



**AS Level Chemistry A**  
**H032/02 Depth in chemistry**  
Sample Question Paper

**Date – Morning/Afternoon**

Time allowed: 1 hour 30 minutes



**You must have:**

- the Data Sheet for Chemistry A

**You may use:**

- a scientific calculator



<b>First name</b>										
<b>Last name</b>										
<b>Centre number</b>										
<b>Candidate number</b>										

**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.
- 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,  $\text{PBr}_3$ , and iodine monobromide,  $\text{IBr}$ , are examples of covalent compounds used in organic synthesis.

(a)  $\text{PBr}_3$  can be prepared by heating bromine with phosphorus,  $\text{P}_4$ .

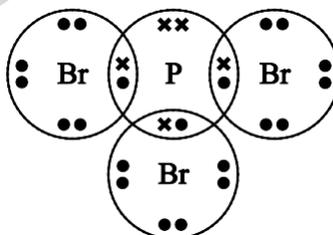
(i) Write an equation for this reaction.

..... [1]

(ii) How many molecules are present in 1.3535 g of  $\text{PBr}_3$ ?

number of molecules = ..... [3]

(iii) The 'dot-and-cross' diagram of a molecule of  $\text{PBr}_3$  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 / $\text{kJ mol}^{-1}$
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  $\text{Br}_2$  and  $\text{I}_2$  **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.

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

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

Suggest an equation for this reaction.

..... [1]



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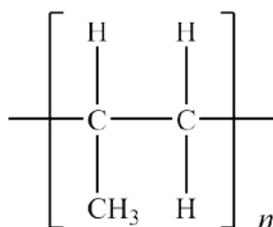
Specimen



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.

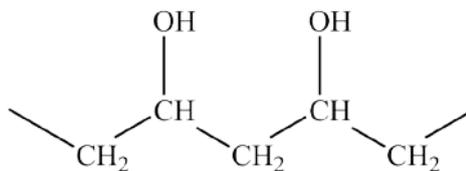
Describe **two** other ways in which waste poly(propene) can be processed in a sustainable way.

.....  
.....  
.....  
..... [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).

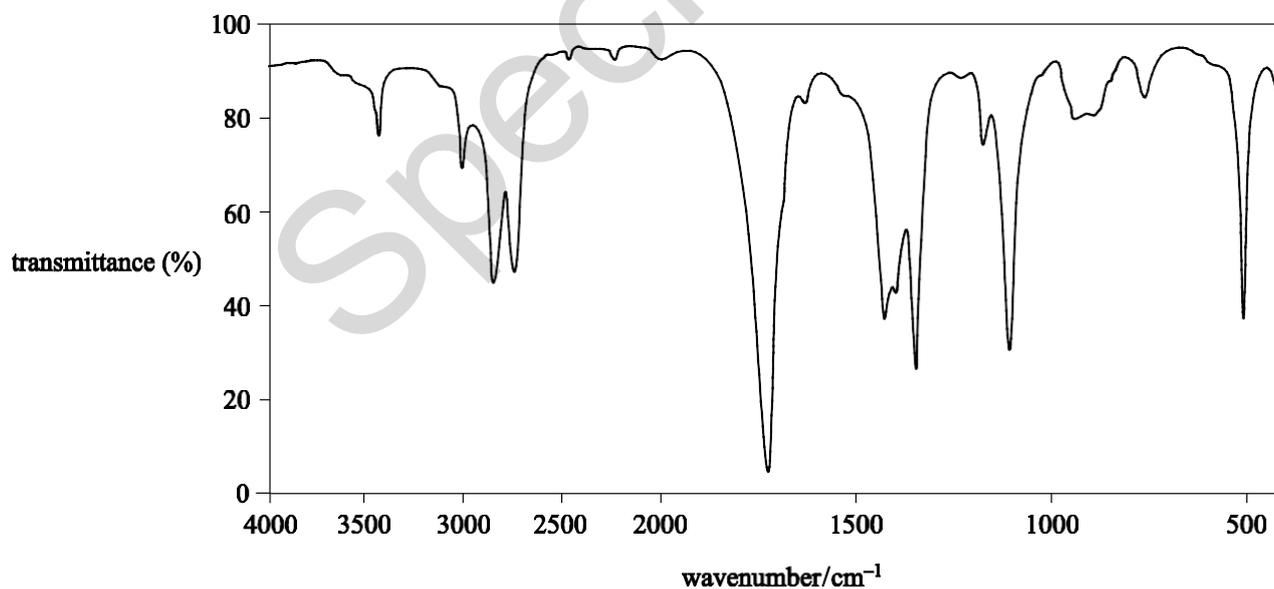
[1]

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

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

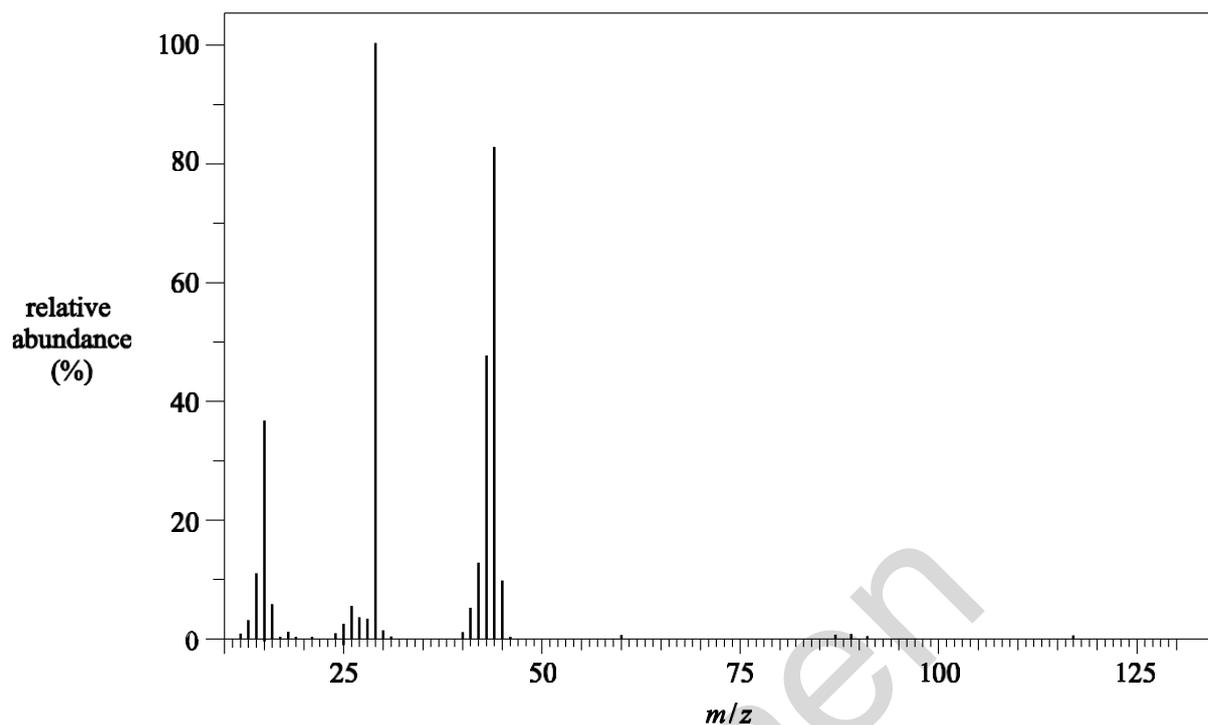
Analysis of the structural isomer gave the following data.

### 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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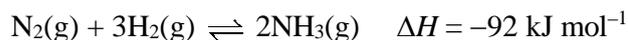
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[4]



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.

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

(b) A mixture of  $\text{N}_2$  and  $\text{H}_2$  was left to react until it reached equilibrium. The equilibrium mixture had the following composition:

$\text{N}_2$	$1.20 \text{ mol dm}^{-3}$
$\text{H}_2$	$2.00 \text{ mol dm}^{-3}$
$\text{NH}_3$	$0.877 \text{ mol dm}^{-3}$

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

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

(ii) Explain how the following changes would affect the amount of  $\text{NH}_3$  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,  $\text{NH}_2\text{CONH}_2$ .



1.35 tonnes of urea are formed.

Calculate the percentage yield of urea.

Show **all** your working.

yield = ..... % [3]

Specimen



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,  $\text{Na}_2\text{SO}_4$
- sodium chloride,  $\text{NaCl}$
- potassium bromide,  $\text{KBr}$ .

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.

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[6]

(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.

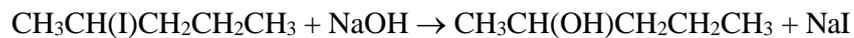
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[1]



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: .....

Specimen

[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.

.....

.....

.....

[2]

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  $250.0 \text{ cm}^3$  solution of the carbonate.
- The student carries out a titration using  $25.0 \text{ cm}^3$  of this solution measured using a pipette with  $0.100 \text{ mol dm}^{-3}$  hydrochloric acid in the burette.

(a) The sample of carbonate is dissolved in approximately  $100 \text{ cm}^3$  of distilled water in a beaker and the solution transferred to a volumetric flask. The volume of the solution is made up to  $250.0 \text{ cm}^3$  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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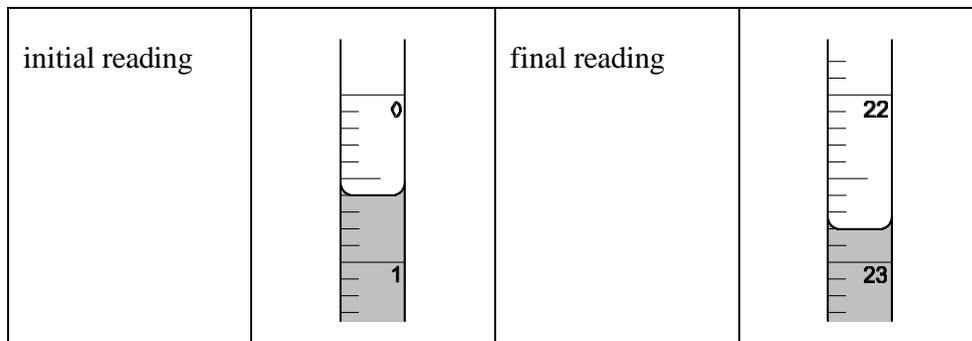
[2]



- (b) The student carries out the final part of the experiment by adding  $0.100 \text{ mol dm}^{-3}$  hydrochloric acid to a burette and performing a titration using a  $25.0 \text{ cm}^3$  sample of the aqueous carbonate.

The student reads the burette to the nearest  $0.05 \text{ cm}^3$ .

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.

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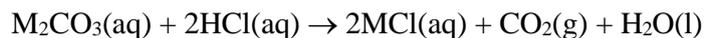
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.....

[1]



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



(i) Calculate the amount, in mol, of  $\text{M}_2\text{CO}_3$  used in the titration.

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

(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,  $\text{M}_2\text{CO}_3$ .

Show **all** your working.

Specimen

[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 cm<sup>3</sup> 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**.

Show **all** your working.

molar mass = .....g mol<sup>-1</sup>

Structure of **A**

[5]

**END OF QUESTION PAPER**

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Specimen

Specimen

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