Pearson Edexcel International Advanced Level

Monday 8 June 2026

Morning (Time: 1 hour 20 minutes)

Paper reference **WCH16/01A**

Chemistry

International Advanced Level

UNIT 6: Practical Skills in Chemistry II

Question Paper

You must have:
Answer Book (sent separately)
Scientific calculator, ruler

Turn over ▶

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Answer ALL questions.

Write your answers in the spaces provided in the Answer Book.

1 Compound **X** is a pink crystalline solid containing one transition metal cation and a sulfate anion.
A student investigates some reactions of **X**.

Procedure

Step **1** A sample of **X** is dissolved in deionised water.
The solution formed is divided into three test tubes.

Step **2** A few drops of dilute aqueous sodium hydroxide are added to the first test tube.

Step **3** Excess aqueous ammonia is added to the second test tube, which is then left to stand in air.

Step **4** A test to confirm the presence of the sulfate anion is carried out on the solution in the third test tube.

(a) A pink solution forms in Step **1**, which changes to a blue precipitate in Step **2**.

(i) Give the **formula** of the complex ion in the pink solution.

(1)

(ii) Name the type of reaction that occurs when the blue precipitate forms.

(1)

(b) In Step **3**, an ammine complex forms and the colour of the solution darkens on standing.

(i) Give the colour of the ammine complex that forms **initially**.

(1)

(ii) Suggest why the colour of the solution darkens.

(1)

(c) Describe the test **and** the expected positive result in Step **4**.

(2)

(Total for Question 1 = 6 marks)

2 The concentration of chloride ions in seawater can be determined by titration with silver nitrate solution, $AgNO_3(aq)$.
A sodium chromate(VI) solution is used as an indicator.
A student follows the procedure shown.

Procedure

Step **1** Filter the seawater to remove solid material.

Step **2** Prepare a diluted sample by pipetting 20.0 cm^3 of the filtered seawater into a 100 cm^3 volumetric flask. Make up to the mark with deionised water.

Step **3** Add 10.0 cm^3 of the diluted seawater sample to a conical flask containing a few drops of indicator.

Step **4** Titrate the flask contents with 0.100 mol dm^{-3} silver nitrate solution. Record the titre volume at the end-point, when a red-brown precipitate of silver chromate(VI) forms.

(a) Explain why the filtered seawater is diluted in Step **2**, before titrating with silver nitrate solution.

(2)

(b) State what would be seen when silver nitrate solution is added to the conical flask in Step **4**, **before** the end-point is reached.

(1)

(c) Write the ionic equation for the formation of the red-brown precipitate in Step **4**. Include state symbols.

(1)

(d) A student obtained a mean titre of 10.20 cm^3 in this titration.

Calculate the concentration, in **mg dm^{-3}**, of chloride ions in the **undiluted** filtered seawater.

Give your answer to an appropriate number of significant figures.

(5)

(e) The student intends to use the same method to determine the concentration of chloride ions in tap water used for drinking.

State whether or not this method would be valid. Justify your answer.

(2)

(Total for Question 2 = 11 marks)

3 This question is about the use of acidified potassium manganate(VII), $KMnO_4(aq)$.

(a) Redox reactions with acidified potassium manganate(VII) can be used to investigate reaction kinetics.
An initial rates method to investigate the rate of oxidation of a solution of glucose, $C_6H_{12}O_6$, is shown.

Procedure

Step **1** Known volumes of glucose solution, sulfuric acid and deionised water are added to a conical flask.

Step **2** A known volume of potassium manganate(VII) solution is added to the flask. The mixture is swirled and a timer is started.

Step **3** The time taken for the mixture to change from pink to colourless is recorded.

The procedure is repeated using different volumes of reactants, as shown in Table **1**.

The rate of reaction is determined by calculating the volume of potassium manganate(VII) solution, $KMnO_4(aq)$ that reacts per second.

Table **1**

Run	Volume $C_6H_{12}O_6(aq)$ / cm^3	Volume $H_2SO_4(aq)$ / cm^3	Volume $KMnO_4(aq)$ / cm^3	Volume $H_2O(l)$ / cm^3	Time / s	Rate / $cm^3 s^{-1}$
A	20.0	15.0	5.0	0.0	43	0.116
B	20.0	15.0	2.5	2.5	41	0.061
C	10.0	15.0	2.5	12.5	45	
D	10.0	7.5	5.0	17.5	88	

(i) Suggest **two** reasons why a student used a burette, rather than a 10 cm^3 measuring cylinder, to measure the volume of potassium manganate(VII) solution.

(2)

(ii) Explain why water is added to the conical flask in runs **B**, **C** and **D**.

(2)

(iii) Complete the unshaded cells in Table **1** in the Answer Book.

(1)

(iv) Deduce the order with respect to each reactant, using data in Table **1**.

(2)

(b) Another student considered the method used in part (a). It was noted that changing the volumes used in run **D** would make it easier to deduce the order with respect to sulfuric acid, $H_2SO_4(aq)$.

Complete the unshaded cells in Table **2** in the Answer Book to show the volumes that would enable the order to be deduced, stating which run it is being compared to.

(2)

Table **2**

Run	Volume $C_6H_{12}O_6(aq)$ / cm^3	Volume $H_2SO_4(aq)$ / cm^3	Volume $KMnO_4(aq)$ / cm^3	Volume $H_2O(l)$ / cm^3
A	20.0	15.0	5.0	0.0
B	20.0	15.0	2.5	2.5
C	10.0	15.0	2.5	12.5
D				

(c) Another student investigates the oxidation of ethanedioic acid, $(COOH)_2$, by acidified potassium manganate(VII) to form a colourless solution.

Data related to redox half-equations for ethanedioic acid and species containing manganese are shown in Table **3**.

Table **3**

Right-hand electrode system	$E^{\ominus}$ / V
$2CO_2 + 2H^+ + 2e^- \rightleftharpoons (COOH)_2$	– 0.43
$MnO_4^- + 2H_2O + 3e^- \rightleftharpoons MnO_2 + 4OH^-$	+ 0.60
$MnO_2 + 4H^+ + 2e^- \rightleftharpoons Mn^{2+} + 2H_2O$	+ 1.23
$MnO_4^- + 8H^+ + 5e^- \rightleftharpoons Mn^{2+} + 4H_2O$	+ 1.51
$MnO_4^- + 4H^+ + 3e^- \rightleftharpoons MnO_2 + 2H_2O$	+ 1.70

(i) Show that the oxidation of ethanedioic acid by acidified potassium manganate(VII) is feasible.
Use **two** equations from Table **3**.

(2)

(ii) While carrying out trial oxidation experiments, the student notices a colour change. The purple solution changes to colourless solution with a dark precipitate, rather than just a colourless solution.

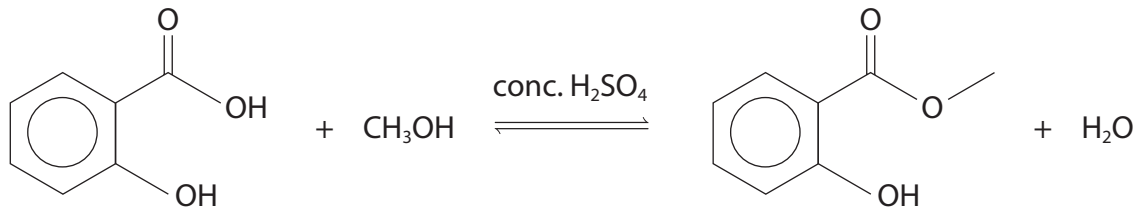
Suggest why the precipitate forms, using the data in Table **3**.

(2)

(Total for Question 3 = 13 marks)

4 Oil of wintergreen is an ingredient of creams used to treat joint pain.

It is synthesised by the reaction of 2-hydroxybenzoic acid with methanol, in the presence of concentrated sulfuric acid.



2-hydroxybenzoic acid oil of wintergreen

Part of the practical procedure is shown.

Procedure

Step **1** 9.00 g of 2-hydroxybenzoic acid, 15.0 cm^3 of methanol and 2.00 cm^3 of concentrated sulfuric acid are added to a round-bottomed flask.

Step **2** This mixture is heated under reflux for 1 hour.

Step **3** The contents of the round-bottomed flask are allowed to cool and then added to a separating funnel containing 30 cm^3 of deionised water.

Step **4** The round-bottomed flask is rinsed with ethyl ethanoate and the contents are added to the separating funnel.

(a) (i) Name the type of reaction that occurs in this synthesis.

(1)

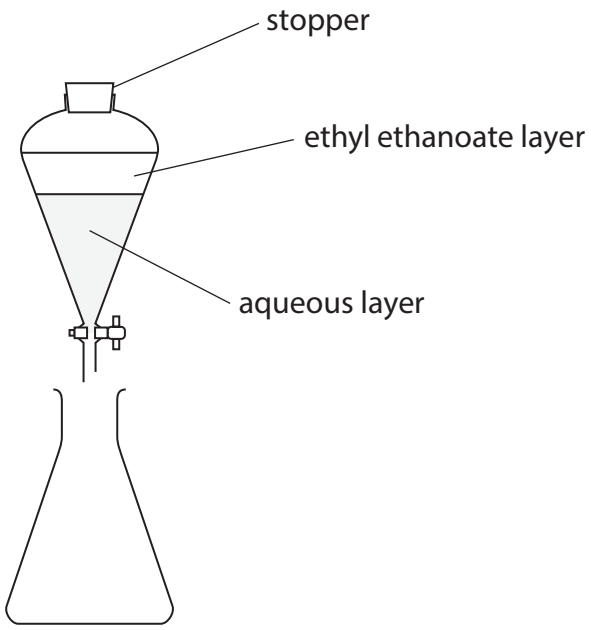
(ii) State the role of the concentrated sulfuric acid.

(1)

(b) Identify the risk of using a Bunsen burner to heat the reaction mixture in Step **2**. Justify your answer.

(2)

(c) The apparatus used at the end of Step **4** is shown.



Explain what would be **seen** when a student opens the tap of the separating funnel.

(2)

(d) The aqueous layer is removed.

Describe an experimental procedure to remove any sulfuric acid remaining in the ethyl ethanoate layer after Step **4**.

(4)

(e) The student pours the ethyl ethanoate layer into a conical flask, and then adds a drying agent.

(i) Name a suitable drying agent.

(1)

(ii) Describe how the student knows when sufficient drying agent has been added.

(1)

(f) The student separates the pure oil of wintergreen by distillation of the dry ethyl ethanoate layer.
The distillate is collected in the range 220–222 °C.

(i) Draw a labelled diagram of the apparatus used to distil off the oil of wintergreen in the Answer Book.

Diagrams of clamps and stands are **not** required.

(3)

(ii) The equation for the synthesis of oil of wintergreen is repeated here.

2-hydroxybenzoic acid oil of wintergreen

Show, by calculation, which is the limiting reagent when 9.00 g of 2-hydroxybenzoic acid and 15.0 cm^3 of methanol are used.

[Data: Density of methanol = 0.793 g cm^{-3}]

(3)

(iii) The mass of oil of wintergreen obtained is 2.52 g.

Calculate the percentage yield.

(2)

(Total for Question 4 = 20 marks)

TOTAL FOR PAPER = 50 MARKS

Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

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Morning (Time: 1 hour 20 minutes)

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Chemistry

International Advanced Level
UNIT 6: Practical Skills in Chemistry II
Answer Book

You must have:
Question Paper (sent separately)
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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P 8 7 9 2 9 A 0 1 1 6

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

1 (a) (i)

(1)

1 (a) (ii)

(1)

1 (b) (i)

(1)

1 (b) (ii)

(1)

1 (c)

(2)

(Total for Question 1 = 6 marks)

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2 (a)

(2)

2 (b)

(1)

2 (c)

(1)

2 (d)

(5)

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2 (e)

(2)

(Total for Question 2 = 11 marks)

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3 (a) (i)

(2)

3 (a) (ii)

(2)

3 (a) (iii)

Table **1**

Run	Volume $C_6H_{12}O_6(aq)$ / cm^3	Volume $H_2SO_4(aq)$ / cm^3	Volume $KMnO_4(aq)$ / cm^3	Volume $H_2O(l)$ / cm^3	Time / s	Rate / $cm^3 s^{-1}$
A						
B						
C						
D						

(1)

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3 (a) (iv)

(2)

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.....

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3 (b)

Table **2**

Run	Volume $C_6H_{12}O_6(aq)$ / cm^3	Volume $H_2SO_4(aq)$ / cm^3	Volume $KMnO_4(aq)$ / cm^3	Volume $H_2O(l)$ / cm^3
A				
B				
C				
D				

Run **D** is being compared to Run .....

(2)

3 (c) (i)

(2)

3 (c) (ii)

(2)

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.....

.....

.....

(Total for Question 3 = 13 marks)

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4 (a) (i)

(1)

4 (a) (ii)

(1)

4 (b)

(2)

4 (c)

(2)

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DO NOT WRITE IN THIS AREA

4 (d)

(4)

4 (e) (i)

(1)

4 (e) (ii)

(1)

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4 (f) (i)

(3)

4 (f) (ii)

(3)

4 (f) (iii)

(2)

(Total for Question 4 = 20 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: 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 damstadtium 110	[272] Rg roentgenium 111							

* 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