Please check the examination details below before entering your candidate information

Candidate surname	Other names

Pearson Edexcel
International
Advanced Level

Centre Number | | | | | |

Candidate Number | | | | |

Thursday 24 January 2019

Morning (Time: 1 hour 15 minutes) | Paper Reference **WCH06/01**

Chemistry

Advanced

Unit 6: Chemistry Laboratory Skills II

Candidates must have:
Scientific calculator

Total Marks

Instructions

- Use **black** ink or **black** 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.
- Show all your working in calculations and include units where appropriate.
- Check your answers if you have time at the end.

Turn over ▶

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P 5 4 5 6 4 A 0 1 1 6

Pearson

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

1 The inorganic compounds **A** and **B** each contain one cation and one anion.

(a) **A** is a green solid.

Two tests were carried out on separate portions of an aqueous solution of **A**.

(i) Complete the table.

(2)

Test	Observation	Inference
Test **1** A few drops of aqueous sodium hydroxide were added to a sample of the solution of **A** More of the sodium hydroxide was added until it was in excess	A green precipitate formed The precipitate dissolved to form a green solution	The **formula** of the cation in **A** is .....
Test **2** Dilute nitric acid and aqueous silver nitrate were added to a sample of the solution of **A**	....	The formula of the anion in **A** is Cl^-

(ii) Give the **formula** of the **anion** responsible for the green colour of the final solution in Test **1**.

(1)

.....

(iii) Write the **ionic** equation for the reaction in Test **2**. Include state symbols.

(1)

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(b) **B** is a white solid.

Two tests were carried out on separate portions of an aqueous solution of **B**.

(i) Complete the table.

(3)

Test	Observation	Inference
Test **3** A few drops of aqueous sodium hydroxide were added to a sample of the solution of **B** More of the sodium hydroxide was added until it was in excess	....	The formula of the cation in **B** is Zn^{2+}
Test **4** Dilute hydrochloric acid and aqueous barium chloride were added to a sample of the solution of **B**	A white precipitate formed	The name or formula of the anion in **B** is .....

(ii) Write the **ionic** equations for the **two** reactions in Test **3**.
State symbols are not required.

(2)

(Total for Question 1 = 9 marks)

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2 An ester **C** was hydrolysed by heating with aqueous sodium hydroxide.

The resulting mixture was distilled to give an organic liquid **D**.

The residue was acidified and the mixture purified to produce an organic liquid **E**.

(a) A spatula measure of phosphorus(V) chloride was added to separate portions of **D** and **E**.
They both gave off a gas which produced steamy fumes in air and turned damp blue litmus paper red.

Identify, by name or formula, the gas produced and the group in **D** and **E** indicated by this test.

(2)

Gas .....

Group .....

(b) **D** was oxidised to produce a carbonyl compound.

State what additional information this gives about **D**.

(1)

.....

(c) In the mass spectrum of **D**, the molecular ion peak is at $m / e = 60$.
The low resolution proton nmr spectrum of **D** consists of three peaks with relative peak areas in the ratio 6 : 1 : 1.

Draw the structural or displayed formula of **D**.

(2)

(d) Aqueous sodium hydrogencarbonate was added to a portion of **E**.
There was immediate effervescence.

Identify, by name or formula, the gas produced and the functional group in **E**.

(2)

Gas .....

Functional group .....

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(e) In the mass spectrum of **E**, the molecular ion peak is also at $m/e = 60$.

Draw the structural or displayed formula of **E**.

(1)

(f) Draw the structural or displayed formula of the ester **C**.

(1)

(Total for Question 2 = 9 marks)

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3 This question is about compounds of manganese in different oxidation states.

(a) Describe what you would **see** when aqueous sodium hydroxide is added to an aqueous solution containing manganese(II) ions and the mixture is left to stand for a few minutes.

(2)

(b) A sample of an aqueous solution of manganate(VI) ions is prepared from an aqueous solution of manganate(VII) ions and solid manganese(IV) oxide under appropriate conditions.

The relevant standard electrode potentials are

$$MnO_4^- + e^- \rightleftharpoons MnO_4^{2-} \qquad E^\ominus = +0.56\,V$$

$$MnO_4^{2-} + 2H_2O + 2e^- \rightleftharpoons MnO_2 + 4OH^- \qquad E^\ominus = +0.59\,V$$

$$MnO_4^{2-} + 4H^+ + 2e^- \rightleftharpoons MnO_2 + 2H_2O \qquad E^\ominus = +2.26\,V$$

(i) Choose appropriate standard electrode potentials to calculate $E^\ominus_{cell}$ for the formation of manganate(VI) ions in **acidic** solution.
Use your calculated value of $E^\ominus_{cell}$ to explain why manganate(VI) ions cannot be prepared under acidic conditions.

(2)

(ii) Explain, in terms of standard electrode potentials, why manganate(VI) ions can be prepared in a **concentrated** alkaline solution.

(2)

(c) An outline procedure for determining the amount of dissolved oxygen in pond water is given.

Step **1** Shake 100 cm^3 of pond water with manganese(II) hydroxide in a closed container. The manganese(II) hydroxide is oxidised to manganese(III) hydroxide.

$$4Mn(OH)_2 + O_2 + 2H_2O \rightarrow 4Mn(OH)_3$$

Step **2** Add excess acidified potassium iodide to the mixture. The manganese(III) ions oxidise iodide ions to iodine.

$$2Mn^{3+} + 2I^- \rightarrow 2Mn^{2+} + I_2$$

Step **3** Titrate the iodine with 0.0100 mol dm^{-3} sodium thiosulfate.

$$2S_2O_3^{2-} + I_2 \rightarrow S_4O_6^{2-} + 2I^-$$

Step **4** Repeat the titration until concordant titres are obtained.

(i) State a suitable indicator for this titration and give the colour change at the end-point.

(2)

Indicator.....

Colour change from.....to.....

(ii) Following this procedure, a mean titre of 16.20 cm^3 was recorded.

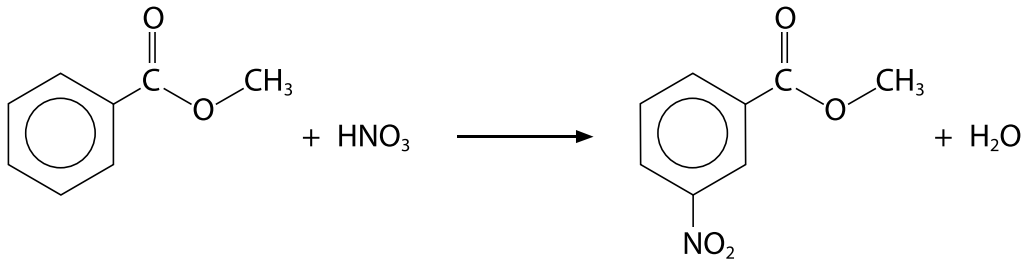
Calculate the volume of dissolved oxygen, in cm^3, in the 100 cm^3 sample of pond water at room temperature and pressure.

[Molar volume of gas at room temperature and pressure = 24 000 $cm^3\,mol^{-1}$]

(4)

(Total for Question 3 = 12 marks)

4 Two students carried out an experiment to nitrate methyl benzoate.



methyl 3-nitrobenzoate

The following outline procedure was used.

Step **1** Place 5.0 cm^3 of concentrated sulfuric acid into a two-necked, round-bottomed flask and cool it to 5 °C.
Slowly add 3.0 cm^3 of methyl benzoate to the sulfuric acid, keeping the temperature at 5 °C.

Step **2** Place 3.0 cm^3 of concentrated nitric acid in a boiling tube and cool it to 5 °C.
Slowly add 3.0 cm^3 of concentrated sulfuric acid to the boiling tube, while mixing and keeping the temperature at 5 °C. This is the nitrating mixture.

Step **3** Pour the nitrating mixture into a tap funnel. Place this **vertically** in the round-bottomed flask and put the flask in an ice-bath.
Place a thermometer in the other neck of the flask.

Step **4** Add the nitrating mixture, a drop at a time, to the mixture in the flask.
Do not allow the temperature to rise above 15 °C.
When all the nitrating mixture has been added, leave the mixture for about 10 minutes at room temperature.

Step **5** Pour the mixture from the flask into a small beaker containing crushed ice.

Step **6** Filter the impure solid methyl 3-nitrobenzoate under reduced pressure.

Step **7** Recrystallise the methyl 3-nitrobenzoate using methanol as the solvent.

Step **8** Dry the methyl 3-nitrobenzoate and find the mass of crystals obtained.

Step **9** Determine the melting temperature of the crystals obtained.

(a) Give a reason why **benzene** should not be used in a school laboratory.

(1)

.....

.....

.....

(b) Give a reason why the temperature is kept low in Steps **1** and **2**.

(1)

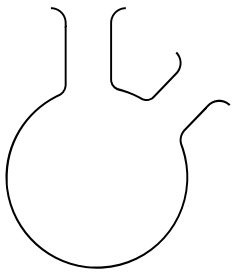
.....

.....

.....

(c) Complete the diagram to show the apparatus set up at the end of Step **3**.

(3)



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(d) The molar mass of methyl 3-nitrobenzoate is 181 g mol^{-1}. However, a small amount of a product with molar mass 226 g mol^{-1} is also formed if the temperature is allowed to rise above 15 °C in Step **4**.

Suggest the structure and name of a possible product with this molar mass.

(2)

Structure

Name .....

(e) Give a reason why the methyl 3-nitrobenzoate is separated from the reaction mixture by filtration under reduced pressure, rather than normal filtration.

(1)

.....

.....

.....

(f) **Student 1** described how to carry out the recrystallisation in Step **7** to obtain a pure sample of methyl 3-nitrobenzoate.

Step A	*Dissolve the impure solid in some hot methanol.*
Step B	*Cool the solution in an ice-bath.*
Step C	*Separate the crystals using suction filtration.*
Step D	*Dry the crystals by mixing them with solid anhydrous sodium sulfate in a stoppered boiling tube.*

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(i) The student's description of **Step A** omitted an important detail.
State how the method for **Step A** should be changed.
Justify your answer.

(2)

(ii) Describe what the student should do after **Step A** and before carrying out **Step B**.
Justify your answer.

(2)

(iii) Give a reason why **Step D** would not work and describe how the student should dry the crystals.

(2)

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(g) **Student 2** carried out the recrystallisation correctly and obtained 2.28 g of methyl 3-nitrobenzoate from 3.0 cm^3 of methylbenzoate.

Calculate the percentage yield of methyl 3-nitrobenzoate.

Data

Density of methyl benzoate = 1.09 g cm^{-3}

Molar mass of methyl benzoate = 136 g mol^{-1}

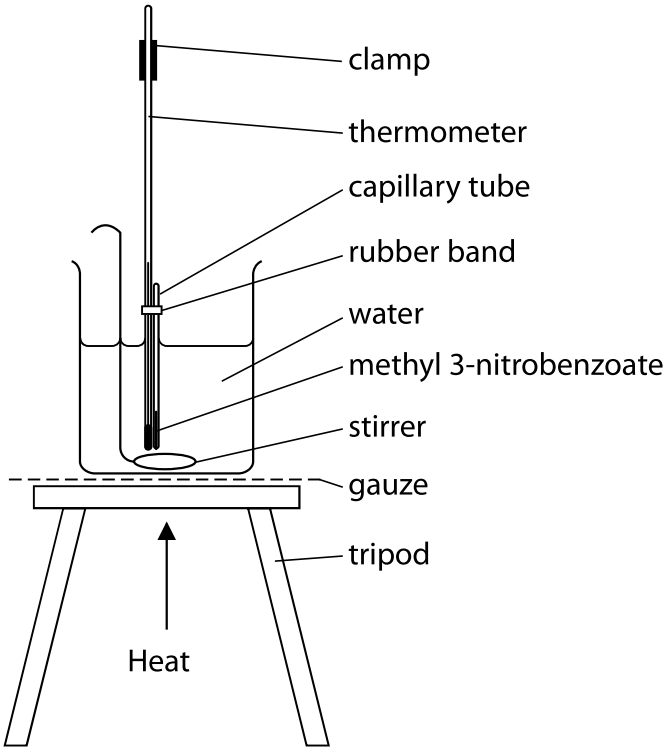
Molar mass of methyl 3-nitrobenzoate = 181 g mol^{-1}

(3)

(h) The melting temperature of methyl 3-nitrobenzoate is 77 °C.

Describe how the students should use the apparatus shown to determine the melting temperature **range** of a sample of their crystallised methyl 3-nitrobenzoate.

(3)



(Total for Question 4 = 20 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									(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 darmstactium 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