Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel International Advanced Level

Monday 12 June 2023

Morning (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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P 7 3 4 5 8 A 0 1 1 6

Pearson

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

1 A student investigated two aqueous solutions, labelled **P** and **Q**.
Both solutions were green. Each solution contained one cation and one anion.

(a) Tests were carried out on solution **P**.

Complete the table.

	Test	Observation	Inference	
(i)	A few drops of aqueous sodium hydroxide were added to 5 cm^3 of **P**	....	Chromium(III) ions may be present in **P**	**(1)**
(ii)	More sodium hydroxide solution was added to the mixture from (a)(i) until there was no further change	....	Chromium(III) ions are confirmed to be present in **P**	**(1)**
(iii)	A few drops of dilute nitric acid were added to 5 cm^3 of a fresh sample of **P** A few drops of aqueous silver nitrate were added to this acidified solution of **P**	A white precipitate formed	The **formula** of the anion likely to be responsible for the white precipitate is	**(1)**

(b) State why, in the silver nitrate test on **P**, the nitric acid was not needed in this case. Justify your answer by considering the role of nitric acid in the silver nitrate test.

(2)

.....

.....

.....

.....

(c) The student carried out tests on **Q** and inferred that it was a solution of iron(II) sulfate.

(i) The addition of dilute aqueous ammonia to a sample of solution **Q** produced a green precipitate which changed colour on standing.

Explain why the colour change led the student to infer that **Q** contained iron(II) ions.

(2)

(ii) Describe a test, and its positive result, that the student could have carried out to show the presence of sulfate ions.

(2)

(d) Identify, by name or formula, a metal cation, other than chromium(III) and iron(II), which could give a **green** colour in an aqueous solution.

(1)

(Total for Question 1 = 10 marks)

2 Two organic compounds, **X** and **Y**, are colourless liquids.
Each compound contains only **one** functional group.

(a) A few drops of deionised water are added to a beaker containing **X**.
Misty fumes are formed.

A drop of concentrated ammonia on the tip of a glass rod is placed in the misty fumes. White smoke is formed.

(i) Deduce the functional group in **X**.
Justify your answer by referring to the observations.

(3)

.....

.....

.....

.....

.....

.....

(ii) State the precaution that you would take to minimise the risk of carrying out this test on the misty fumes.
Assume gloves, safety goggles and laboratory coat are worn.

(1)

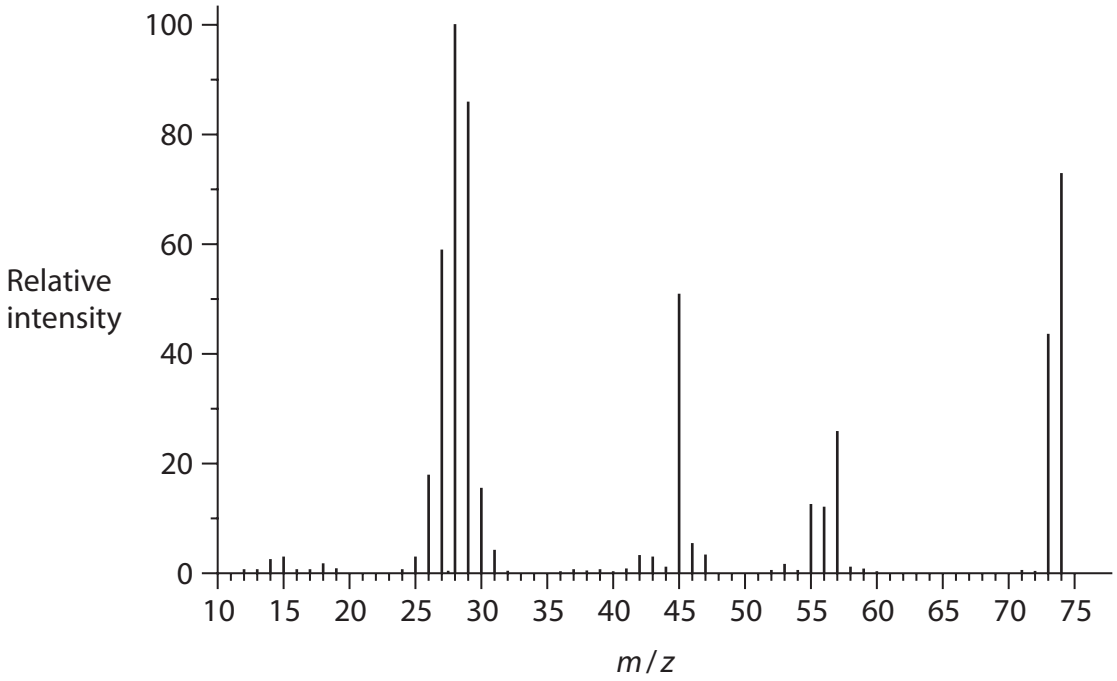
.....

(b) The ^{13}C NMR spectrum of **X** has two peaks.

Draw the displayed formula of **X**.

(1)

(c) The mass spectrum of **Y** is shown.



(i) Bubbles are observed when aqueous sodium hydrogencarbonate is added to **Y**.

Deduce the formula of the **ion** responsible for the peak at $m/z = 45$.

(1)

.....

(ii) Draw the structural formula of **Y**.

(1)

(d) Both **X** and **Y** can be used to produce esters.

(i) **Name** the compound that would react with both **X** and **Y** to form ethyl esters.

(1)

(ii) A student prepared an ester using **X** and a suitable compound.

Explain why the student added aqueous sodium hydrogencarbonate to the reaction mixture to allow the presence of an ester to be detected.

(2)

(e) Both **X** and **Y** react with concentrated ammonia but form different products.

Identify these products, by name or formula.

(2)

Product with **X**

Product with **Y**

(Total for Question 2 = 12 marks)

3 This question is about an experiment to investigate the kinetics of the reaction between iodine and propanone with an acid catalyst.

The equation for the reaction is shown.

$$I_2(aq) + CH_3COCH_3(aq) + H^+(aq) \rightarrow CH_3COCH_2I(aq) + 2H^+(aq) + I^-(aq)$$

To obtain the order of reaction with respect to iodine, the concentration of iodine in the reaction mixture was determined at various times.

Procedure

Step **1** Mix 25 cm^3 of 1.0 mol dm^{-3} sulfuric acid with 25 cm^3 of 1.0 mol dm^{-3} propanone in a beaker.

Step **2** Start a clock as 50 cm^3 of 0.020 mol dm^{-3} iodine solution is added to the beaker. Mix the reactants thoroughly.

Step **3** Tip a spatula measure of sodium hydrogencarbonate into a conical flask. After 3 minutes, pipette a 10.0 cm^3 sample of the reaction mixture into the conical flask and mix thoroughly.

Step **4** Titrate the iodine in the sample with 0.010 mol dm^{-3} sodium thiosulfate solution using a suitable indicator. Record the titre.

Step **5** Repeat Steps **3** and **4** every 3 minutes to obtain four more titres.

(a) State why the sulfuric acid and propanone concentrations are both much larger than the iodine concentration.

(1)

.....

.....

(b) State why sodium hydrogencarbonate is used in Step **3**.

(1)

.....

.....

(c) Name the indicator that would be used for the titration in Step **4**, stating the colour **change** that would be seen at the end-point of the reaction.

(2)

.....

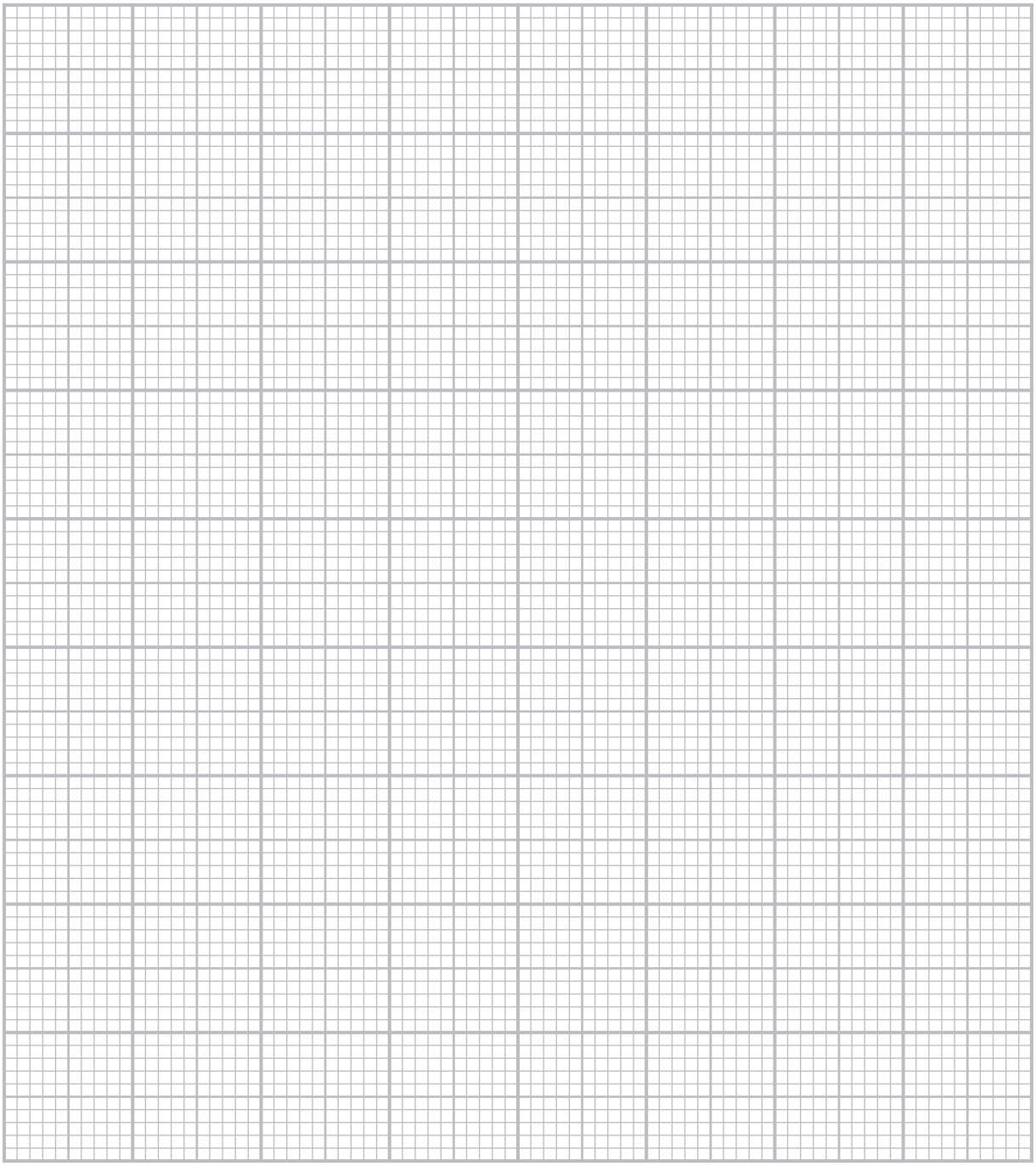
.....

(d) Titration results from the experiment are shown.

Time / minutes	3	6	9	12	15
Titre / cm^3	16.05	15.30	14.50	13.70	12.95

(i) Plot a graph of titre against time.

(3)



(ii) State why the volume of thiosulfate may be used for plotting the graph rather than the concentration of iodine.

(1)

.....

.....

.....

(iii) State the order of reaction with respect to iodine.
Justify your answer by referring to your graph.

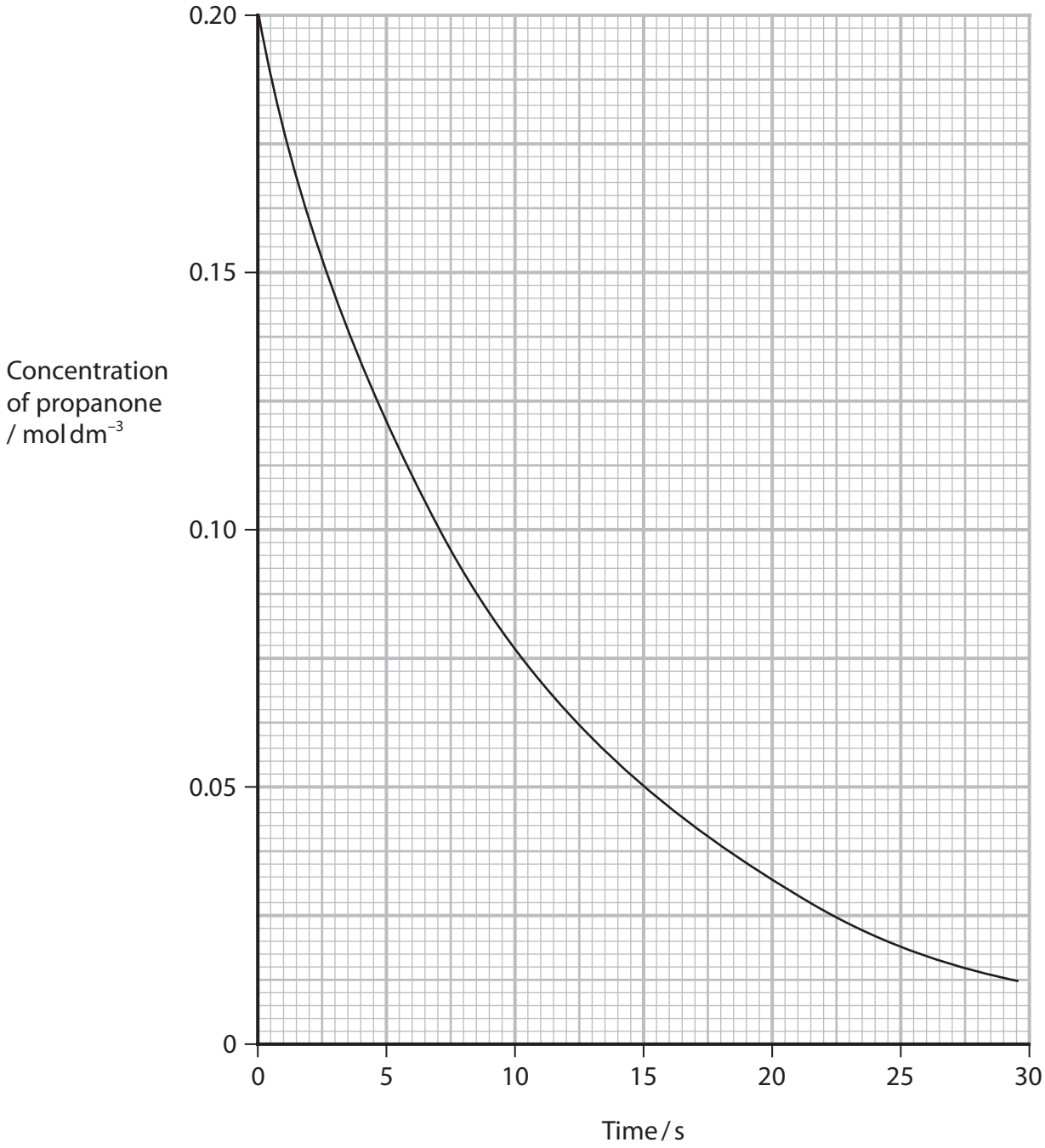
(1)

.....

.....

(e) Further experiments were carried out to determine the reaction orders with respect to propanone and sulfuric acid.

(i) A graph of the concentration of propanone against time is shown.



The reaction is first order with respect to propanone.

Determine two half-lives for this reaction.
You **must** show your working on the graph.

(2)

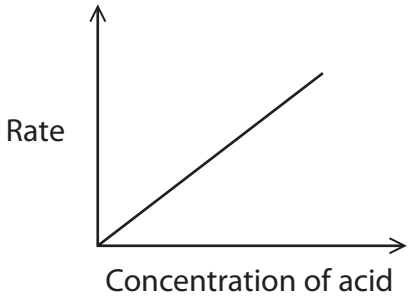
First half-life

.....

Second half-life

.....

(ii) A graph of the reaction rate against the concentration of sulfuric acid is shown.

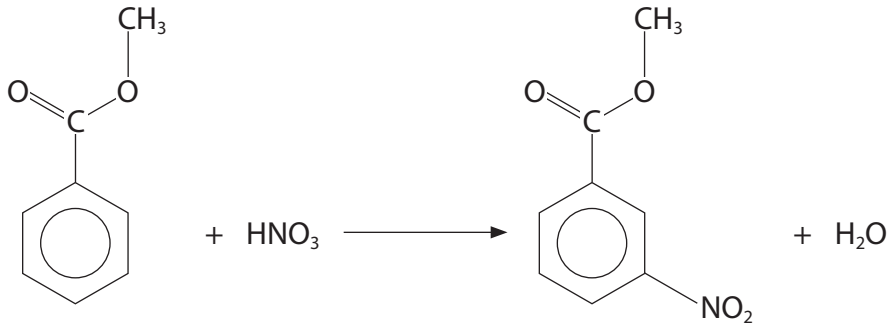


Deduce the rate equation for the overall reaction of iodine and propanone with an acid catalyst.
Use your answer from (d)(iii) and information from (e)(i) and the graph in (e)(ii).

(1)

(Total for Question 3 = 12 marks)

4 A group of students prepared methyl 3-nitrobenzoate by the nitration of methyl benzoate.



Procedure

Step **1** Measure 9 cm^3 of concentrated sulfuric acid into a small, dry conical flask. Label the flask **A** and place it in an ice bath.

Step **2** Add 4.0 cm^3 of methyl benzoate to flask **A**. Gently swirl the flask.

Step **3** Mix 3 cm^3 of concentrated nitric acid and 3 cm^3 of concentrated sulfuric acid in a test tube to form the nitrating mixture. Place this test tube in the ice bath.

Step **4** Place a thermometer in flask **A**. Add the nitrating mixture very slowly to flask **A** using a dropping pipette. Take care to ensure that the temperature of the flask contents does not rise above 15 °C.

Step **5** Remove flask **A** from the ice bath and allow it to stand at room temperature for about 10 minutes. Pour the reaction mixture into a small beaker containing crushed ice. Stir the contents of the beaker with a glass rod.

Step **6** Allow the ice to melt. Separate the solid methyl 3-nitrobenzoate by suction filtration. Wash the solid with a small amount of deionised water and then with a little ice-cold ethanol.

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

Step **8** Determine the melting temperature of the purified crystals of methyl 3-nitrobenzoate.

(a) An ice bath is a mixture of ice and water in a beaker.

Suggest an advantage of using an ice bath in Steps **1** and **3** rather than a beaker containing only ice cubes. Justify your answer.

(1)

.....

.....

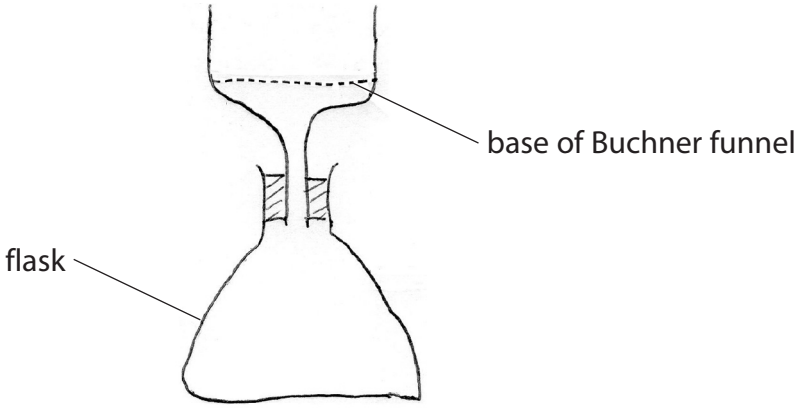
.....

(b) Side products form if the temperature rises above 15 °C in Step **4**.

Give the structure of **one** side product that may form.

(1)

(c) One student drew the suction filtration apparatus in Step **6** as shown.



Identify the **three** ways in which this diagram is incorrect.
You may assume that the apparatus is suitably clamped.

(3)

(d) Describe the stages in the recrystallisation of methyl 3-nitrobenzoate in Step **7**, stating which stages are required to remove the insoluble and soluble impurities. Only outline details of the method are required.

(4)

(e) The crystals must be dried before the melting temperature can be determined. Methyl 3-nitrobenzoate cannot be dried by the addition of a solid drying agent such as anhydrous calcium chloride.

(i) Suggest why the addition of a solid drying agent is not suitable to dry methyl 3-nitrobenzoate.

(1)

(ii) State how the crystals of methyl 3-nitrobenzoate could be dried.

(1)

(f) The mass of dry methyl 3-nitrobenzoate crystals prepared by one of the students was 3.05 g.

Calculate the percentage yield by mass of methyl 3-nitrobenzoate using the data shown.

Compound	Molar mass / g mol^{-1}	Density / g cm^{-3}
methyl benzoate	136	1.08
methyl 3-nitrobenzoate	181	

(3)

(g) The melting temperature range of methyl 3-nitrobenzoate is given in a data book as 78–80 °C.

Suggest a melting temperature **range** for a sample of the methyl 3-nitrobenzoate **before** recrystallisation. Justify your answer.

(2)

(Total for Question 4 = 16 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

* 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