

AS Level Chemistry A

H032/02 Depth in chemistry

Sample Question Paper

Date – Morning/Afternoon

Version 2.0

Time allowed: 1 hour 30 minutes

You must have:

- the Data Sheet for Chemistry A

You may use:

- a scientific or graphical calculator



First name

Last name

Centre
number

Candidate
number

INSTRUCTIONS

- Use black ink. HB pencil may be used for graphs and diagrams only.
- Complete the boxes above with your name, centre number and candidate number.
- 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.
- Additional paper may be used if required but you must clearly show your candidate number, centre number and question number(s).
- Do **not** write in the bar codes.

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.

Answer **all** the questions.

- 1** Bromine is a reactive element. It combines with other non-metals to form covalent compounds. Phosphorus tribromide, PBr_3 , and iodine monobromide, IBr , are examples of covalent compounds used in organic synthesis.

(a) PBr_3 can be prepared by heating bromine with phosphorus, P_4 .

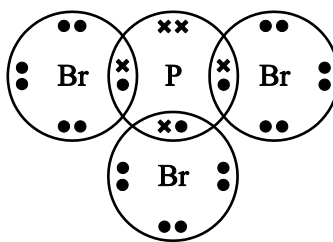
(i) Write an equation for this reaction.

..... [1]

(ii) How many molecules are present in 1.3535 g of PBr_3 ?

number of molecules = [3]

(iii) The 'dot-and-cross' diagram of a molecule of PBr_3 is given below.



Name the shape of this molecule and explain why the molecule has this shape.

name:

explanation:

.....

.....

[3]

(b) Bromine reacts with iodine to form iodine monobromide, IBr.

The table below lists some average bond enthalpies which are required in different parts of this question.

Bond	Average bond enthalpy / kJ mol ⁻¹
Br–Br	+193
I–I	+151
I–Br	+175

(i) Average bond enthalpy is the enthalpy change for the breaking of 1 mole of bonds in gaseous molecules.

Why do Br₂ and I₂ **not** exist in the gaseous state under standard conditions?

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

(ii) Calculate the enthalpy change of formation, $\Delta_f H$, for IBr.

$\Delta_f H = \dots\dots\dots \text{kJ mol}^{-1}$ [2]

(c) Iodine monobromide, I–Br, is a polar molecule.

Heterolytic fission of the I–Br bond forms an electrophile.

State the meaning of the term *electrophile* and suggest the formula of the electrophile formed from IBr.

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..... [2]

(d) Bromine disproportionates when it reacts with potassium hydroxide solution.

Suggest an equation for this reaction.

..... [1]

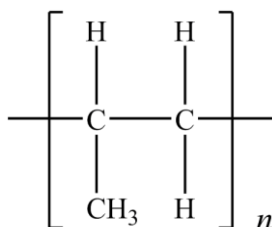
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SPECIMEN

- 2 A large proportion of the world's output of organic chemicals is used to make addition polymers. These polymers have a variety of uses.

(a) Poly(propene) is used to make packaging, textiles and rope.

A repeat unit for poly(propene) is shown below.



- (i) Explain why poly(propene) is a *saturated* hydrocarbon.

.....
 [1]

- (ii) State the bond angle around each carbon atom in poly(propene).

..... [1]

- (iii) After polymers have been used for packaging, the waste polymers need to be processed to save resources, for example, by recycling.

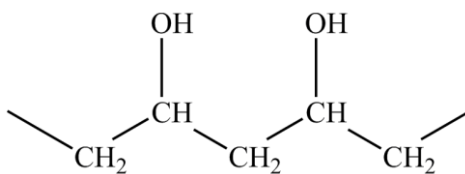
Describe **two** other ways in which waste poly(propene) can be processed in a sustainable way.

.....

 [2]

(b) Poly(ethenol) is used to make soluble laundry bags.

A section of the structure of poly(ethenol) is shown below.



(i) Draw a structure to represent one repeat unit of poly(ethenol).

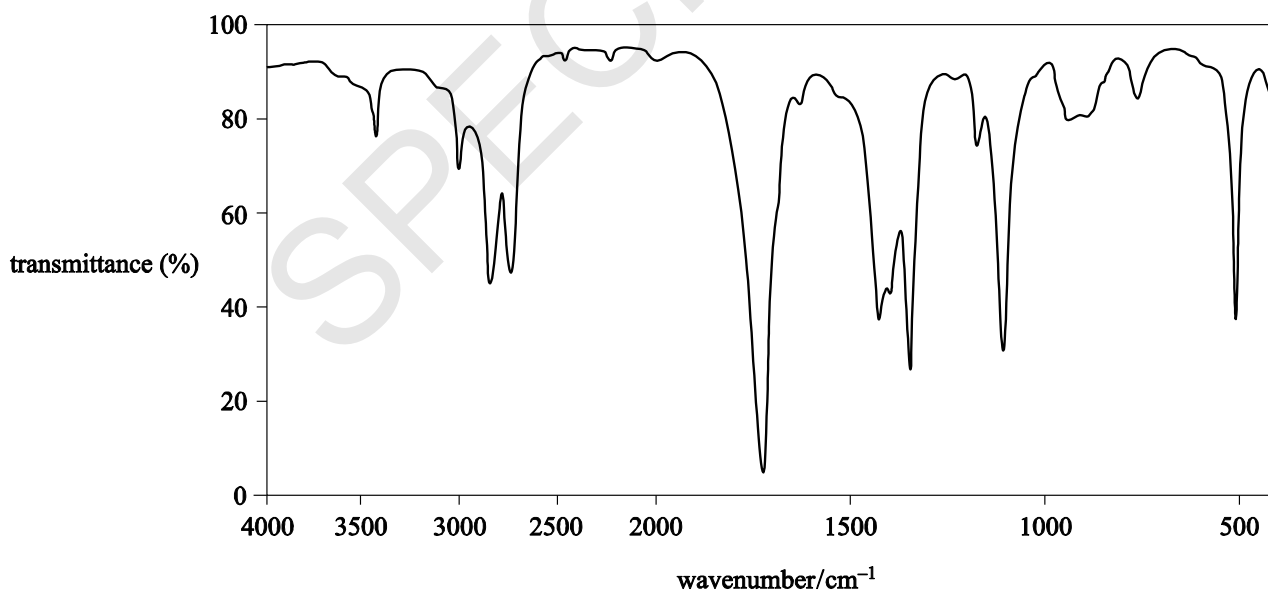
[1]

(ii) Poly(ethenol) is not manufactured from ethenol.

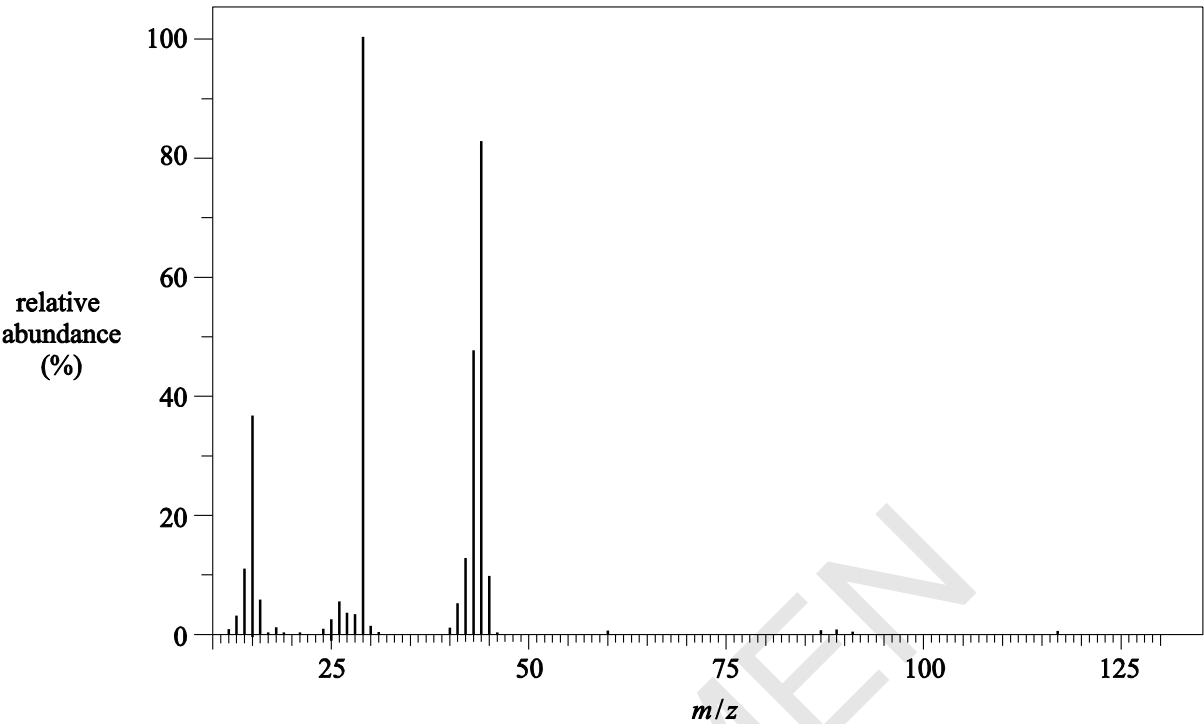
Ethenol is unstable and it forms a more stable structural isomer.

Analysis of the structural isomer gave the following data.

Infrared spectrum



Mass spectrum



Use **all** the data to show that the isomer is **not** ethenol.

Identify the structural isomer of ethenol.

In your answer you should make clear how your explanation is linked to the evidence.

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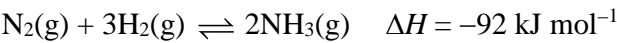
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[4]

3 Nitrogen can be reacted with hydrogen in the presence of a catalyst to make ammonia in the Haber process.



(a) Describe and explain the effect of increasing the pressure on the rate of this reaction.

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..... [2]

(b) A mixture of N₂ and H₂ was left to react until it reached equilibrium. The equilibrium mixture had the following composition:

N ₂	1.20 mol dm ⁻³
H ₂	2.00 mol dm ⁻³
NH ₃	0.877 mol dm ⁻³

(i) Calculate a value for K_c for this equilibrium.

$$K_c = \dots\dots\dots \text{dm}^6 \text{mol}^{-2} \quad [3]$$

(ii) Explain how the following changes would affect the amount of NH₃ present in the equilibrium mixture.

Use of a catalyst:

.....

.....

A higher temperature:

.....

.....

[3]

- (c) 1.00 tonne of ammonia from the Haber process is reacted with carbon dioxide to prepare the fertiliser urea, NH_2CONH_2 .



1.35 tonnes of urea are formed.

Calculate the percentage yield of urea.

yield = % [3]

4 Students work together in groups to identify four different solutions.

Each solution contains one of the following compounds:

- ammonium sulfate, $(\text{NH}_4)_2\text{SO}_4$
- sodium sulfate, Na_2SO_4
- sodium chloride, NaCl
- potassium bromide, KBr .

Your group has been provided with universal indicator paper and the following test reagents:

- barium chloride solution
- silver nitrate solution
- dilute ammonia solution
- sodium hydroxide solution.

(a)* A student in your group suggests the following plan:

- Add about 1 cm depth of each solution into separate test-tubes.
- Add a few drops of barium chloride solution to each test-tube.
- A white precipitate will show which solutions contain sulfate ions.
- Two of the solutions will form a white precipitate.

Describe how you would expand this plan so that all four solutions could be identified using a positive test result.

You should provide observations and conclusions that would enable your group to identify all four solutions. [6]

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Additional answer space if required.

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- (b) Solid barium chloride has a high melting point. Barium chloride dissolves in water to form a solution that can be used to test for sulfate ions.
- (i) Draw a ‘dot-and-cross’ diagram to show the bonding in solid barium chloride.
Show outer electrons only.

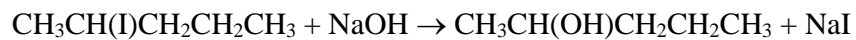
[2]

- (ii) A solution of barium chloride can be made in the laboratory using dilute hydrochloric acid.
Suggest a compound that can be reacted with hydrochloric acid to make barium chloride.

..... [1]

5 Alcohols are used in organic synthesis.

(a) Pentan-2-ol can be prepared by the alkaline hydrolysis of 2-iodopentane.



The reaction mixture is boiled for 20 minutes.

(i) State the most appropriate technique that could be used to boil the reaction mixture for 20 minutes.

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

(ii) Describe the mechanism for the alkaline hydrolysis of 2-iodopentane.

In your answer, include the name of the mechanism, curly arrows and relevant dipoles.

name of mechanism:

[4]

(b) Alcohols can be converted into haloalkanes in a substitution reaction.

Plan an experiment to prepare approximately 0.1 mol of 2-bromopentane, $\text{CH}_3\text{CHBrCH}_2\text{CH}_2\text{CH}_3$, from pentan-2-ol, $\text{CH}_3\text{CH}(\text{OH})\text{CH}_2\text{CH}_2\text{CH}_3$.

Your plan should include a calculation of the mass of alcohol required and details of the chemicals to be used in the reaction.

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..... [2]

SPECIMEN

Additional answer space if required.

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SPECIMEN

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SPECIMEN

- 6 A student carries out an experiment to identify an unknown carbonate.
- The student weighs a sample of the solid carbonate in a weighing bottle.
 - The student tips the carbonate into a beaker and weighs the empty weighing bottle.
 - The student prepares a 250.0 cm³ solution of the carbonate.
 - The student carries out a titration using 25.0 cm³ of this solution measured using a pipette with 0.100 mol dm⁻³ hydrochloric acid in the burette.
- (a) The sample of carbonate is dissolved in approximately 100 cm³ of distilled water in a beaker and the solution transferred to a volumetric flask. The volume of the solution is made up to 250.0 cm³ with distilled water.

Another student suggests two possible sources of error:

- A small amount of solid remained in the weighing bottle.
- A small amount of solution remained in the beaker.

State whether the other student’s statements are correct.

How could the procedure be improved?

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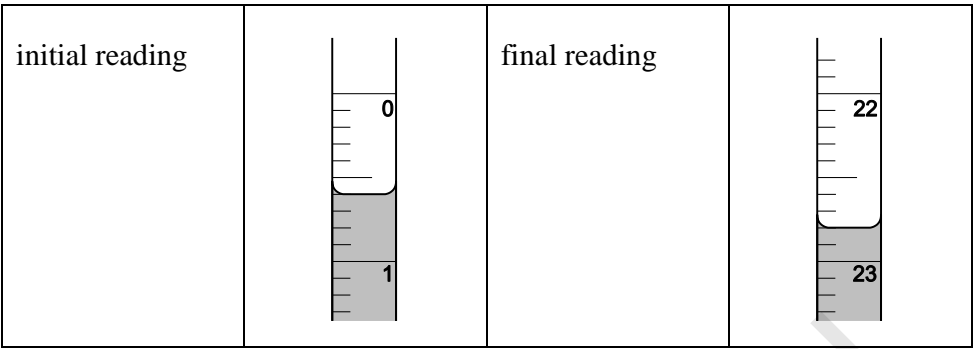
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..... [2]

- (b) The student carries out the final part of the experiment by adding 0.100 mol dm⁻³ hydrochloric acid to a burette and performing a titration using a 25.0 cm³ sample of the aqueous carbonate.

The student reads the burette to the nearest 0.05 cm³.

The diagrams below show the initial burette reading and the final burette reading.



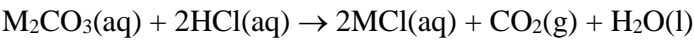
- (i) Record the student's readings and the titre.

[1]

- (ii) Describe what the student should do next to obtain reliable results for the titration.

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

(c) The equation below represents the reaction between the carbonate and hydrochloric acid.



(i) Calculate the amount, in mol, of M_2CO_3 used in the titration.

$n(\text{M}_2\text{CO}_3) = \dots\dots\dots \text{ mol}$ [2]

(ii) The student’s mass readings are recorded below.

Mass of weighing bottle + carbonate / g	14.92
Mass of weighing bottle / g	13.34

Use the student’s results to identify the carbonate, M_2CO_3 .

[4]

- 7 An alcohol **A** contains carbon, hydrogen and oxygen only. The alcohol is a liquid at room temperature and pressure but can easily be vaporised.

1.15 g of **A** produces 761 cm³ of gas when vaporised, measured at 100 kPa and 366 K.

Determine the molar mass of compound **A** and draw a possible structure for **A**.

molar mass = g mol⁻¹

Structure of **A**

[5]

END OF QUESTION PAPER

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