Surname	Centre Number	Candidate Number
Other Names		2

GCE A LEVEL

A410U30-1

S18-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**	
Total	**60**	

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.

BLANK PAGE

Examiner only

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

1. Outline **two** simple reactions, including relevant observations, formulae and equations, to show that complexes of copper(II) ions can undergo ligand exchange.

You may choose from the following chemicals **ONLY**, not all of which need to be used.

- aqueous copper(II) sulfate
- aqueous potassium iodide
- aqueous sulfuric acid
- aqueous ammonia
- concentrated hydrochloric acid

[6 QER]

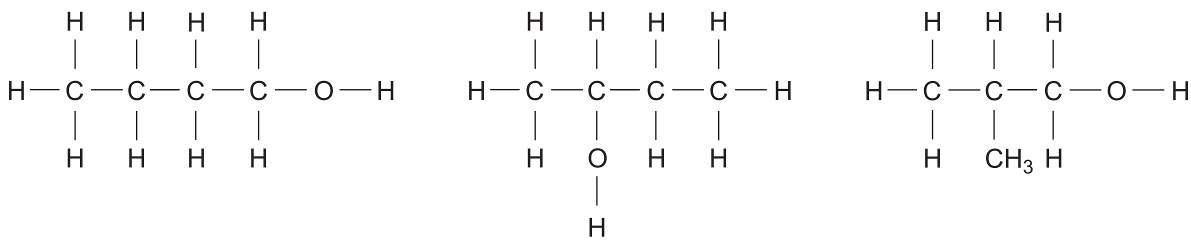
A410U301 03

6

Examiner only

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]

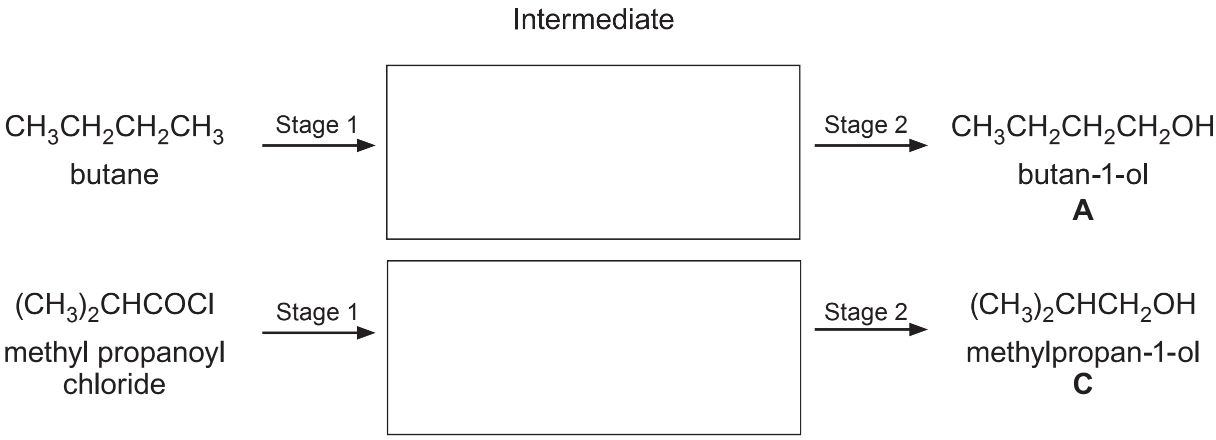
Reagent(s) ....

Observation(s) ....

Examiner only

(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 (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.

$$CH_3CH_2CH_2CH_2NH_2 + HNO_2 \longrightarrow CH_3CH_2CH_2CH_2OH + N_2 + H_2O$$

1-aminobutane

Calculate the volume **in cm³** of liquid 1-aminobutane used if 6.60 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 $g\,cm^{-3}$ at 298 K)

A410U301
05

Volume = ... 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.

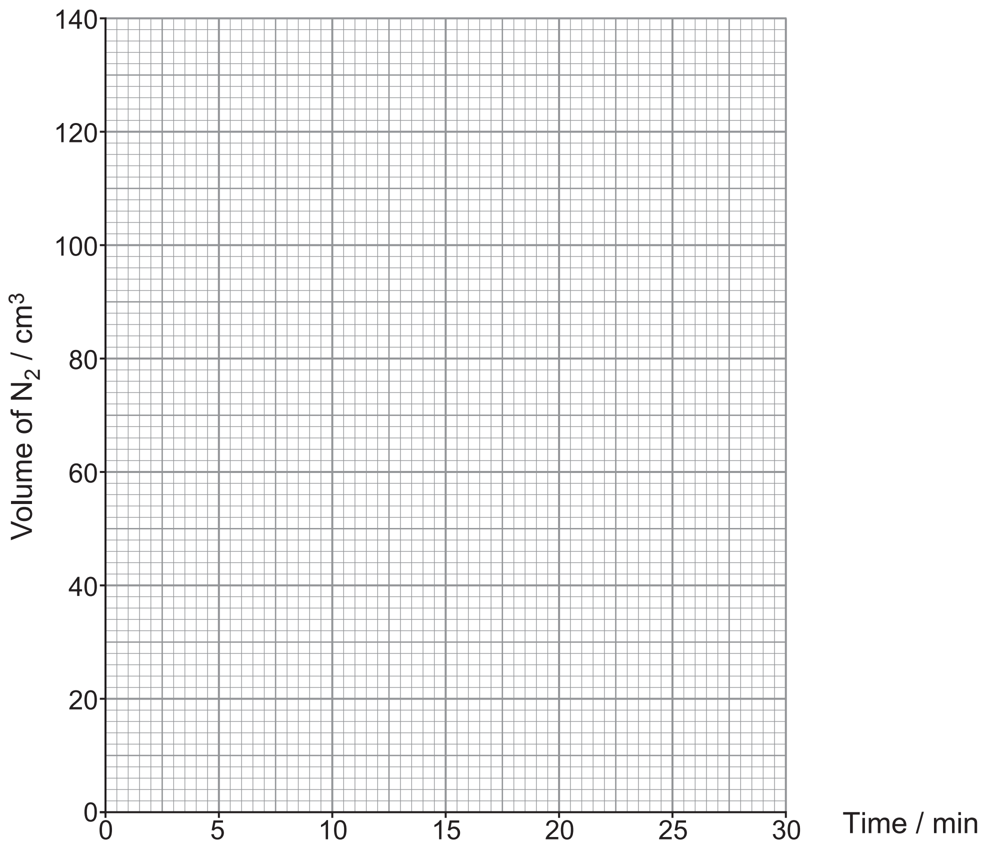
$$C_6H_5N_2Cl(aq) + H_2O(l) \longrightarrow C_6H_5OH(aq) + N_2(g) + HCl(aq)$$

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

Time / min	0	2.0	4.0	6.0	9.0	12.0	16.0	22.0	28.0
Volume of N_2 / 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]



Examiner only

(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^3

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

Initial rate = ... $dm^3\ min^{-1}$

A410U301 07

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

Rate constant = ...

Unit ....

21

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

  Mg^{2+} Ba^{2+} Pb^{2+} Fe^{2+}

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

  I^- Cl^- NO_3^- SO_4^{2-}

The student tested approximately 2 cm^3 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.

	P	**Q**	**R**	**S**
NaOH(aq)	white precipitate, insoluble in excess NaOH(aq)	white precipitate, soluble in excess NaOH(aq)	green precipitate, insoluble in excess NaOH(aq)	NOR
S	NOR	white precipitate	heavy white precipitate	
R	NOR	white precipitate		
Q	bright yellow precipitate			

Examiner only

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
P		
Q		
R		
S		

A410U301 09

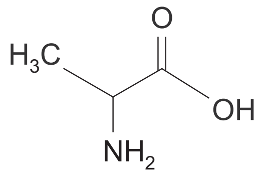
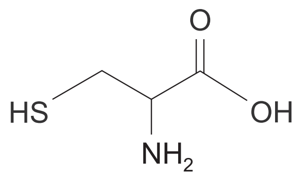
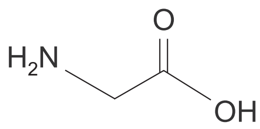
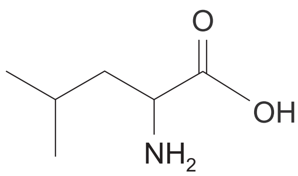
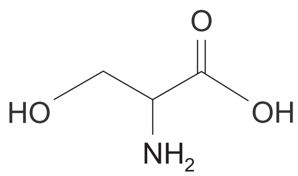
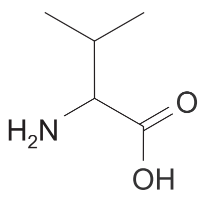
Ionic equation

....

10

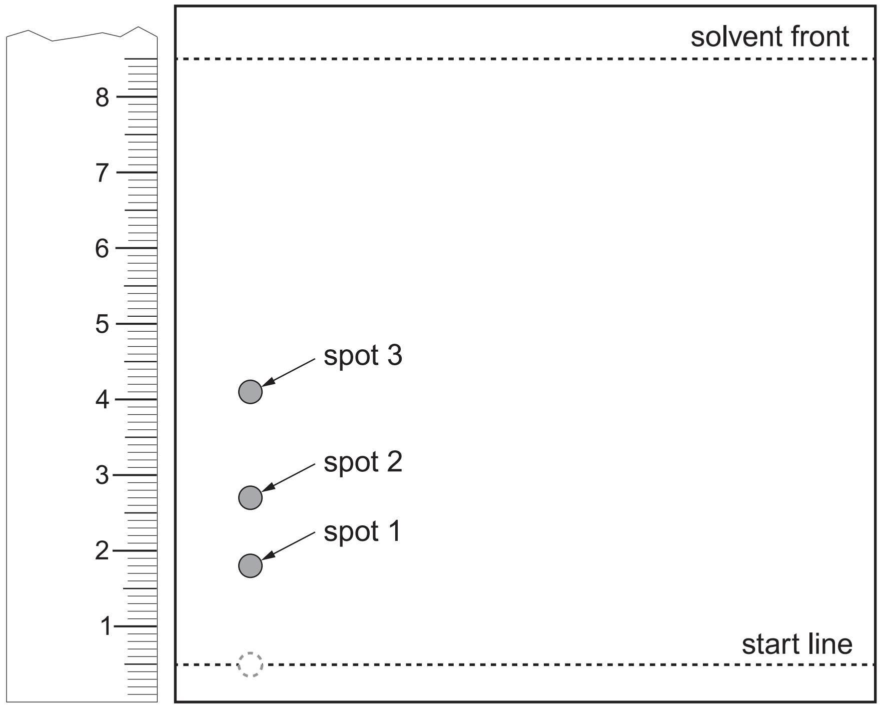
4. A mixture of amino acids produced on hydrolysis of a peptide can be analysed by thin layer chromatography.

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

Amino acid		R_f phenol/ammonia solvent	R_f butanol/ethanoic acid 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

Examiner only

(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 = ...

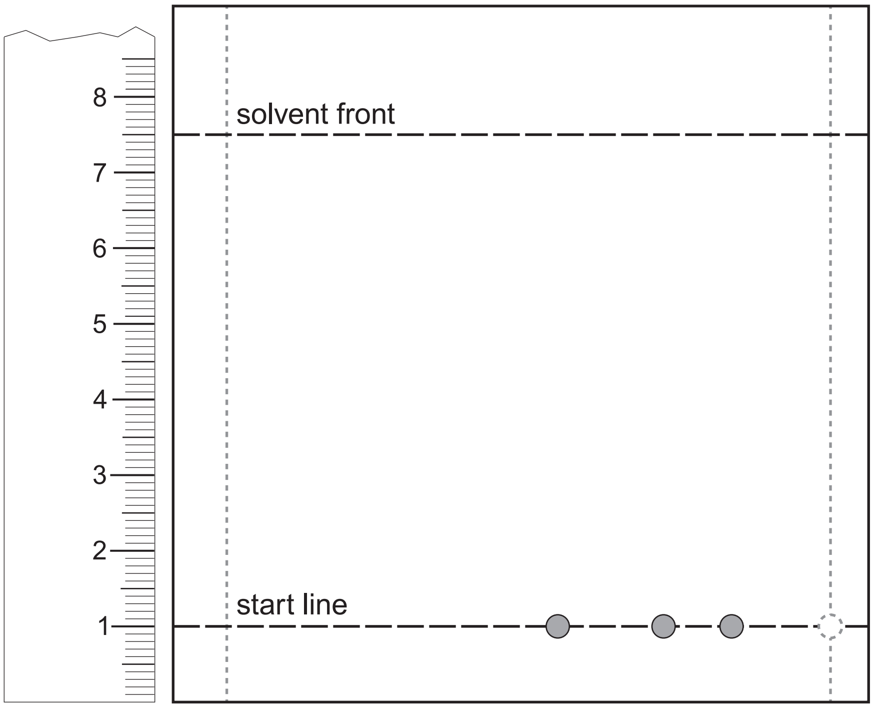
(ii) Explain, in terms of the data provided, why only three spots are present on this chromatogram even though the solution contains a mixture of four different amino acids. [1]

....

....

Examiner only

(iii) The plate was rotated through 90° 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]



Chromatogram 2: phenol/ammonia solvent

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

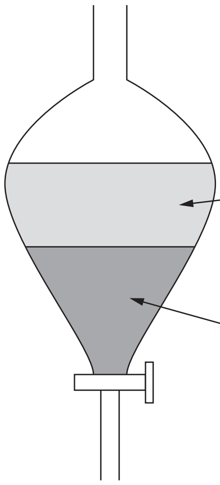
8

BLANK PAGE

Examiner only

5. A very weak carboxylic acid **X**, RCOOH, with a molar mass of 116 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 298 K for one week, two layers are formed as shown below.



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

$$\mathbf{X}\text{(aqueous layer)} \rightleftharpoons \mathbf{X}\text{(organic layer)}$$

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

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

In an experiment to find the value for the equilibrium constant *K*, 15.0 g of pure **X** was shaken with 200 cm^3 of water and 200 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 cm^3 of the aqueous solution of **X** needed 23.50 cm^3 of aqueous sodium hydroxide of concentration 0.0200 mol dm^{-3} to neutralise the acid.

$$RCOOH + NaOH \longrightarrow RCOO^-Na^+ + H_2O$$

Examiner only

(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 **X** in the aqueous layer	
Calculate the mass of **X** in the organic layer and hence its concentration in $mol\,dm^{-3}$	
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 **X** in the aqueous layer and hence its concentration in $mol\,dm^{-3}$	
Calculate the number of moles of **X** in $25.0\,cm^3$ of the aqueous layer	

(ii) Calculate the value of *K*. [5]

K = ...

Examiner only

(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 (±0.05 cm^3). [1]

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 1.32×10^{-5} mol dm^{-3} at 298 K)

pH = ...

Examiner only

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

15

END OF PAPER

Examiner only

For continuation only.

Examiner only

For continuation only.