Write your name here

Surname	Other names

Centre Number | | | | | |

Candidate Number | | | | |

Edexcel GCE

Chemistry

Advanced

Unit 6B: Chemistry Laboratory Skills II Alternative

Tuesday 7 June 2011 – Morning
Time: 1 hour 15 minutes

Paper Reference
6CH08/01

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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P 3 8 4 8 1 A 0 1 1 2

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

1 Solid **W** is a blue salt containing a transition metal complex cation and one anion.

(a) Give the formulae of **two** different transition metal ions which can form blue complex cations.

(2)

.....

(b) Complete the following table.

	Test	Observation	Inference(s)	
(i)	Heat compound **W**.	.....	Water	**(1)**
(ii)	Test any gas evolved with moist red litmus paper.	Red litmus paper turns blue	.....	**(1)**

(iii) Suggest **two** sources of the water which was given off when a pure dry sample of **W** was heated.

(2)

.....

.....

(c) The following tests are carried out on **separate** portions of an aqueous solution of **W**.

Complete the table.

Note: in the third column, the **formula** of the ion, molecule or compound giving rise to the observation is required.

	Test	Observation	**Formula**	
(i)	Add concentrated hydrochloric acid slowly,	..... -coloured precipitate	$Cu(OH)_2$	**(1)**
	until in excess.	green-yellow solution	.....	**(1)**
(ii)	Acidify with dilute hydrochloric acid and then add barium chloride solution.	white precipitate	.....	**(1)**
(iii)	Add dilute sulfuric acid until the solution is pale blue; then add potassium iodide solution.	white precipitate	.....	**(1)**
		in a brown solution	.....	**(1)**

(d) Suggest the **formula** of the complex cation in an aqueous solution of compound **W**.

(1)

.....

(Total for Question 1 = 12 marks)

2 The tertiary halogenoalkane 2-chloro-2-methylpropane reacts with hydroxide ions in solution as follows:

$$(CH_3)_3CCl + OH^- \rightarrow (CH_3)_3COH + Cl^-$$

The progress of the reaction can be followed by titrating the reaction mixture with a solution of hydrochloric acid of known concentration.

In an experiment designed to determine the order of the reaction, the following procedure was used.

1. 250 cm^3 of an ethanolic solution of 2-chloro-2-methylpropane, of concentration 0.100 mol dm^{-3}, was placed in a flask in a water bath at 25 °C. 250 cm^3 of aqueous sodium hydroxide solution, also of concentration 0.100 mol dm^{-3}, was placed in a similar flask in the same water bath. The temperature of the solutions was allowed to reach 25 °C.
2. A series of conical flasks were prepared, each containing about 40 cm^3 of propanone.
3. The reaction was started by mixing the halogenoalkane solution and the sodium hydroxide solution in a large flask in the water bath. A clock was started as the solutions were mixed.
4. At intervals, a 25 cm^3 pipette was used to withdraw samples of the reaction mixture. Each sample was added to a flask containing propanone and the time was noted. The propanone slows but does not completely stop the reaction.
5. Each sample was titrated immediately with a solution of hydrochloric acid of concentration 0.0500 mol dm^{-3}, using methyl orange as the indicator.

(a) (i) What colour change would you see at the end point of the titration?

(1)

.....

(ii) Explain why it is necessary to titrate the samples **immediately** after they have been withdrawn from the reaction mixture. State the effect, if any, on the titre if this were not done.

(2)

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.....

.....

(b) Suggest why it is necessary to use a solvent of aqueous ethanol rather than water alone for this reaction.

(1)

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.....

.....

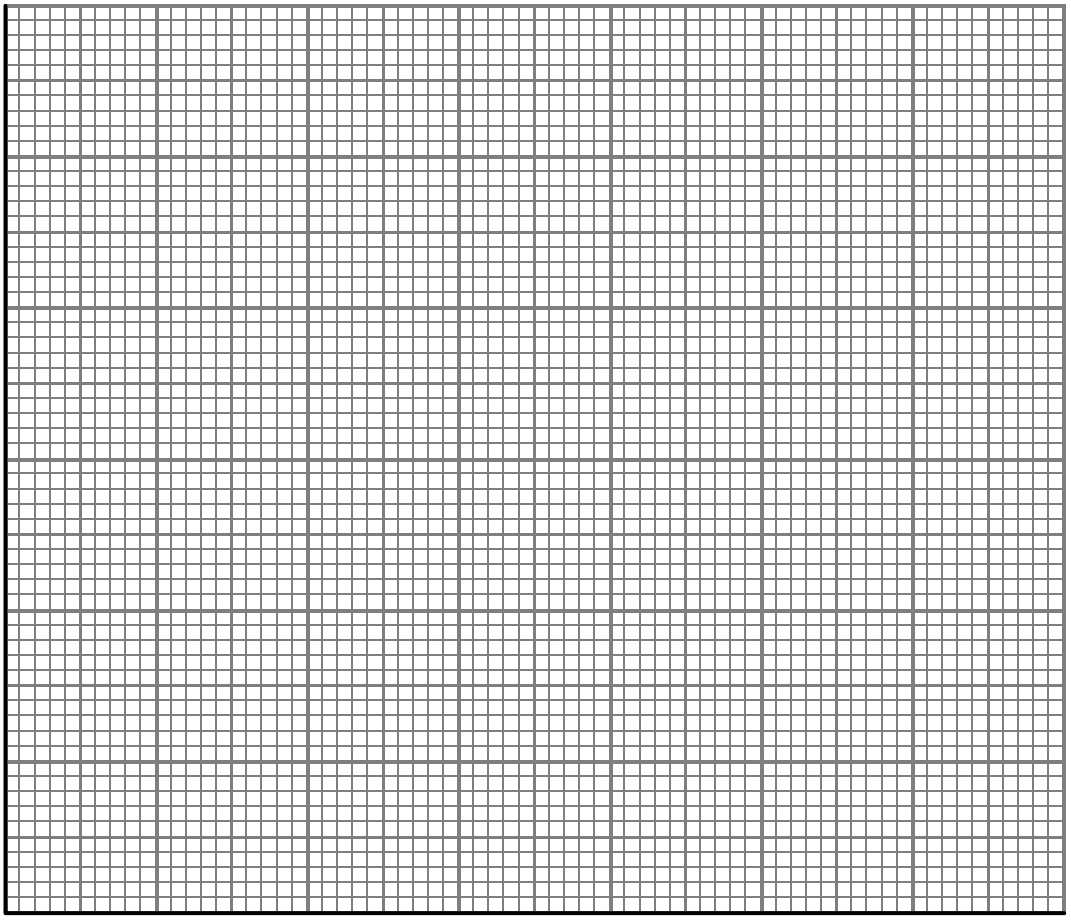
(c) In an experiment which was carried out as described above, the following data were obtained.

Time/min	1	5	12	20	32	49	65
Volume of HCl/cm^3	25.5	22.5	18.5	15.5	11.5	8.0	5.5

(i) Using the axes below, plot a suitable graph of these data.

(2)

Volume of HCl/cm^3



Time/min

(ii) Show **two** successive half-life measurements on your graph and write their values below.

(2)

First half-life .....

Second half-life .....

(iii) Explain how your answers to (ii) show that this reaction is first order.

(1)

.....

.....

(iv) Give the units of the rate constant for this reaction.

(1)

.....

(v) Because the initial concentrations of the reactants are the same, it is not possible to tell whether the rate equation is of the form

$$\text{rate} = k[(CH_3)_3CCl]$$

or of the form $\text{rate} = k[OH^-]$

Suggest a further experiment which could be carried out to show that it is in fact first order with respect to the halogenoalkane.

(2)

.....

.....

.....

(d) In a further experiment to investigate the hydrolysis, a solution of 2-chloro-2-methylpropane in aqueous ethanol was prepared at room temperature. The pH of this solution was measured at intervals using narrow-range pH paper. The reaction occurring is

$$(CH_3)_3CCl + H_2O \rightarrow (CH_3)_3COH + H^+ + Cl^-$$

(i) Suggest what the initial pH of the mixture would be. Justify your answer.

(1)

.....

.....

(ii) The pH rapidly falls to 2 or lower. Explain why this confirms that the rate of the hydrolysis of 2-chloro-2-methylpropane is independent of the hydroxide ion concentration in the reaction

$$(CH_3)_3CCl + OH^- \rightarrow (CH_3)_3COH + Cl^-$$

(2)

(iii) Assuming that the reaction rate follows the rate equation

$$\text{rate} = k[(CH_3)_3CCl]$$

write the equation for the rate-determining step.

(2)

(Total for Question 2 = 17 marks)

3 Propyl ethanoate is an ester which has a smell similar to that of bananas or pears. It can be made in the laboratory from propan-1-ol and ethanoic acid. The equation for the reaction is

$$CH_3COOH + CH_3CH_2CH_2OH \rightleftharpoons CH_3COOCH_2CH_2CH_3 + H_2O$$

Procedure

1. Propan-1-ol (50 cm^3) and ethanoic acid (50 cm^3) are mixed thoroughly in a 250 cm^3 round-bottomed flask.
2. Concentrated sulfuric acid (10 cm^3) is added drop by drop to the mixture, keeping the contents of the flask well-shaken and cooled in an ice-water bath.
3. When the acid has all been added, a reflux condenser is fitted to the flask and the mixture gently boiled over an electric heating mantle for about 30 minutes.
4. The mixture is cooled, and the apparatus rearranged for distillation. The crude ester (about 60 cm^3) is distilled off.
5. The distillate is placed in a separating funnel and shaken with about half its volume of 30% sodium carbonate solution, with the pressure being released at intervals. The lower aqueous layer is then discarded.
6. The crude ester is shaken in a separating funnel with about half its volume of 50% calcium chloride solution, which removes unreacted alcohol. The lower layer is discarded.
7. The ester is run into a clean, dry flask containing some anhydrous calcium chloride and swirled.
8. The ester is filtered into a clean, dry flask, with a few anti-bumping granules, and distilled. The fraction boiling between 100 °C and 103 °C is collected.

(a) (i) Explain why the concentrated sulfuric acid is added slowly with **cooling**.

(1)

.....

.....

.....

(ii) Explain why the mixture is heated **under reflux** for **about 30 minutes**.

(2)

Under reflux .....

.....

For about 30 minutes .....

.....

(iii) What is the **main** function of the sulfuric acid in this reaction?

(1)

(iv) Suggest the identity of **two** impurities that might be present in the crude distillate from step 4.

(2)

(v) What data would you need about propyl ethanoate to be sure that the instruction in step 5 to discard the lower layer is correct?

(1)

(vi) Step 5 requires that you release the pressure at intervals. Explain why the pressure in the funnel increases.

(2)

(vii) Explain why anhydrous calcium chloride is added in step 8 and state how the appearance of the liquid changes when this stage is complete.

(2)

(viii) What is the reason for adding anti-bumping granules in step 8?

(1)

(b) (i) Use the data in the table below to show, by calculating the numbers of moles, which reactant is in excess.

(2)

Substance	Density / g cm^{-3}	Molar mass / g mol^{-1}
Ethanoic acid	1.05	60.1
Propan-1-ol	0.804	60.1

(ii) The mass of the ester collected was 35.0 g. Calculate the percentage yield of the ester propyl ethanoate.

Assume the molar mass of propyl ethanoate is 102 g mol^{-1}.

(2)

(c) A student who carried out this experiment, according to the instructions, obtained a product that boiled at 95 °C. The student suspected that the alcohol originally provided was not propan-1-ol, but was 2-methylpropan-2-ol, since that would have given an ester with this boiling temperature.

(i) Draw the structural formula for the ester that is formed from the reaction of ethanoic acid with 2-methylpropan-2-ol.

(1)

(ii) Suggest a simple test-tube experiment that the student could carry out on the original alcohol to see if the suspicion could be correct. Give the reagents used and the expected result for both propan-1-ol and 2-methylpropan-2-ol. Explain why the results are different.

(4)

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(Total for Question 3 = 21 marks)

TOTAL FOR PAPER = 50 MARKS

The Periodic Table of Elements

1	2											3	4	5	6	7	0 (8)
							1.0 H hydrogen 1										(18) 4.0 He helium 2
(1)	(2)		Key: relative atomic mass / atomic symbol / name / atomic (proton) number									(13)	(14)	(15)	(16)	(17)	
6.9 Li lithium 3	9.0 Be beryllium 4											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

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

* Lanthanide series

* Actinide series