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|-------------|---------------|------------------|
| Surname     | Centre Number | Candidate Number |
| Other Names |               | 2                |

## GCE A LEVEL



A410U30-1



## CHEMISTRY – A level component 3

### Chemistry in Practice

WEDNESDAY, 20 JUNE 2018 – MORNING

1 hour 15 minutes

| For Examiner's use only |              |              |
|-------------------------|--------------|--------------|
| Question                | Maximum Mark | Mark Awarded |
| 1.                      | 6            |              |
| 2.                      | 21           |              |
| 3.                      | 10           |              |
| 4.                      | 8            |              |
| 5.                      | 15           |              |
| <b>Total</b>            | <b>60</b>    |              |

A410U301  
01

### ADDITIONAL MATERIALS

In addition to this examination paper, you will need a:

- calculator;
- **Data Booklet** supplied by WJEC.

### INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen.

Write your name, centre number and candidate number in the spaces at the top of this page.

Answer **all** questions in the spaces provided.

### INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

The maximum mark for this paper is 60.

Your answers must be relevant and must make full use of the information given to be awarded full marks for a question.

The assessment of the quality of extended response (QER) will take place in **Q.1**.

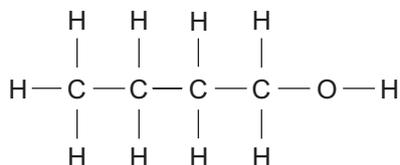
If you run out of space, use the additional page(s) at the back of the booklet, taking care to number the question(s) correctly.

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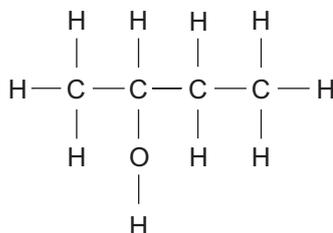


2. **A**, **B**, **C** and **D** are the four isomeric alcohols of formula  $C_4H_{10}O$ .

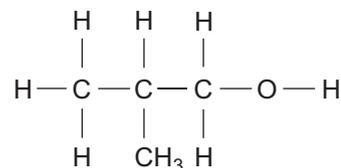
The structural formulae and systematic names of **A**, **B** and **C** are shown below.



**A**  
butan-1-ol



**B**  
butan-2-ol



**C**  
methylpropan-1-ol

(a) Give the structural formula and systematic name of alcohol **D**.

[2]

.....

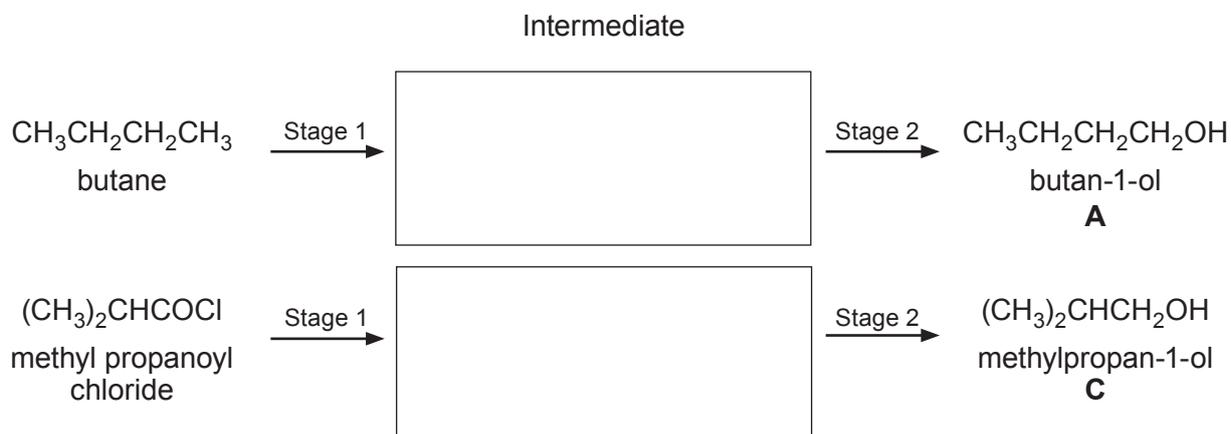
(b) Describe a test that would give a positive result for butan-2-ol (alcohol **B**) but not for alcohols **A**, **C** and **D**. Give the name of the reagent(s) used and the observation(s) made. [2]

Reagent(s) .....

Observation(s) .....

- (c) Two-stage processes for the preparation of alcohols **A** and **C** are shown below. In each case the intermediate compound has been omitted.

Complete the schemes by inserting the shortened structural formula of the intermediate compounds in the spaces provided. [2]



- (d) Butan-1-ol can also be prepared directly from 1-aminobutane by reaction with nitric(III) acid ( $\text{HNO}_2$ ). Butan-1-ol is only one of many organic products formed, including butan-2-ol and but-1-ene.

Nitrogen gas, however, is given off in quantities exactly as shown in the equation below. Thus, by measuring the volume of nitrogen gas produced, the exact amount of amine present in the solution can be found.



Calculate the volume in  $\text{cm}^3$  of liquid 1-aminobutane used if  $6.60 \text{ dm}^3$  of nitrogen gas are produced. Assume that all gas volumes are measured at 298 K and 1 atm pressure. [3]

(density of 1-aminobutane =  $0.740 \text{ g cm}^{-3}$  at 298 K)

Volume = .....  $\text{cm}^3$

- (e) Benzenediazonium chloride,  $C_6H_5N_2Cl$ , also forms nitrogen gas on decomposition. The reaction is first order with respect to benzenediazonium chloride.

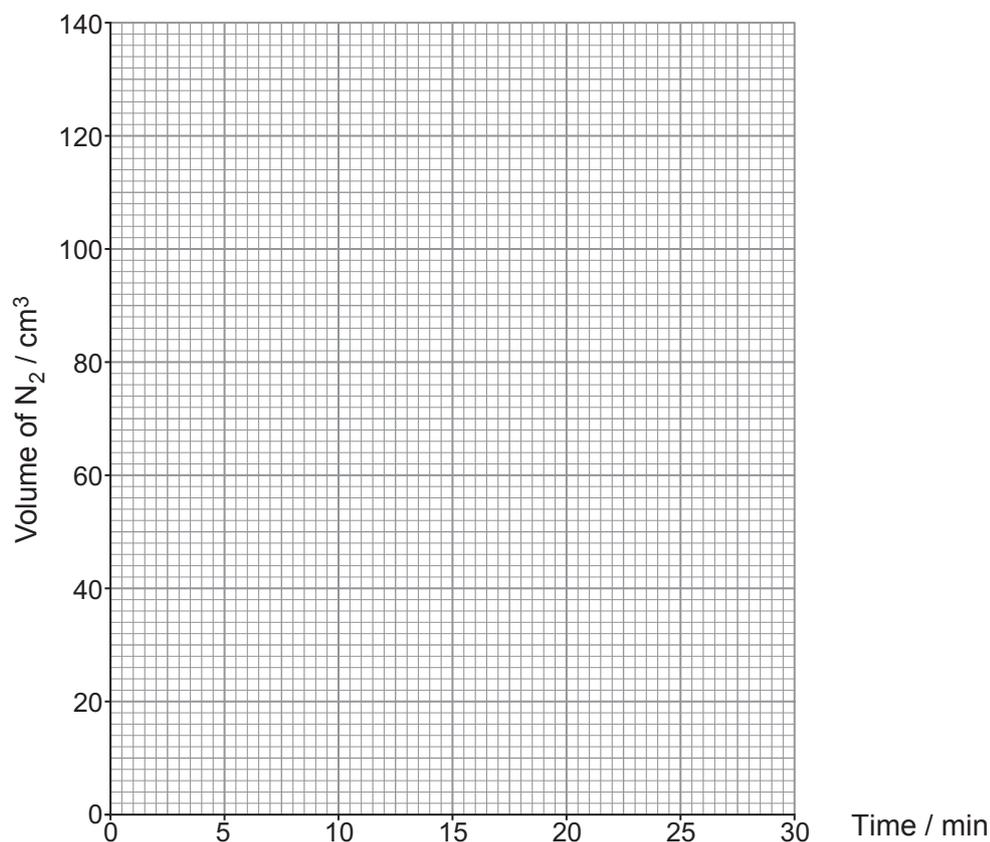


The following table gives the volume of nitrogen gas collected over time in the decomposition of  $50\text{ cm}^3$  of a  $0.110\text{ mol dm}^{-3}$  solution of benzenediazonium chloride at  $20^\circ\text{C}$ .

|                                 |   |     |     |     |     |      |      |      |      |
|---------------------------------|---|-----|-----|-----|-----|------|------|------|------|
| Time / min                      | 0 | 2.0 | 4.0 | 6.0 | 9.0 | 12.0 | 16.0 | 22.0 | 28.0 |
| Volume of $N_2$ / $\text{cm}^3$ | 0 | 17  | 34  | 49  | 66  | 81   | 95   | 112  | 122  |

- (i) Draw a labelled diagram of the apparatus that could be used to follow this reaction. [2]

- (ii) Plot the volume of nitrogen gas collected against time on the graph below. [2]



- (iii) Assuming the decomposition of the benzenediazonium chloride is complete, calculate the total volume of nitrogen gas that would be formed at the end of the reaction at 1 atm and 20 °C. [3]

Volume = ..... cm<sup>3</sup>

- (iv) I. Use the graph to determine the initial rate of formation of nitrogen gas in **dm<sup>3</sup> min<sup>-1</sup>**. Give your answer in standard form. [3]

Initial rate = ..... dm<sup>3</sup> min<sup>-1</sup>

- II. Calculate the rate constant for this reaction giving the unit. [2]

Rate constant = .....

Unit .....

3. A student was asked to identify four inorganic salts, labelled **P**, **Q**, **R** and **S**, by their reaction with aqueous sodium hydroxide and by the interactions between their solutions. The student was told that each solution contains

- a **different cation** and that the cations present are



- a **different anion** and that the anions present are



The student tested approximately 2 cm<sup>3</sup> at a time of each solution with NaOH(aq) and then with a few drops of the other solutions in turn.

When no observable reaction happened, "NOR" was recorded in the results table below.

|          | <b>P</b>  | <b>Q</b>                                      | <b>R</b>  | <b>S</b> |
|----------|---|---|---|----------|
| NaOH(aq) | white precipitate, insoluble in excess NaOH(aq) | white precipitate, soluble in excess NaOH(aq) | green precipitate, insoluble in excess NaOH(aq) | NOR      |
| <b>S</b> | NOR   | white precipitate                             | heavy white precipitate                         |          |
| <b>R</b> | NOR   | white precipitate                             |   |          |
| <b>Q</b> | bright yellow precipitate                       |   |   |          |

Complete the table below.

- Identify the cation and anion present in each of the four inorganic salts **P**, **Q**, **R** and **S**.
- Give an **ionic** equation to show the formation of **any one** of the precipitates formed. Include state symbols.

[10]

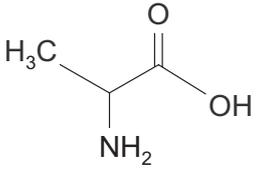
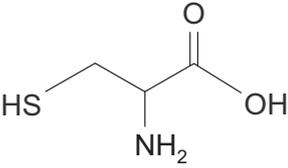
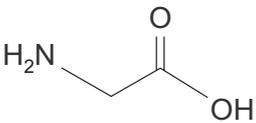
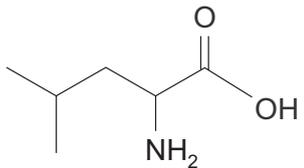
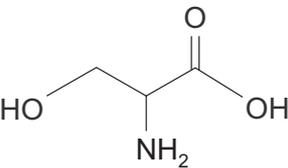
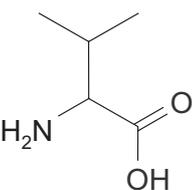
| Inorganic salt | Cation | Anion |
|----------------|--------|-------|
| <b>P</b>       |        |       |
| <b>Q</b>       |        |       |
| <b>R</b>       |        |       |
| <b>S</b>       |        |       |

Ionic equation

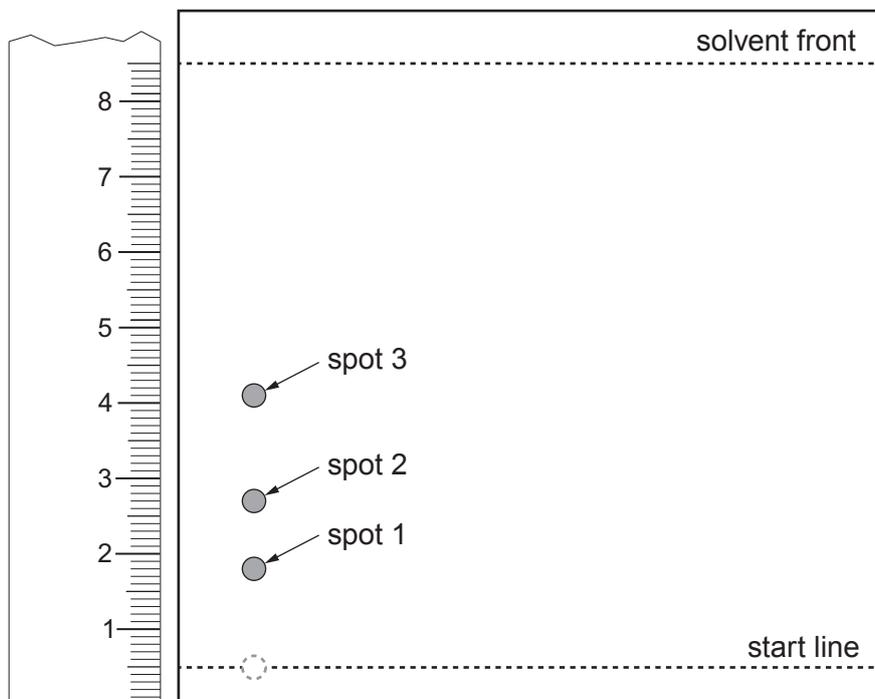
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4. A mixture of amino acids produced on hydrolysis of a peptide can be analysed by thin layer chromatography.

$R_f$  values for different amino acids in two different solvents are given in the table below.

| Amino acid |   | $R_f$<br>phenol/ammonia<br>solvent | $R_f$<br>butanol/ethanoic acid<br>solvent |
|------------|---|------------------------------------|---|
| alanine    |    | 0.55                               |   |
| cysteine   |   | 0.13                               | 0.05                                      |
| glycine    |  | 0.41                               | 0.17                                      |
| leucine    |  | 0.86                               | 0.61                                      |
| serine     |  | 0.35                               | 0.17                                      |
| valine     |  | 0.76                               | 0.45                                      |

- (a) A drop of solution that contains a mixture of **four** amino acids was analysed using thin layer chromatography. The plate was placed in a butanol/ethanoic acid solvent for 30 minutes. It was then dried and sprayed with a developing agent. The following chromatogram was obtained.



Chromatogram 1: butanol/ethanoic acid solvent

- (i) Spot 2 on this chromatogram corresponds to alanine. Calculate the  $R_f$  value of alanine in this solvent. [2]

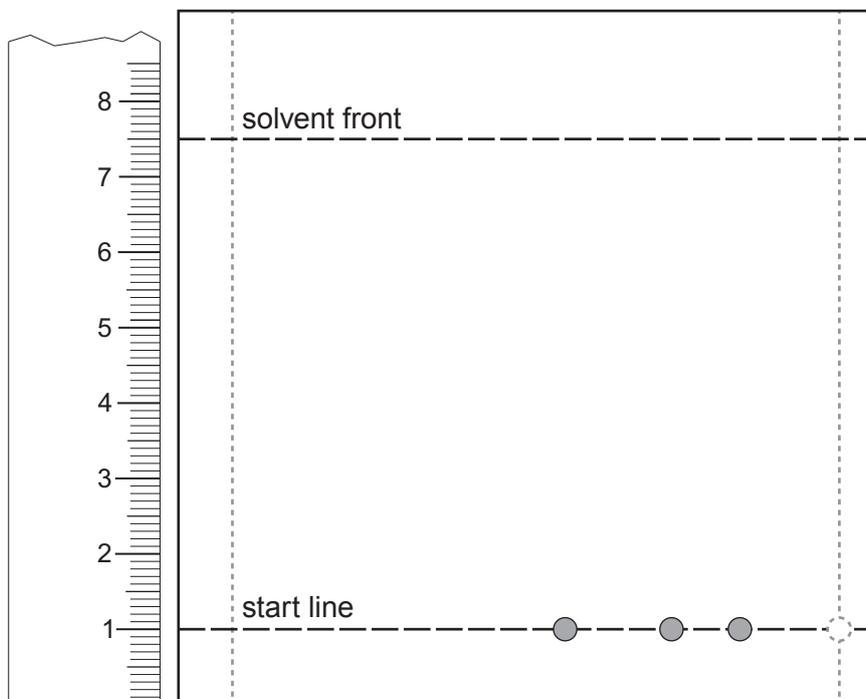
$$R_f = \dots\dots\dots$$

- (ii) Explain, in terms of the data provided, why only three spots are present on this chromatogram even though the solution contains a mixture of four different amino acids. [1]

.....

.....

- (iii) The plate was rotated through  $90^\circ$  in an anticlockwise direction and then placed in a phenol/ammonia solvent. Complete the diagram below to show the chromatogram you would expect to obtain. [4]

Examiner  
only

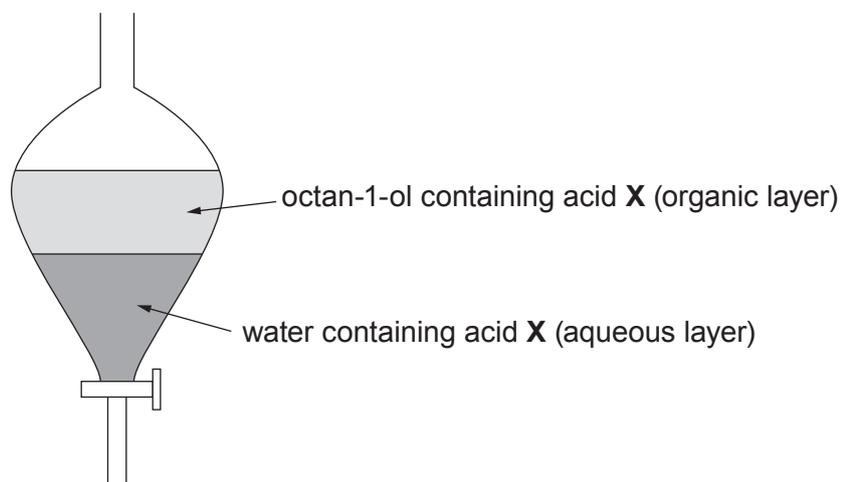
Chromatogram 2: phenol/ammonia solvent

- (b) Give the structural formula of **one** of the dipeptides that may be formed from serine and leucine. [1]

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5. A very weak carboxylic acid **X**, RCOOH, with a molar mass of  $116 \text{ g mol}^{-1}$  dissolves to some extent in **both** water and the organic solvent octan-1-ol. Water and octan-1-ol **do not mix**.

When a sample of pure **X** is shaken with water and octan-1-ol in a separating funnel and allowed to stand at a constant temperature of 298K for one week, two layers are formed as shown below.



An equilibrium is established between the amount of **X** in the two solvents.



Under these conditions at equilibrium the equilibrium constant  $K$  is given as

$$K = \frac{[\text{X}(\text{organic layer})]}{[\text{X}(\text{aqueous layer})]}$$

In an experiment to find the value for the equilibrium constant  $K$ , 15.0g of pure **X** was shaken with  $200 \text{ cm}^3$  of water and  $200 \text{ cm}^3$  of octan-1-ol in a separating funnel and left until equilibrium had been established.

After separating the aqueous and organic layers, it was found that  $25.0 \text{ cm}^3$  of the aqueous solution of **X** needed  $23.50 \text{ cm}^3$  of aqueous sodium hydroxide of concentration  $0.0200 \text{ mol dm}^{-3}$  to neutralise the acid.



- (a) (i) The six steps in the calculation to find the value for the equilibrium constant  $K$  are shown in a random order in the table below.

Number these steps in the correct order. The first step has already been numbered. [1]

| Step  | Correct order |
|---|---------------|
| Calculate the number of moles of <b>X</b> in the aqueous layer  |               |
| Calculate the mass of <b>X</b> in the organic layer and hence its concentration in $\text{mol dm}^{-3}$ |               |
| Calculate the number of moles of NaOH used in the titration   | 1             |
| Calculate the value for the equilibrium constant $K$ at 298 K   |               |
| Calculate the mass of <b>X</b> in the aqueous layer and hence its concentration in $\text{mol dm}^{-3}$ |               |
| Calculate the number of moles of <b>X</b> in $25.0 \text{ cm}^3$ of the aqueous layer                   |               |

- (ii) Calculate the value of  $K$ .

[5]

$K = \dots\dots\dots$

- (b) Calculate the total maximum percentage error in the volume of sodium hydroxide delivered from the burette, with a maximum error of half a division ( $\pm 0.05 \text{ cm}^3$ ). [1]

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only

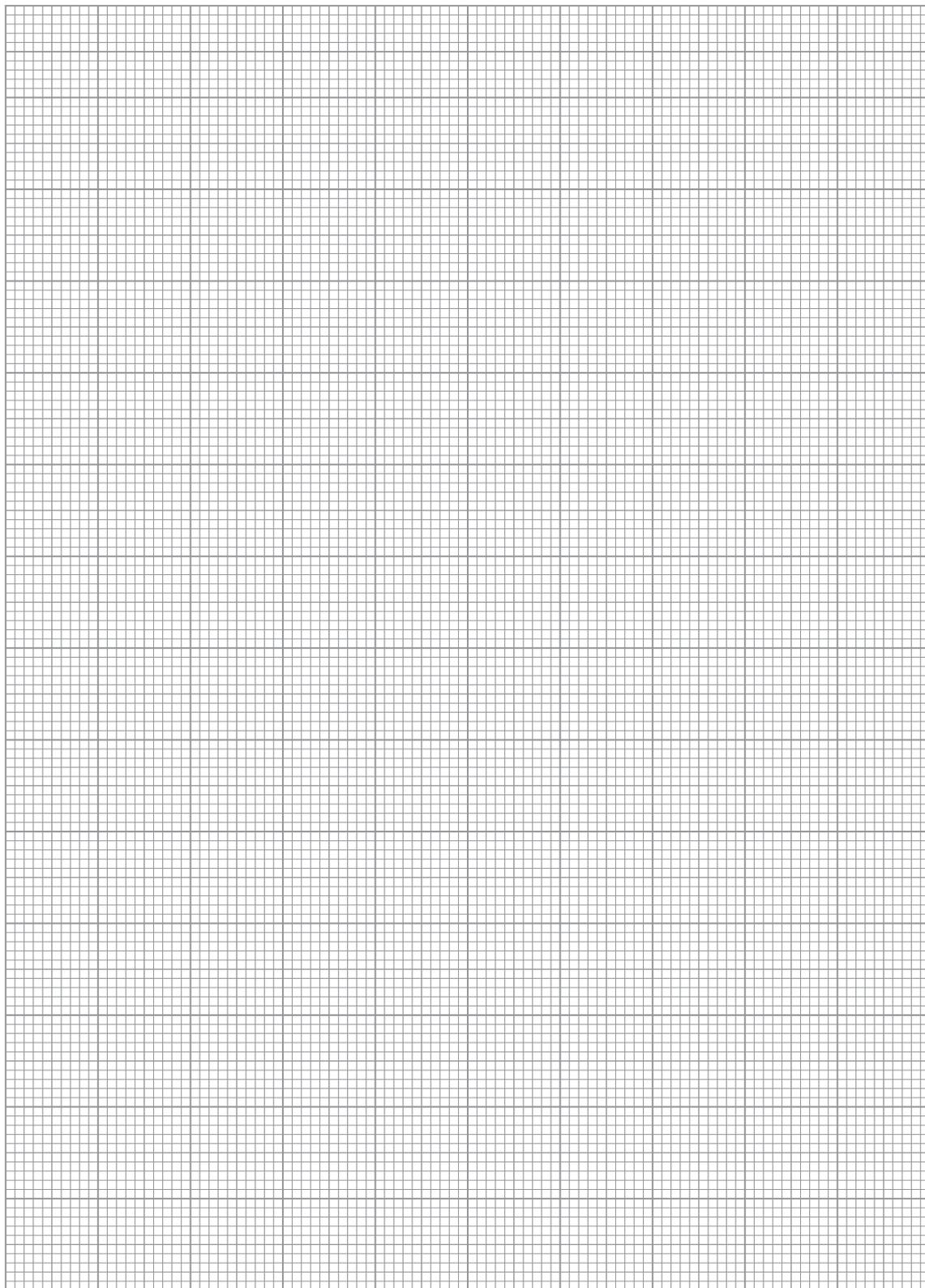
Maximum percentage error = ..... %

- (c) (i) Calculate the pH of the aqueous solution of the weak carboxylic acid **X** at 298 K. [3]

( $K_a$  for carboxylic acid **X** is  $1.32 \times 10^{-5} \text{ mol dm}^{-3}$  at 298 K)

pH = .....

- (ii) Sketch a curve to show the variation in pH when  $50.0\text{ cm}^3$  of  $0.0200\text{ mol dm}^{-3}$  sodium hydroxide solution is gradually added to  $25.0\text{ cm}^3$  of the solution of carboxylic acid **X**. Label the axes and significant points on the curve. [5]

Examiner  
only**END OF PAPER****Turn over.**



