Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number

Candidate Number

Pearson Edexcel International Advanced Level

Time 1 hour 20 minutes

Paper reference **WCH16/01**

Chemistry

International Advanced Level
UNIT 6: Practical Skills in Chemistry II

You must have:
Scientific calculator, ruler

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B).
- **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.
- Show all your working in calculations and include units where appropriate.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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Pearson

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

1 Solution **A** and solution **B** are aqueous solutions.
The compound in each solution contains one cation and one anion.
The cations are different but the anions are the same.
Both solutions are green.

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

(2)

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(b) A student added dilute aqueous sodium hydroxide, drop by drop, to samples of each solution.
Initially a green precipitate formed in both solutions.

More aqueous sodium hydroxide was added until the sodium hydroxide was present in excess.
The precipitate produced from solution **A** was insoluble and turned brown on standing.
The precipitate produced from solution **B** dissolved to give a dark green solution **C**.

(i) Give the formula of the green precipitate from solution **A**.

(1)

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(ii) Give the formula of the species responsible for the dark green colour in solution **C**.

(1)

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(c) The student added hydrogen peroxide solution to **C** and warmed the mixture, which turned yellow. The yellow solution was boiled to remove excess hydrogen peroxide, cooled and then pure ethanoic acid was added, drop by drop. The yellow solution gradually turned orange.

(i) State the type of reaction involved when the dark green solution turned yellow.

(1)

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(ii) Identify, by name or formula, the ion responsible for the final orange colour of the solution.

(1)

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(iii) Pure ethanoic acid is corrosive.

Identify the appropriate control measure to reduce the risk associated with this hazard.
Assume the student carried out the addition in a fume cupboard, wearing safety glasses and a lab coat.

(1)

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(iv) Describe the corrosive hazard label present on a bottle containing pure ethanoic acid. You may use a diagram in your answer.

(2)

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(d) The student attempted to identify the anion present in the green solution **A**.
The student added dilute nitric acid and a few drops of aqueous silver nitrate to about 2 cm^3 of solution **A**.
A pale precipitate formed, which the student thought might be white or cream coloured.

(i) Identify, by name or formula, **two** anions which might give this precipitate.

(1)

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(ii) The precipitate formed in (d)(i) was separated from the mixture and aqueous ammonia was added.

Describe how this test allows the student to distinguish between the two anions.

(2)

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(iii) Explain why, with solution **A**, the precipitate must be separated before adding aqueous ammonia.

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(Total for Question 1 = 14 marks)

2 The reaction between the tertiary halogenoalkane 2-chloro-2-methylpropane and hydroxide ions to form 2-methylpropan-2-ol is shown.

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

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

An experiment to determine the order of the reaction was carried out.

Procedure

Step **1** A flask containing 250 cm^3 of an ethanolic solution of 2-chloro-2-methylpropane, with a concentration 0.100 mol dm^{-3}, was placed in a water bath at 25 °C.
A similar flask, containing 250 cm^3 of aqueous sodium hydroxide, with a concentration 0.100 mol dm^{-3}, was placed in the same water bath.
The temperature of each solution was allowed to reach 25 °C.

Step **2** Seven conical flasks were prepared, each containing about 50 cm^3 of propanone.

Step **3** The reaction was started by mixing the two solutions from the water bath in a large flask. The flask was returned to the water bath.
A timer was started as the solutions were mixed.

Step **4** At intervals, 25.0 cm^3 samples of the reaction mixture were transferred to a conical flask containing propanone. The time was noted.

Step **5** Each sample was immediately titrated with a solution of hydrochloric acid, of concentration 0.0500 mol dm^{-3}, using methyl orange as the indicator.

(a) (i) Give the expected colour **change** at the end-point.

(1)

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(ii) Explain the effect on the volume of hydrochloric acid required if the titration was not carried out immediately after Step **4**.

(2)

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(iii) Explain how the use of aqueous ethanol in the reaction mixture allows the reaction in Step **3** to proceed at a relatively fast rate.
A description of the forces involved is not required.

(2)

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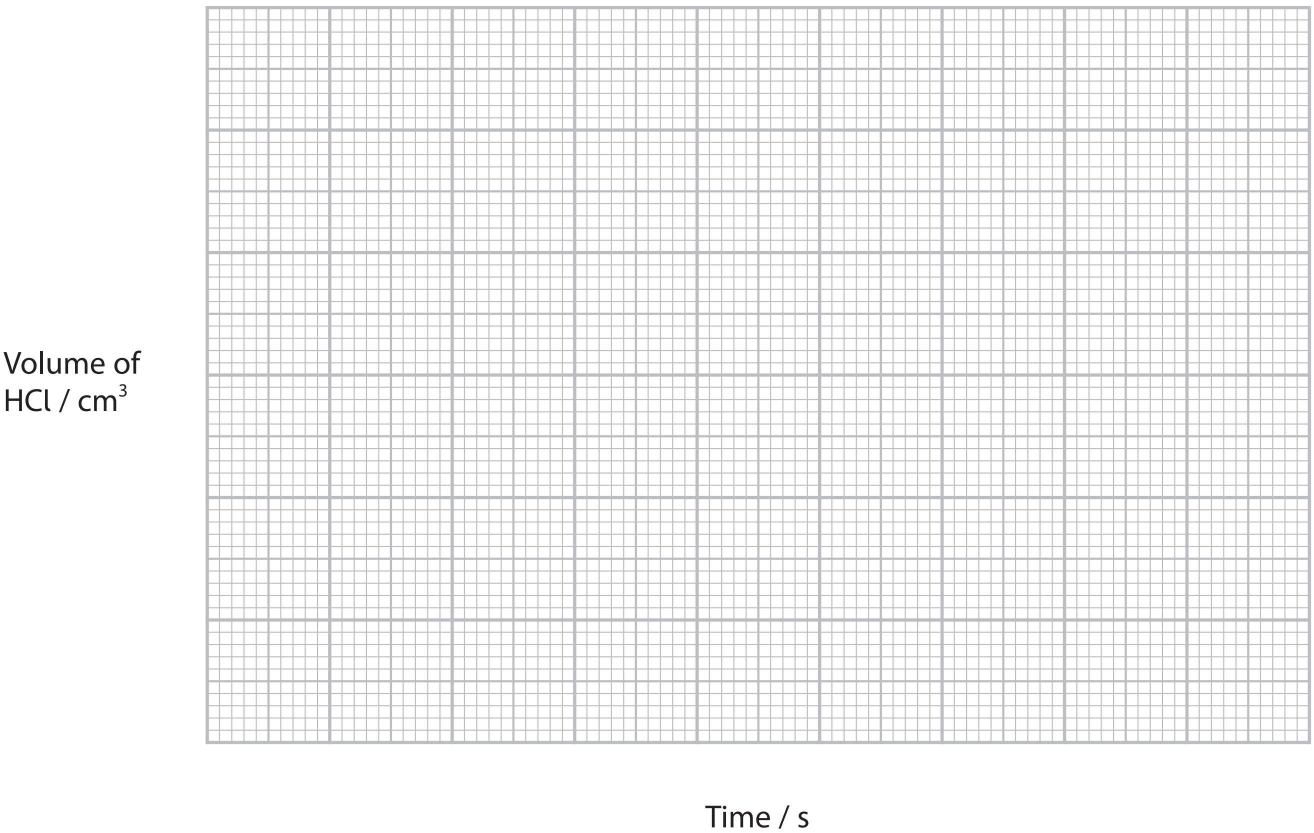
(b) An experiment was carried out using this procedure. The results are shown.

Time / s	50	320	750	1200	2050	3180	4020
Volume of HCl / cm^3	24.5	22.0	18.5	15.5	11.0	7.0	5.0

(i) Plot a graph of the data using the axes given.

(2)



(ii) Determine two successive half-lives for the reaction.
You must show your working on the graph.

(2)

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(iii) State the order of this reaction. Justify your answer.

(1)

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(Total for Question 2 = 10 marks)

3 Moss in lawns can be treated with 'lawn sand', a mixture that contains sand and a double salt, ammonium iron(II) sulfate, $(NH_4)_2Fe(SO_4)_2{\cdot}6H_2O$.
The percentage by mass of Fe^{2+} in the mixture can be found by titration with a solution of potassium manganate(VII) of known concentration.

Procedure

4.50 g of lawn sand was accurately weighed in a 250 cm^3 conical flask.
The sample was shaken with 50 cm^3 of dilute sulfuric acid (an excess).
The resulting mixture was titrated with potassium manganate(VII) solution of concentration 0.0200 mol dm^{-3}.
The titration volume was 40.35 cm^3.

(a) (i) State what would happen in the titration if the mixture was **not** acidified.

(1)

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(ii) Neither hydrochloric acid nor nitric acid can be used to acidify the titration mixture.

For each acid give a reason why it cannot be used.

(2)

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(b) The ionic half-equations for the reactions of the iron(II) ions and the manganate(VII) ions are shown.

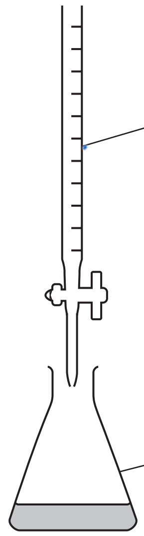
$$Fe^{2+} \rightarrow Fe^{3+} + e^-$$

$$MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$$

Calculate the percentage by mass of Fe^{2+} in the sample of lawn sand.

(4)

(c) The titration is carried out using the apparatus shown.



At the end-point, the solution changes to a permanent pale pink.

To repeat the experiment, the burette is refilled with potassium manganate(VII) and the procedure carried out again.

Give **three** ways in which a titration is carried out to give the most accurate possible burette reading.

Assume that the equipment is the same, the burette is clamped in a vertical position and that the titration volumes are read at eye level from the bottom of the meniscus.

(3)

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(Total for Question 3 = 10 marks)

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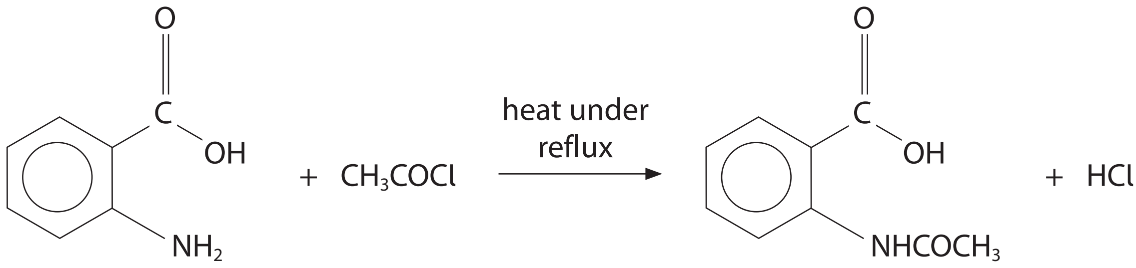
4 The compound 2-ethanoylaminobenzoic acid can be prepared by the reaction of 2-aminobenzoic acid and ethanoyl chloride.



2-aminobenzoic acid ethanoyl chloride 2-ethanoylaminobenzoic acid

Procedure

Step **1** Add 5.00 g of 2-aminobenzoic acid and a few anti-bumping granules to a dry 100 cm^3 pear-shaped flask and fit a reflux condenser.

Step **2** Add 10 cm^3 of ethanoyl chloride (an excess) by pouring it slowly down the condenser.

Step **3** Gradually bring the mixture to boil and heat under reflux for 15 minutes.

Step **4** Allow the mixture to cool and slowly add 10 cm^3 of water down the condenser.

Step **5** Heat the solution slowly until boiling.

Step **6** Allow the solution to cool to room temperature.

Step **7** Collect the crystals of 2-ethanoylaminobenzoic acid by filtration under reduced pressure.

Step **8** Recrystallise the impure product from a mixture containing equal volumes of ethanoic acid and water.

(a) Give **two** reasons why it is often necessary to heat a reaction under reflux as in Step **3**.

(2)

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(b) Explain why, in Step **4**, water is added **slowly** to the cooled solution.

(2)

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(c) Draw a labelled diagram of the apparatus used for filtration under reduced pressure in Step **7**.

(3)

(d) The melting temperature may be used to confirm the identity of the crystals.

(i) Draw a labelled diagram of the apparatus you would use to measure the melting temperature.

(2)

(ii) State how this melting temperature determination would show that a pure sample of 2-ethanoylaminobenzoic acid had been prepared.

(2)

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(e) Show by calculation that, in the preparation, 10 cm^3 of ethanoyl chloride is an excess compared to 5.00 g of 2-aminobenzoic acid.

Data

Molar mass / g mol^{-1}	CH_3COCl = 78.5	$C_6H_4(NH_2)COOH$ = 137
Density / g cm^{-3}	CH_3COCl = 1.1	

(2)

(f) A student carried out the preparation using the amounts of reagents given in (e) and obtained a yield of 56.7 % of 2-ethanoylaminobenzoic acid.

Calculate the mass of 2-ethanoylaminobenzoic acid obtained.

(3)

(Total for Question 4 = 16 marks)

TOTAL FOR PAPER = 50 MARKS

The Periodic Table of Elements

Key

relative atomic mass **atomic symbol** name atomic (proton) number

1 (1)	2 (2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	3 (13)	4 (14)	5 (15)	6 (16)	7 (17)	0 (8) (18)
							1.0 **H** hydrogen 1										4.0 **He** helium 2
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											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	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
* Actinide series	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