Write your name here

Surname	Other names

Pearson Edexcel
International
Advanced Level

Centre Number | | | | | |

Candidate Number | | | | |

Chemistry

Advanced

Unit 6: Chemistry Laboratory Skills II

Thursday 16 January 2014 – Morning
Time: 1 hour 15 minutes

Paper Reference
WCH06/01

Candidates may use a calculator.

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
  – *there may be more space than you need.*

Information

- The total mark for this paper is 50.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*
- You will be assessed on your ability to organise and present information, ideas, descriptions and arguments clearly and logically, including your use of grammar, punctuation and spelling.
- A Periodic Table is printed on the back cover of this paper.

Advice

- Read each question carefully before you start to answer it.
- Keep an eye on the time.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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6/6/6/6/2/2/3/

P 4 2 9 7 5 R A 0 1 1 6

PEARSON

Answer ALL the questions. Write your answers in the spaces provided.

1 Substance **A** is a green solid which dissolves in water to form a green solution.
Substance **A** is an ionic compound containing one cation and one anion.

(a) Give the **formulae** of **two** cations which could be responsible for the green colour in the solid.

(2)

.....

(b) A student added dilute sodium hydroxide, drop by drop, to an aqueous solution of **A**. Initially, a green precipitate was formed. The precipitate did not dissolve in excess sodium hydroxide solution. The precipitate darkened on standing to give a brown solid.

(i) Write the **formula** of the cation in substance **A**.

(1)

.....

(ii) Write a **formula** for the green precipitate.

(1)

.....

(iii) Write a **formula** for the brown solid.

(1)

.....

(iv) State the type of reaction involved when the green precipitate turns brown.

(1)

.....

(c) The student added a few drops of acidified potassium manganate(VII) solution to another sample of a solution of **A** in a test tube.

Describe the colour change that occurs.

(1)

.....

.....

(d) The student acidified about 2 cm^3 of a solution of **A** with dilute nitric acid in a test tube and then added a few drops of aqueous silver nitrate solution. A white precipitate was formed.

(i) Give the **formula** of the anion present in **A**.

(1)

.....

(ii) The test in (d)(i) is usually followed by the addition of ammonia solution to test the solubility of the precipitate.

Explain why this is not a useful procedure in this case.

(2)

.....

.....

.....

.....

(Total for Question 1 = 10 marks)

2 Solution **B** is copper(II) sulfate dissolved in water.

(a) When an excess of concentrated hydrochloric acid is added to solution **B**, the colour of **B** changes from blue to yellow.

Give the **formula** of the complex ion responsible for the yellow colour.

(1)

.....

(b) What would you observe as dilute ammonia solution is added, drop by drop, to another sample of solution **B**?

(3)

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.....

.....

.....

.....

(c) 20.0 cm^3 of solution **B** was added to excess aqueous potassium iodide solution and the volume made up to 250 cm^3. The following reaction occurred:

$$2Cu^{2+}(aq) + 4I^-(aq) \rightarrow 2CuI(s) + I_2(aq)$$

25.0 cm^3 samples of the resulting mixture were titrated with 0.120 mol dm^{-3} sodium thiosulfate solution. The mean titre was 17.85 cm^3.

(i) Complete the ionic equation for the reaction of thiosulfate ions with iodine. State symbols are not required.

(1)

$$2S_2O_3^{2-} + I_2 \rightarrow \text{.....} + \text{.....}$$

(ii) Calculate the concentration of solution **B**, in mol dm^{-3}.

(3)

(Total for Question 2 = 8 marks)

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3 An ester is hydrolysed in the presence of an acid catalyst forming a carboxylic acid and an alcohol **C**. The alcohol contains four carbon atoms.

In order to investigate the kinetics of this reaction, two solutions, **X** and **Y**, were made up.

Solution **X**: 100 cm^3 of a 0.20 mol dm^{-3} solution of the ester
Solution **Y**: 100 cm^3 of a 0.20 mol dm^{-3} solution of hydrochloric acid

Flasks containing the two solutions were placed in a water bath at 50 °C and when both solutions had reached the temperature of the water bath, the solutions were mixed and a clock started. As soon as the clock was started, a 10 cm^3 sample was taken from the reaction mixture, transferred to a cooled conical flask and titrated with 0.050 mol dm^{-3} sodium hydroxide solution. Other samples were taken at two minute intervals and analysed in the same way.

Results:

Time/min	0	2	4	6	8	10	12	14	16
Titre/cm^3	20.0	23.4	26.2	28.5	30.5	32.1	33.4	34.5	35.5
V = (40 – titre)/cm^3	20.0	16.6	13.8	11.5	9.5	7.9	6.6	5.5	4.5

V is directly proportional to the concentration of the ester remaining in the solution.

(a) Why was each sample cooled before titration?

(1)

.....

(b) Two indicators are available for the titrations: phenolphthalein and methyl orange.
Which one should be used? Give a reason for your answer.

(1)

Indicator .....

Reason .....

.....

(c) (i) Explain why the titre at time zero is 20.0 cm^3 rather than 0.0 cm^3. No calculation is required.

(1)

.....

(ii) Explain why the titre increases as the reaction proceeds.

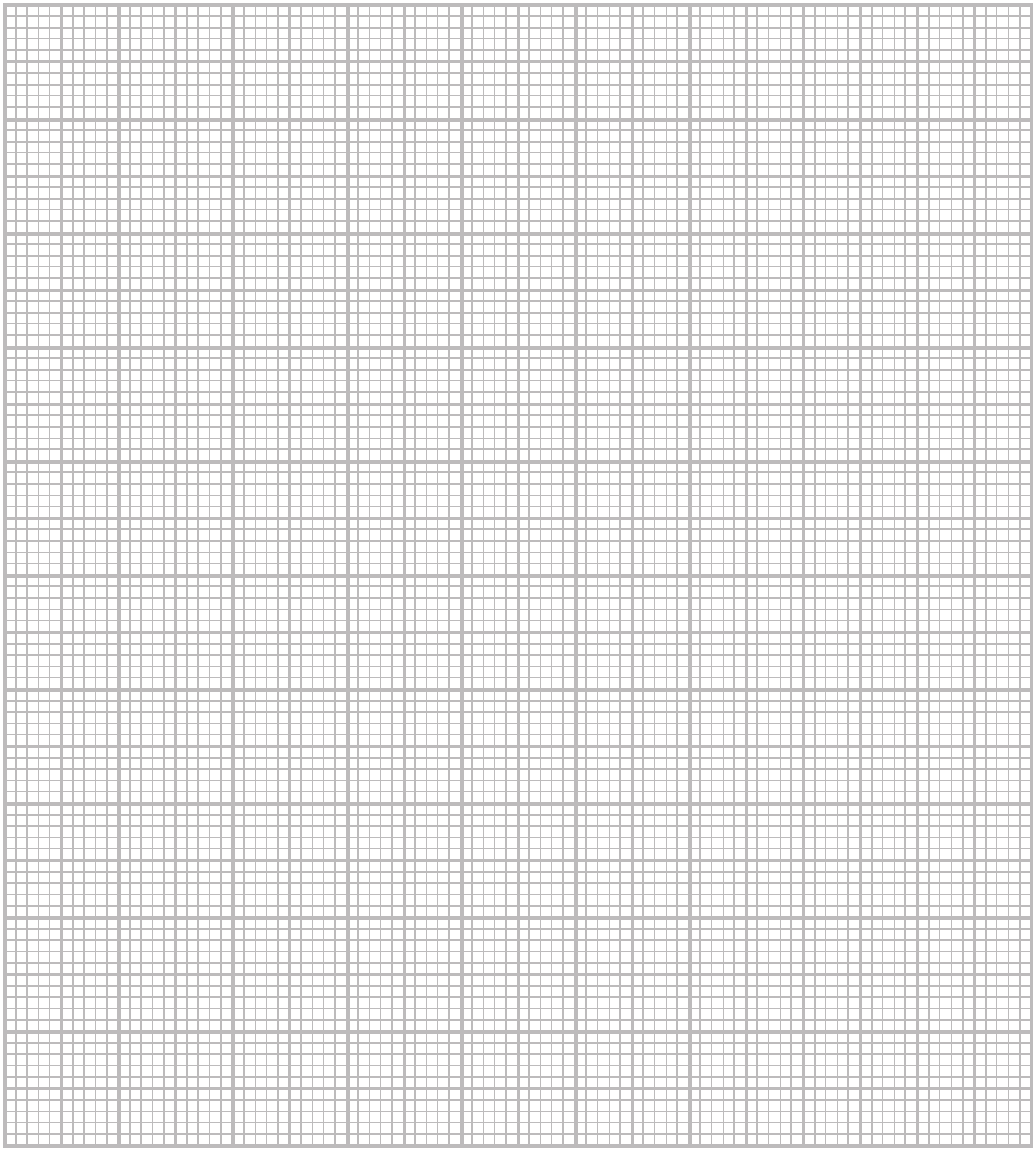
(1)

.....

.....

(d) Plot a graph of **V** on the vertical axis against time on the horizontal axis. Use your graph to determine the order of the reaction by measuring two successive half-lives.

(4)



First half-life .....

Second half-life .....

Order .....

(e) The alcohol **C** is oxidized using potassium dichromate(VI) and dilute sulfuric acid. State the colour change observed.

(1)

From ..... To .....

(f) The oxidation results in the formation of either a carboxylic acid or a ketone.

(i) Suggest a chemical test that could be used to show that the purified product is a carboxylic acid.

Give the observation that you would make when this test is carried out.

(2)

Reagent .....

Observation .....

.....

(ii) Suggest a chemical test that could be used to show that the purified product is a ketone.

Give the observation that you would make when this test is carried out.

(2)

Reagent .....

Observation .....

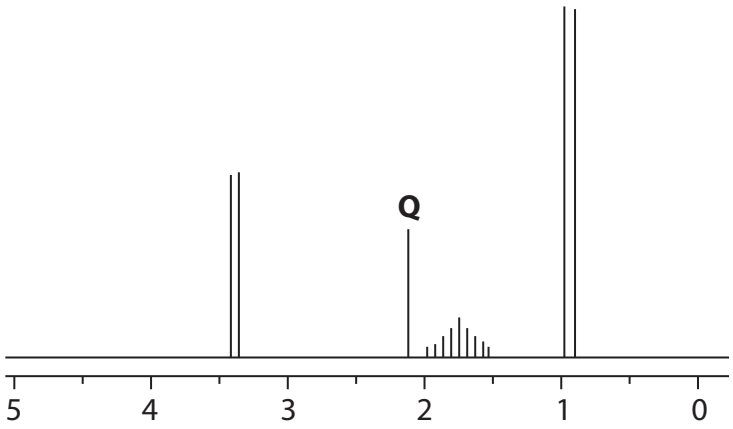
.....

(g) Tests show that **C** is oxidized to a carboxylic acid. What type of alcohol is **C**?

(1)

.....

(h) A simplified nmr spectrum for alcohol **C** is shown below:



(i) What can you conclude from the fact that there are four sets of peaks?

(1)

.....

.....

(ii) Using your answers to (g) and (h)(i), and the fact that alcohol **C** contains four carbon atoms, draw the displayed formula of alcohol **C**.

(1)

(iii) On the displayed formula you have drawn in (h)(ii), circle the atom or group of atoms responsible for the peak labelled **Q**.

(1)

(Total for Question 3 = 17 marks)

4 This question concerns the preparation of an ester, 3-methylbutyl ethanoate. The ester can be produced by the reaction of 3-methylbutan-1-ol and ethanoic anhydride:

$$C_5H_{11}OH + (CH_3CO)_2O \rightarrow CH_3COOC_5H_{11} + CH_3CO_2H$$

Reagents

- 3-methylbutan-1-ol [molar mass = 88.0 g mol^{-1}; density = 0.81 g cm^{-3}]
- ethanoic anhydride

Required product

- 3-methylbutyl ethanoate

  [molar mass = 130.0 g mol^{-1}; boiling temperature = 142 °C]

Safety information

- 3-methylbutan-1-ol is highly flammable
- 3-methylbutyl ethanoate is highly flammable
- ethanoic anhydride is corrosive, causing skin blistering and peeling

The steps of the experimental procedure are as follows:

Step 1 Place 10.0 cm^3 of 3-methylbutan-1-ol in a flask and add a few anti-bumping granules.

Step 2 Set up the apparatus for reflux. Pour 12.5 cm^3 of ethanoic anhydride (a slight excess) down the condenser. Warm the mixture until the reaction starts and then reflux gently for five minutes. Allow the mixture to cool.

Step 3 Transfer the cooled mixture to a separating funnel, leaving the anti-bumping granules in the flask. Add about 25 cm^3 of water and shake the mixture. Allow the two layers to separate and discard the lower aqueous layer. The addition of water converts any unreacted ethanoic anhydride into ethanoic acid.

Step 4 Add about 10 cm^3 of aqueous sodium hydrogencarbonate to the separating funnel and shake carefully. When the vigorous effervescence has finished, insert the stopper and shake the funnel, frequently releasing the pressure. Repeat the washing with further quantities of aqueous sodium hydrogencarbonate until no more gas is produced. Discard the lower aqueous layer each time.

Step 5 Transfer the ester to a conical flask and shake the flask for five minutes with a suitable drying agent.

Step 6 Filter the dried ester directly into a flask. Set up the apparatus for simple distillation, adding a few anti-bumping granules to the flask. Distil off the ester.

(a) State **two** safety precautions, each related to a specific hazard of this experiment. You may assume that eye protection and laboratory coats are being worn and that the experiment was carried out in a fume cupboard.

(2)

Hazard 1 .....

Precaution 1 .....

Hazard 2 .....

Precaution 2 .....

(b) Draw a labelled diagram of the apparatus needed for heating under reflux in **Step 2**. You do not need to show stands or clamps.

(3)

(c) Why are anti-bumping granules added to the flask in **Step 1**?

(1)

.....

.....

(d) What is the purpose of adding aqueous sodium hydrogencarbonate in **Step 4**?

(1)

.....

.....

(e) In the following list of substances, only one would be a suitable drying agent to use in **Step 5**. Identify this drying agent, giving a reason for your choice:

(2)

- concentrated phosphoric(V) acid
- sodium hydroxide solid
- anhydrous sodium sulfate
- concentrated sulfuric acid

Drying agent .....

Reason .....

.....

(f) In **Step 6**, the ester is distilled off. Suggest a suitable temperature range over which to collect the ester.

(1)

From .....°C to .....°C

(g) (i) Calculate the maximum mass of 3-methylbutyl ethanoate that could be obtained in this experiment from 10 cm^3 of 3-methylbutan-1-ol. Give your answer to **three** significant figures.

(3)

(ii) A student carried out the synthesis and obtained 9.45 g of 3-methylbutyl ethanoate. Calculate the percentage yield.

(2)

(Total for Question 4 = 15 marks)

TOTAL FOR PAPER = 50 MARKS

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The Periodic Table of Elements

1	2											3	4	5	6	7	0 (8) (18)
							1.0 H hydrogen 1										4.0 He helium 2
(1)	(2)		Key									(13)	(14)	(15)	(16)	(17)	
6.9 Li lithium 3	9.0 Be beryllium 4		relative atomic mass atomic symbol name atomic (proton) number									10.8 B boron 5	12.0 C carbon 6	14.0 N nitrogen 7	16.0 O oxygen 8	19.0 F fluorine 9	20.2 Ne neon 10
23.0 Na sodium 11	24.3 Mg magnesium 12	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	27.0 Al aluminium 13	28.1 Si silicon 14	31.0 P phosphorus 15	32.1 S sulfur 16	35.5 Cl chlorine 17	39.9 Ar argon 18
39.1 K potassium 19	40.1 Ca calcium 20	45.0 Sc scandium 21	47.9 Ti titanium 22	50.9 V vanadium 23	52.0 Cr chromium 24	54.9 Mn manganese 25	55.8 Fe iron 26	58.9 Co cobalt 27	58.7 Ni nickel 28	63.5 Cu copper 29	65.4 Zn zinc 30	69.7 Ga gallium 31	72.6 Ge germanium 32	74.9 As arsenic 33	79.0 Se selenium 34	79.9 Br bromine 35	83.8 Kr krypton 36
85.5 Rb rubidium 37	87.6 Sr strontium 38	88.9 Y yttrium 39	91.2 Zr zirconium 40	92.9 Nb niobium 41	95.9 Mo molybdenum 42	[98] Tc technetium 43	101.1 Ru ruthenium 44	102.9 Rh rhodium 45	106.4 Pd palladium 46	107.9 Ag silver 47	112.4 Cd cadmium 48	114.8 In indium 49	118.7 Sn tin 50	121.8 Sb antimony 51	127.6 Te tellurium 52	126.9 I iodine 53	131.3 Xe xenon 54
132.9 Cs caesium 55	137.3 Ba barium 56	138.9 La* lanthanum 57	178.5 Hf hafnium 72	180.9 Ta tantalum 73	183.8 W tungsten 74	186.2 Re rhenium 75	190.2 Os osmium 76	192.2 Ir iridium 77	195.1 Pt platinum 78	197.0 Au gold 79	200.6 Hg mercury 80	204.4 Tl thallium 81	207.2 Pb lead 82	209.0 Bi bismuth 83	[209] Po polonium 84	[210] At astatine 85	[222] Rn radon 86
[223] Fr francium 87	[226] Ra radium 88	[227] Ac* actinium 89	[261] Rf rutherfordium 104	[262] Db dubnium 105	[266] Sg seaborgium 106	[264] Bh bohrium 107	[277] Hs hassium 108	[268] Mt meitnerium 109	[271] Ds darmstadtium 110	[272] Rg roentgenium 111							

Elements with atomic numbers 112-116 have been reported but not fully authenticated

* Lanthanide series

* Actinide series

140 Ce cerium 58	141 Pr praseodymium 59	144 Nd neodymium 60	[147] Pm promethium 61	150 Sm samarium 62	152 Eu europium 63	157 Gd gadolinium 64	159 Tb terbium 65	163 Dy dysprosium 66	165 Ho holmium 67	167 Er erbium 68	169 Tm thulium 69	173 Yb ytterbium 70	175 Lu lutetium 71
232 Th thorium 90	[231] Pa protactinium 91	238 U uranium 92	[237] Np neptunium 93	[242] Pu plutonium 94	[243] Am americium 95	[247] Cm curium 96	[245] Bk berkelium 97	[251] Cf californium 98	[254] Es einsteinium 99	[253] Fm fermium 100	[256] Md mendelevium 101	[254] No nobelium 102	[257] Lr lawrencium 103