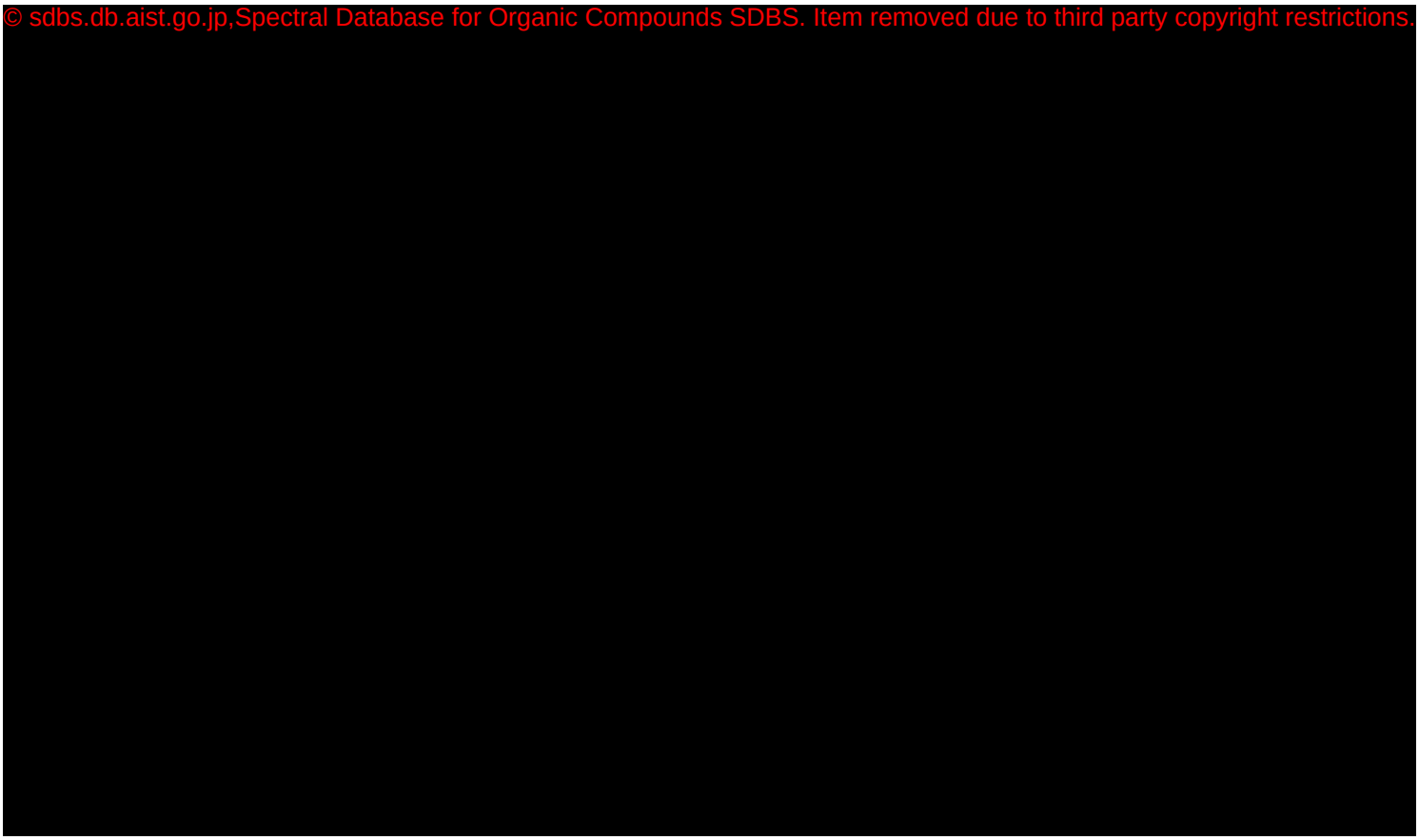

You may do rough work on this page but it will not be marked.

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Use the information on page 12 to deduce the structural formula of compound **A**.

Explain your reasoning, giving evidence from the mass data and both of the spectra.

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Extra answer space if required.

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4 A student investigates the equilibrium in **Equation 4.1**.

$2NO_2(g) \rightleftharpoons N_2O_4(g)$ $\Delta H = -58\,kJ\,mol^{-1}$ **Equation 4.1**

$NO_2(g)$ is brown and $N_2O_4(g)$ is colourless.

(a)
(i) Write the expression for the K_c for the equilibrium in **Equation 4.1**.

[1]

(ii) At a certain temperature, the numerical value of K_c for the equilibrium shown in **Equation 4.1** is 285.

In an equilibrium mixture at this temperature, $[N_2O_4] = 4.2 \times 10^{-2}\,mol\,dm^{-3}$.

Calculate $[NO_2]$ in this equilibrium mixture in $mol\,dm^{-3}$.

$[NO_2]$ = ... $mol\,dm^{-3}$ **[2]**

(iii) The equilibrium is then set up at a higher temperature.

Will the value of K_c increase, decrease or stay the same?

Explain your answer.

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

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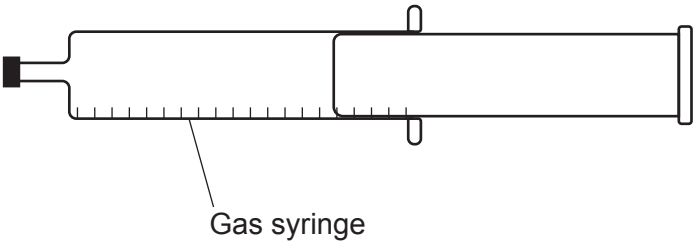
(b)* The student has a sealed gas syringe containing the mixture of the two gases from **Equation 4.1**.

The mixture is brown because of the presence of NO_2.



The student pushes in the plunger to compress the gases.
The mixture slowly becomes lighter brown and then stays that colour.
There are no leaks.

Give chemical explanations of why the reaction is quite slow and why the mixture becomes lighter brown and then does not change.

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..... **[6]**

Extra answer space if required.

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END OF QUESTION PAPER

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EXTRA ANSWER SPACE

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