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Candidate surname	Other names

Pearson Edexcel
International Advanced Level

Centre Number | | | | | |

Candidate Number | | | | |

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 cm^3 of solution **A** separately with 1 cm^3 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)

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(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 cm^3 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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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, $(COOH)_2$, 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)

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(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)

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(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 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)

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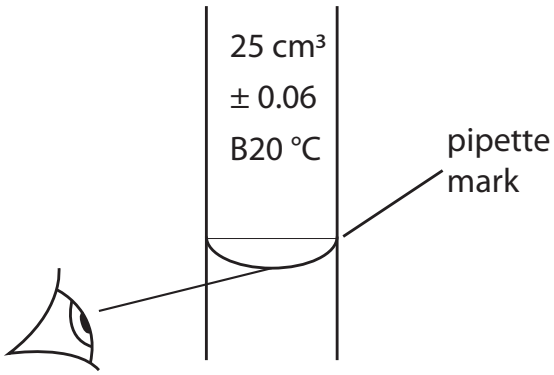
.....

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

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

(2)



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(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)

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.....

.....

.....

(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)

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

The equation for the titration is

$$(COOH)_2 + 2NaOH \rightarrow (COONa)_2 + 2H_2O$$

(3)

(Total for Question 2 = 15 marks)

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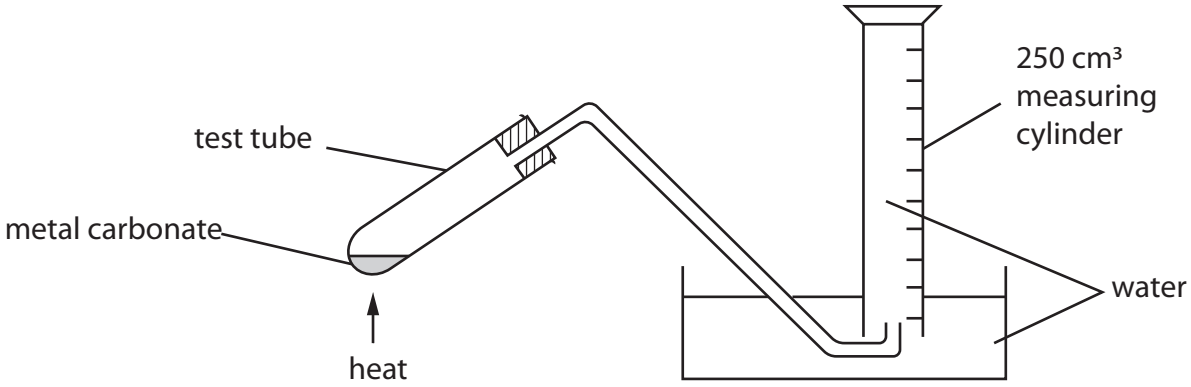
3 This question is about the thermal decomposition of Group 2 carbonates.

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

$$MCO_3(s) \rightarrow MO(s) + CO_2(g)$$



(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)

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.....

(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

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

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

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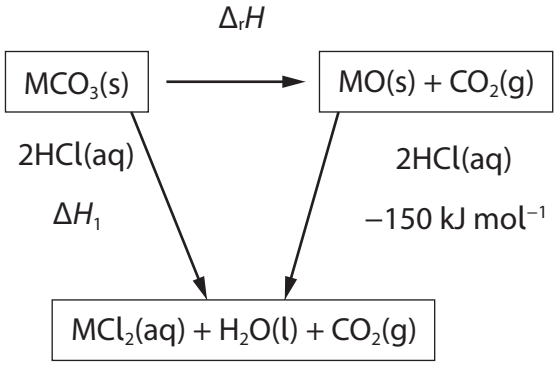
(c) The enthalpy change for the thermal decomposition of a carbonate, $\Delta_r H$, is difficult to measure directly.

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 °C.

[Heat capacity of solution produced = 4.18 J g^{-1} $°C^{-1}$
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)

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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)

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

(1)

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

(1)

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(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

$$(CH_3)_3COH(l) + HCl(aq) \rightarrow (CH_3)_3CCl(l) + H_2O(l)$$

The final product after distillation weighed 2.62 g.

Calculate the percentage yield.

(3)

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(c) The choroalkane 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)
							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 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

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