

Please check the examination details below before entering your candidate information

Candidate surname

Other names

Pearson Edexcel
International
Advanced Level

Centre Number

Candidate Number

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Wednesday 20 January 2021

Morning (Time: 1 hour 20 minutes)

Paper Reference **WCH13/01**

Chemistry

International Advanced Subsidiary/Advanced Level

Unit 3: Practical Skills in Chemistry I

You must have:

Scientific calculator, ruler

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.*
- Show all your working in calculations and include units where appropriate.

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.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ►

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

- 1 (a) A student was provided with five test tubes labelled **A**, **B**, **C**, **D** and **E**, each containing a colourless aqueous solution.

The five solutions were known to be

barium chloride

nitric acid

potassium bromide

silver nitrate

sodium carbonate

The student carried out a series of tests to identify which test tube contained which solution.

- (i) The student tested each solution using universal indicator paper. Only solution **A** turned the paper red.

Identify solution **A**.

(1)

- (ii) The student mixed 1 cm³ of solution **A** separately with 1 cm³ of each of the other solutions.

There was no change for three of the mixtures but effervescence was observed when solution **A** was added to solution **C**.

Identify solution **C**.

(1)

- (iii) Write an **ionic** equation for the reaction between solution **A** and solution **C**. Include state symbols.

(2)

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(iv) The student then mixed 1 cm³ samples of the remaining solutions as shown in **Table 1**.

Solutions mixed	Observation
B and D	no change
B and E	cream precipitate
D and E	white precipitate

Table 1

Identify the three remaining solutions.

(3)

Solution **B**

Solution **D**

Solution **E**

(b) Three of the cations in the compounds in (a) can be identified using flame tests.

Complete **Table 2**.

(3)

Cation formula	Flame colour

Table 2

(Total for Question 1 = 10 marks)

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Turn over

2 Sodium hydroxide solution reacts with carbon dioxide in the air and should be standardised before use. Ethanedioic acid may be used for this standardisation.

(a) A standard solution of ethanedioic acid, $(\text{COOH})_2$, is prepared.

- 2.40 g of solid ethanedioic acid is dissolved in approximately 100 cm^3 of deionised water in a beaker.
 - The solution is transferred into a 250.0 cm^3 volumetric flask and made up to the mark with deionised water.
- (i) Give a possible reason why any solution remaining in the beaker is washed into the volumetric flask before making up to the mark.

(1)

(ii) Calculate the concentration of this standard solution of ethanedioic acid in mol dm^{-3} .

Give your answer to an appropriate number of significant figures.

[Molar mass of ethanedioic acid = 90.0 g mol^{-1}]

(2)



- (b) A **different** standard solution of ethanedioic acid is used to determine the concentration of a sodium hydroxide solution **J**.

Procedure

Step 1 A burette is rinsed with deionised water.

Step 2 The burette is then rinsed with $0.0900 \text{ mol dm}^{-3}$ ethanedioic acid and filled with this acid solution.

Step 3 A pipette is used to transfer 25.0 cm^3 portions of solution **J** to conical flasks.

Step 4 The portions are titrated with the ethanedioic acid solution using phenolphthalein indicator.

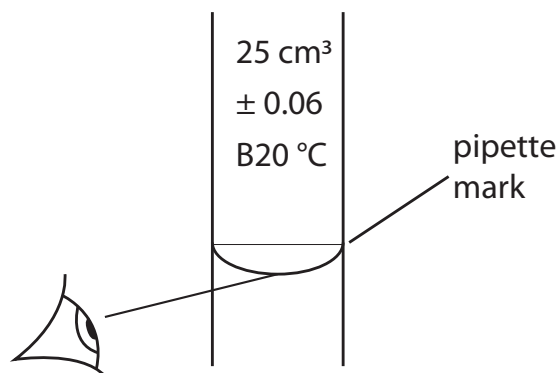
- (i) Explain why the burette is rinsed with ethanedioic acid solution in Step 2.

(1)

- (ii) The diagram shows how the student read the filled pipette in Step 3.

Identify the **two** mistakes the student made.

(2)



(iii) The student completely emptied the pipette for each transfer in Step 3.

Explain the effect **on the titre** of completely emptying the pipette rather than leaving a small amount of solution in the tip.

(2)

(iv) State the colour **change** in the conical flask at the end-point.

(2)

From to

(c) The titration results are shown.

Titration	1	2	3
Final reading / cm ³	25.05	26.60	25.50
Initial reading / cm ³	0.00	2.00	1.00
Titre / cm ³			
Titres used in calculation of mean			

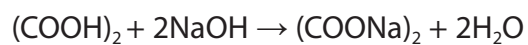
(i) Complete the table and calculate the mean titre.

(2)



(ii) Calculate the concentration of the sodium hydroxide solution in mol dm^{-3} .

The equation for the titration is



(3)

(Total for Question 2 = 15 marks)

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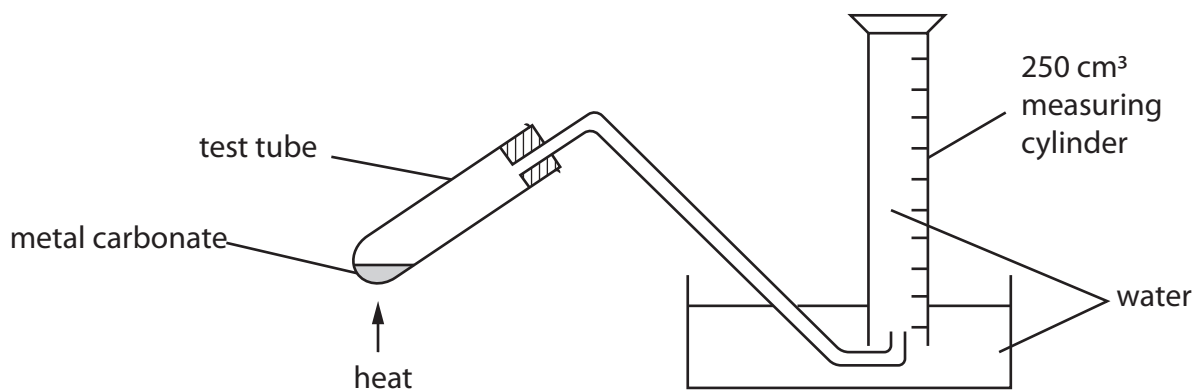
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3 This question is about the thermal decomposition of Group 2 carbonates.

A student heated a sample of a Group 2 carbonate until no more gas was produced. The equation for the decomposition is



(a) Give a reason why the delivery tube must be removed from the water bath before removing the test tube from the heat source.

(1)

(b) The results of the experiment are shown.

Measurement	Value
Volume of carbon dioxide / cm ³	95
Mass of test tube + carbonate / g	21.69
Mass of test tube / g	21.36
Mass of carbonate / g	0.33



(i) Using the results of the experiment identify the Group 2 metal.

[Molar volume of gas at room temperature and pressure = $24.0 \text{ dm}^3 \text{ mol}^{-1}$]

(3)

(ii) The student suggested that the experiment could be made more accurate by increasing the mass of carbonate from 0.33 g to 1.00 g.

No changes to the size of the apparatus or the method of measurement of the gas produced would be made.

Comment on this suggestion.

(2)

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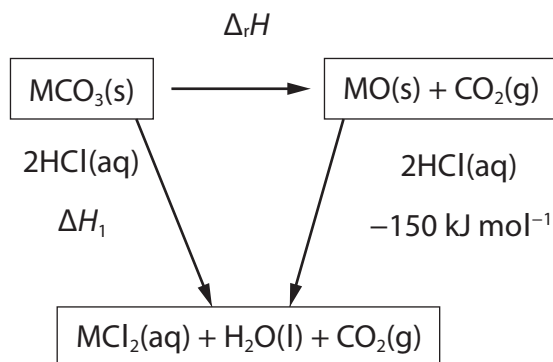
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- (c) The enthalpy change for the thermal decomposition of a carbonate, $\Delta_r H$, is difficult to measure directly.

An example of a Hess's Law cycle to determine it indirectly is



In an experiment to determine ΔH_1 , 0.050 mol of MCO_3 was placed in a 100 cm^3 beaker. 60 cm^3 of 2 mol dm^{-3} hydrochloric acid (an excess) was added and the mixture stirred. The maximum temperature rise measured was $6.0 \text{ }^\circ\text{C}$.

[Heat capacity of solution produced = $4.18 \text{ J g}^{-1} \text{ }^\circ\text{C}^{-1}$
Density of solution = 1.0 g cm^{-3}]

- (i) Calculate the enthalpy change, ΔH_1 , for the reaction between MCO_3 and hydrochloric acid in kJ mol^{-1} . Include a sign with your answer. (2)
- (ii) Using your answer to (c)(i), calculate the enthalpy change, $\Delta_r H$, for the thermal decomposition of this Group 2 carbonate in kJ mol^{-1} . Include a sign with your answer. (1)

(Total for Question 3 = 9 marks)



- 4 The halogenoalkane 2-chloro-2-methylpropane may be prepared from 2-methylpropan-2-ol.

Procedure

- Step 1** Add 35 cm^3 of concentrated hydrochloric acid to 8.00 g of 2-methylpropan-2-ol in a conical flask.
Swirl the mixture gently for 20 minutes.
- Step 2** Two distinct layers form. The upper (organic) layer contains the required product. The lower aqueous layer is removed using a separating funnel.
- Step 3** Add a solution of sodium hydrogencarbonate to the organic layer.
Swirl gently. Stopper the separating funnel and shake it.
Invert the separating funnel and open the tap.
- Step 4** Return the separating funnel to its upright position, remove the stopper and run off the aqueous layer. Transfer the organic layer into a clean conical flask.
- Step 5** Add some anhydrous sodium sulfate.
Leave the flask to stand and decant off the liquid.
- Step 6** Distil the liquid, collecting the product between 50°C and 52°C .
- (a) (i) The concentrated hydrochloric acid used in Step 1 was labelled



Suggest **two** safety precautions, other than wearing safety spectacles and a laboratory coat, to minimise the risk when using this reagent in Step 1.

(2)

- (ii) Explain why the product in the organic layer in Step 2 does not mix with the aqueous layer.

(2)



(iii) State why the tap of the separating funnel must be opened in Step 3.

(1)

(iv) State why anhydrous sodium sulfate is added to the organic layer in Step 5.

(1)

(v) Draw the apparatus required to distil the product and collect the distillate between 50°C and 52°C in Step 6.

(4)

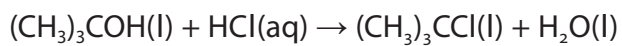
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(b) The equation for the reaction is



The final product after distillation weighed 2.62 g.

Calculate the percentage yield.

(3)

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Turn over

- (c) The haloalkane produced is used in an experiment to compare its rate of hydrolysis with two other halogenoalkanes.

A student dissolves separate 1.0 cm^3 samples of each halogenoalkane in ethanol and adds 2 cm^3 of silver nitrate solution.

The time taken for a precipitate to form is recorded. The results are shown.

Halogenoalkane	Time / s
2-chloro-2-methylpropane	5
1-chloro-2-methylpropane	320
1-bromo-2-methylpropane	140

The student concludes that both the structure of the halogenoalkane and the identity of the halogen affect the rate of hydrolysis.

Explain how the results support this conclusion.

(3)

(Total for Question 4 = 16 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
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Key

relative atomic mass
atomic symbol
name
atomic (proton) number

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)																																																																																													
6.9 Li lithium 3	9.0 Be beryllium 4	23.0 Na sodium 11	24.3 Mg magnesium 12	39.1 K potassium 19	40.1 Ca calcium 20	85.5 Rb rubidium 37	87.6 Sr strontium 38	132.9 Cs caesium 55	[223] Fr francium 87	45.0 Sc scandium 21	47.9 Ti titanium 22	91.2 Zr zirconium 40	178.5 Hf hafnium 72	137.3 Ba barium 56	[226] Ra radium 88	45.0 Sc scandium 21	47.9 Ti titanium 22	91.2 Zr zirconium 40	178.5 Hf hafnium 72	137.3 Ba barium 56	[226] Ra radium 88	50.9 V vanadium 23	50.9 V vanadium 23	92.9 Nb niobium 41	180.9 Ta tantalum 73	138.9 La* lanthanum 57	[227] Ac* actinium 89	54.9 Mn manganese 25	[98]	101.1 Ru ruthenium 44	102.9 Rh rhodium 45	192.2 Ir iridium 77	200.6 Hg mercury 80	55.8 Fe iron 26	55.8 Fe iron 26	101.1 Ru ruthenium 44	102.9 Rh rhodium 45	192.2 Ir iridium 77	200.6 Hg mercury 80	58.7 Ni nickel 28	58.7 Ni nickel 28	106.4 Pd palladium 46	195.1 Pt platinum 78	200.6 Hg mercury 80	58.7 Ni nickel 28	58.9 Co cobalt 27	58.9 Co cobalt 27	102.9 Rh rhodium 45	192.2 Ir iridium 77	200.6 Hg mercury 80	63.5 Cu copper 29	63.5 Cu copper 29	107.9 Ag silver 47	197.0 Au gold 79	200.6 Hg mercury 80	65.4 Zn zinc 30	65.4 Zn zinc 30	112.4 Cd cadmium 48	200.6 Hg mercury 80	69.7 Ga gallium 31	69.7 Ga gallium 31	114.8 In indium 49	204.4 Tl thallium 81	204.4 Tl thallium 81	72.6 Ge germanium 32	72.6 Ge germanium 32	118.7 Sn tin 50	207.2 Pb lead 82	207.2 Pb lead 82	74.9 As arsenic 33	74.9 As arsenic 33	121.8 Sb antimony 51	209.0 Bi bismuth 83	209.0 Bi bismuth 83	79.0 Br bromine 35	79.0 Br bromine 35	127.6 Te tellurium 52	209.0 Po polonium 84	209.0 Po polonium 84	127.6 Te tellurium 52	127.6 Te tellurium 52	126.9 I iodine 53	210.0 At astatine 85	210.0 At astatine 85	19.0 F fluorine 9	19.0 F fluorine 9	16.0 O oxygen 8	16.0 O oxygen 8	16.0 O oxygen 8	16.0 O oxygen 8	32.1 S sulfur 16	32.1 S sulfur 16	32.1 S sulfur 16	32.1 S sulfur 16	35.5 Cl chlorine 17	35.5 Cl chlorine 17	35.5 Cl chlorine 17	35.5 Cl chlorine 17	39.9 Ar argon 18	39.9 Ar argon 18	39.9 Ar argon 18	39.9 Ar argon 18	20.2 Ne neon 10	20.2 Ne neon 10	20.2 Ne neon 10	20.2 Ne neon 10	4.0 He helium 2	4.0 He helium 2	4.0 He helium 2	4.0 He helium 2

Elements with atomic numbers 112-116 have been reported but not fully authenticated

140	141	144	150	152	157	163	165	167	169	173	175
Ce cerium 58	Pr praseodymium 59	Nd neodymium 60	Sm samarium 62	Eu europium 63	Gd gadolinium 64	Dy dysprosium 66	Ho holmium 67	Er erbium 68	Tm thulium 69	Yb ytterbium 70	Lu lutetium 71
232	231	238	242	243	247	251	254	253	256	254	257
Th thorium 90	Pa protactinium 91	U uranium 92	Pu plutonium 94	Am americium 95	Cm curium 96	Cf californium 98	Es einsteinium 99	Fm fermium 100	Md mendelevium 101	No nobelium 102	Lr lawrencium 103

* Lanthanide series

* Actinide series



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