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Candidate surname

Other names

Centre Number

Candidate Number

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Pearson Edexcel International Advanced Level

Friday 24 May 2024

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.
- 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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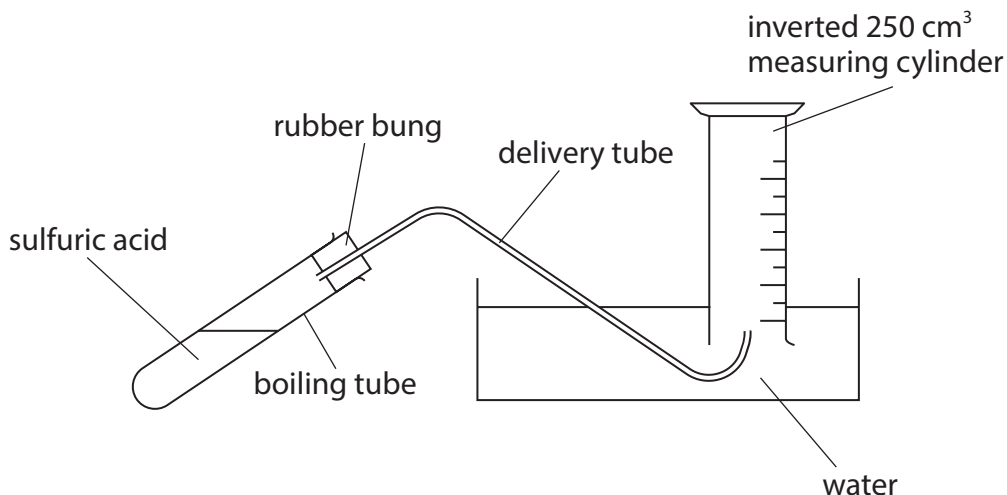
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Pearson

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

- 1 This is a question about practical activities involving the collection of a gas.
- (a) A student used the apparatus shown to collect the gas produced from the reaction between copper(II) carbonate and sulfuric acid.



The bung was removed and 0.650 g of copper(II) carbonate was added to 25.0 cm³ of 2.00 mol dm⁻³ sulfuric acid (an excess) in the boiling tube. The bung was quickly replaced and 120 cm³ of carbon dioxide gas was collected in the measuring cylinder. The equation for the reaction is shown.



Calculate the molar volume of carbon dioxide gas, in dm³ mol⁻¹, from these data. Give your answer to an appropriate number of significant figures.

(3)

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(b) After the reaction, tests can be carried out on the mixture to show that the sulfuric acid was in excess.

(i) State the observation if a small volume of sodium hydrogencarbonate solution was added to show that the acid was in excess. (1)

(ii) Describe a **different** test, and the positive observation, that could be carried out to show that the acid was in excess. (2)

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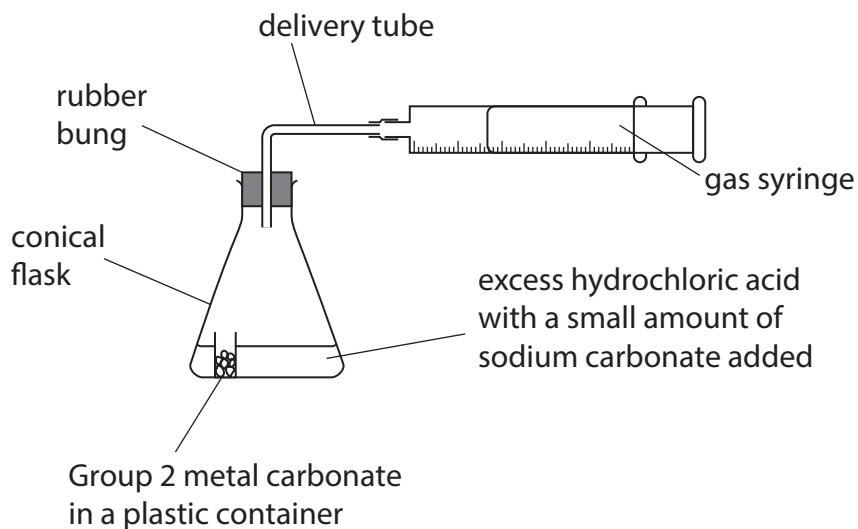
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- (c) Another student used the apparatus shown to collect the volume of gas produced from the reaction between a Group 2 metal carbonate and excess hydrochloric acid.



- (i) Give **two** reasons why the second set of apparatus gives a more accurate measurement of the volume of gas given off. Justify your answers.

(2)

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- (ii) The reaction of 0.320 g of the Group 2 metal carbonate resulted in 89.0 cm³ of carbon dioxide gas being collected in the gas syringe.



Determine, by calculation, the identity of the Group 2 metal from these data.

You **must** show your working.

Assume a molar gas volume of 24 000 cm³ mol⁻¹.

(3)

(Total for Question 1 = 11 marks)

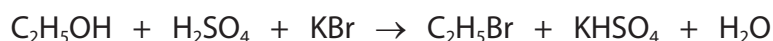
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- 2 Bromoethane was prepared from the reaction of ethanol with sulfuric acid and potassium bromide.



Procedure

Step 1 10.0 cm³ of ethanol was placed in a round-bottomed flask.

Step 2 10.0 cm³ of concentrated sulfuric acid was added carefully and gradually to the ethanol in the flask.

Step 3 12.0 g of potassium bromide was added to the reaction mixture in the flask.

Step 4 The flask was set up for distillation and heated gently.

Step 5 Water, ethanol and bromoethane were collected in a small beaker.

Step 6 The bromoethane was purified.

Step 7 The bromoethane was dried.

- (a) Suggest why the flask in Step 2 was frequently placed in a stream of cold running water as the sulfuric acid was gradually added.

(1)

- (b) The potassium bromide used in Step 3 was initially lumpy and not a fine powder. State the apparatus that would be suitable for breaking up the lumps of potassium bromide into a powder.

(1)

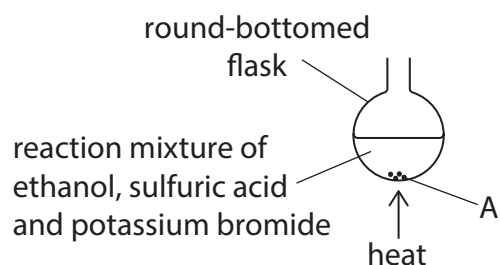
- (c) Explain why an orange colour was seen in the round-bottomed flask when it was first gently heated in Step 4.

(2)



(d) Complete the labelled diagram of the distillation apparatus used in Step 4.

(3)



(e) Identify the solid particles labelled **A** in the flask that have been added to promote smooth boiling.

(1)

(f) Bromoethane is very volatile.

Suggest what could be done with the small beaker, used in Step 5 to collect bromoethane, in order to prevent the loss of the bromoethane distillate.

(1)



- (g) Describe how to use a separating funnel to remove the aqueous layer from the bromoethane collected in Step 6.

[Densities: bromoethane = 1.47 g cm^{-3} water = 1.00 g cm^{-3}]

(2)

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- (h) State why the bromoethane would **not** be dried in Step 7 by placing in a warm oven.

(1)

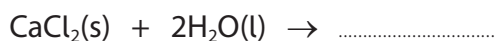
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- (i) A small quantity of water is removed by the drying agent anhydrous calcium chloride.

Complete the equation by adding the formula of the product including its state symbol.

(1)



- (j) State a chemical test for the $-\text{OH}$ group in ethanol and a chemical test for the $-\text{Br}$ group in bromoethane. Include the expected positive observations.

(4)

$-\text{OH}$ group in ethanol

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$-\text{Br}$ group in bromoethane

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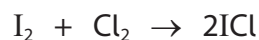
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(Total for Question 2 = 17 marks)

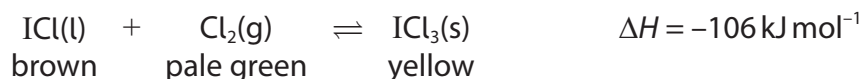


- 3 The equilibrium between iodine(I) chloride, chlorine and iodine(III) chloride can be used to demonstrate the effects of changing conditions on a system at equilibrium.

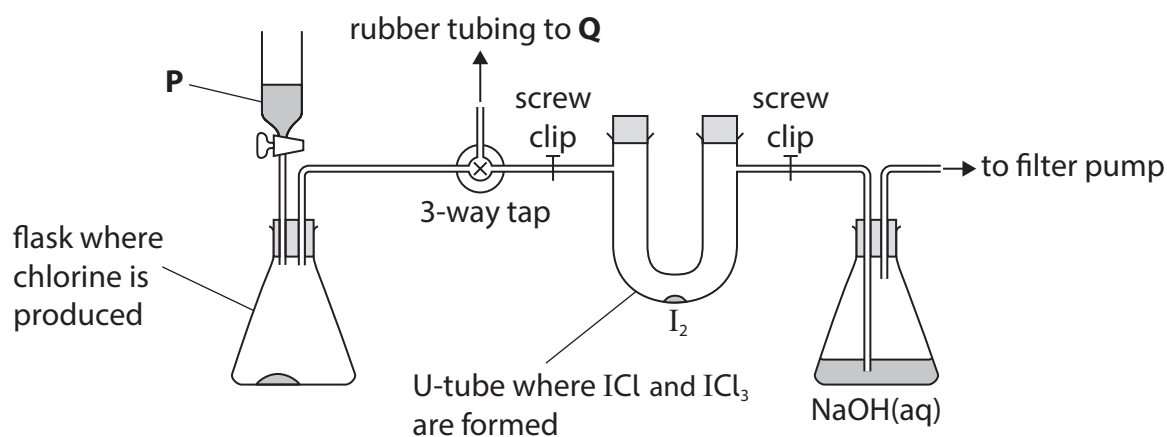
Iodine(I) chloride is formed by passing chlorine over iodine in a U-tube.
The equation for this is shown.



A further reaction then occurs between the iodine(I) chloride and chlorine which results in the equilibrium shown.



The apparatus shown can be used to set up and then to demonstrate how the system at equilibrium responds to changing conditions.



- (a) The addition of more liquid **P** to the flask on the left produces more chlorine gas.
- (i) Explain the observations you would make as the amount of chlorine gas in the U-tube increases.

(3)

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(ii) The 3-way tap can be used to prevent more chlorine gas from entering the equilibrium system.

Identify **Q** and state why it is necessary.

(2)

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(b) Explain what you could do to the U-tube to result in more brown liquid being observed.

(2)

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(c) The sodium hydroxide solution absorbs excess chlorine.

Write the equation for the reaction between cold, dilute sodium hydroxide and chlorine.

State symbols are not required.

(2)

(Total for Question 3 = 9 marks)

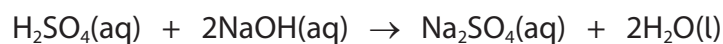
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- 4 An experiment was carried out to determine the enthalpy change of neutralisation for the reaction between sulfuric acid and sodium hydroxide.



Procedure

Step 1 25.0 cm³ of 1.25 mol dm⁻³ sulfuric acid was placed in a polystyrene cup. The polystyrene cup was then placed in a beaker. A thermometer was used to measure the temperature of the acid and a clock was started.

Step 2 The temperature of the sulfuric acid was measured every 30 seconds for 2½ minutes.

Step 3 50.0 cm³ of 1.25 mol dm⁻³ sodium hydroxide solution was added to the acid in the polystyrene cup at 3 minutes and the mixture was constantly stirred.

Step 4 The temperature of the mixture in the polystyrene cup was measured at 3½ minutes and then every 30 seconds until the clock reached 10 minutes.

- (a) Give the reason why the polystyrene cup in Step 1 was placed in a beaker. (1)

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- (b) State the purpose of measuring the temperature every 30 seconds for 2½ minutes in Step 2. (1)

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- (c) Explain why the temperature was not measured at 3 minutes. (2)

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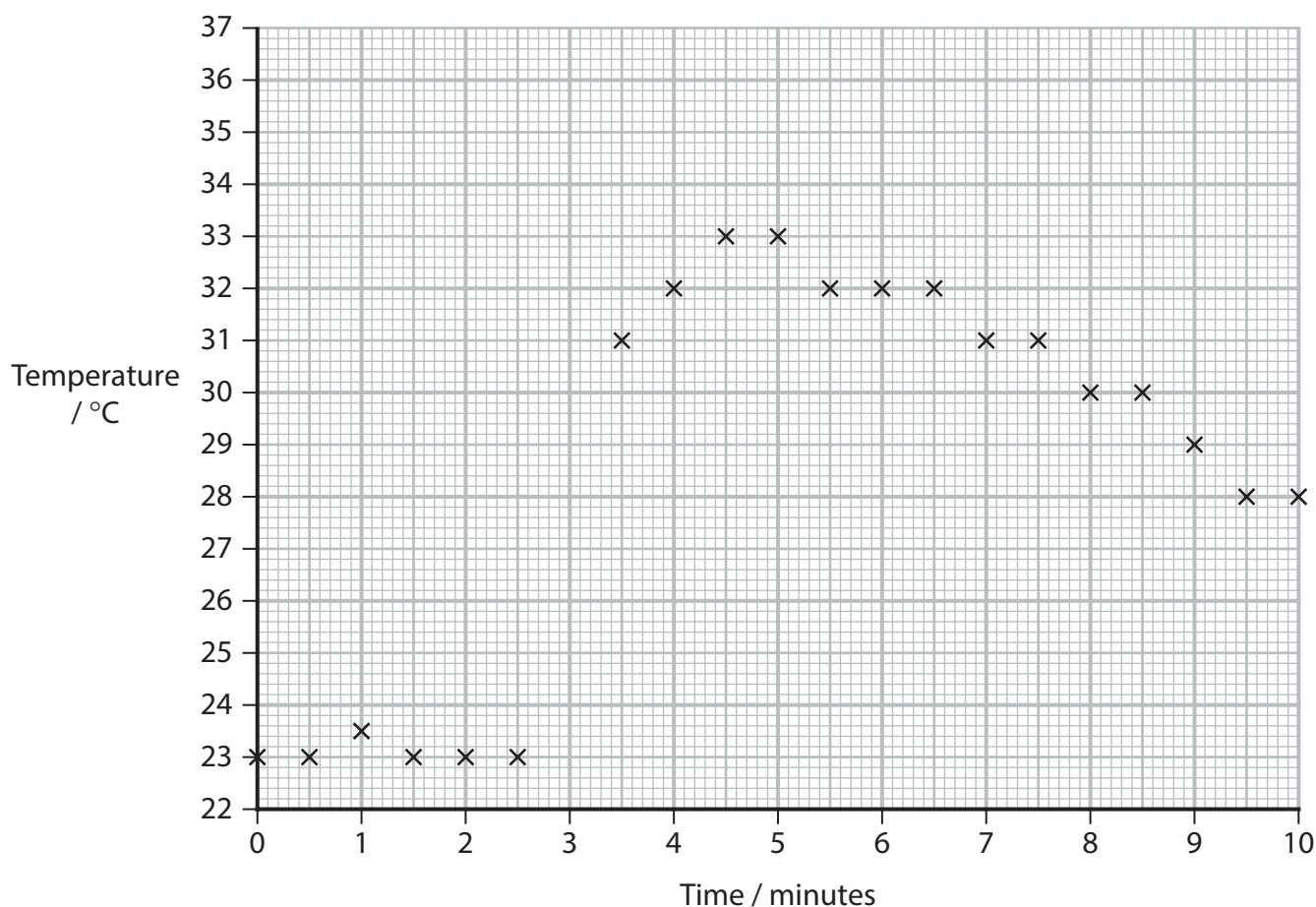
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(d) The data from the experiment are shown on the graph.



- (i) Determine the maximum temperature change, ΔT , for this reaction, using the graph.
You **must** show your working on the graph.

(2)

- (ii) Explain why the temperature decreases over time after 5 minutes.

(2)

- (iii) Give a possible reason why the temperature does not appear to change at various times, such as 5½ to 6½ minutes.

(1)



(iv) State why the data will not result in the **standard** molar enthalpy change of neutralisation being calculated.

(1)

(e) When calculating the enthalpy change of neutralisation, the two expressions shown are used.

$$\text{energy transferred} = \text{mass} \times \frac{\text{specific}}{\text{heat capacity}} \times \text{temperature change}$$

$$\text{enthalpy change} = \text{energy transferred} \div \text{moles}$$

(i) Explain why it may or may not be valid to assume that the specific heat capacity of water is suitable to be used for this reaction.

(2)

(ii) State why the number of moles of sodium hydroxide and **not** the number of moles of sulfuric acid is used in the calculation for this experiment.

(1)

(Total for Question 4 = 13 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	9.0	45.0	47.9	50.9	52.0	54.9	55.8	58.9	58.7	63.5	65.4	10.8	12.0	14.0	16.0	19.0	4.0
Li	Be	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	B	C	N	O	F	He
lithium	beryllium	scandium	titanium	vanadium	chromium	manganese	iron	cobalt	nickel	copper	zinc	boron	carbon	nitrogen	oxygen	fluorine	helium
3	4	21	22	23	24	25	26	27	28	29	30	5	6	7	8	9	2
23.0	24.3	88.9	91.2	92.9	95.9	[98]	101.1	102.9	106.4	107.9	112.4	27.0	28.1	31.0	32.1	35.5	39.9
Na	Mg	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	Al	Si	P	S	Cl	Ar
sodium	magnesium	yttrium	zirconium	niobium	molybdenum	technetium	ruthenium	rhodium	palladium	silver	cadmium	aluminium	silicon	phosphorus	sulfur	chlorine	argon
11	12	39	40	41	42	43	44	45	46	47	48	13	14	15	16	17	18
39.1	40.1	88.9	91.2	92.9	95.9	[98]	101.1	102.9	106.4	107.9	112.4	69.7	72.6	74.9	79.0	79.9	83.8
K	Ca	La*	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Ga	Ge	As	Se	Br	Kr
potassium	calcium	lanthanum	hafnium	tantalum	tungsten	rhenium	osmium	iridium	platinum	gold	mercury	gallium	germanium	arsenic	selenium	bromine	krypton
19	20	57	72	73	74	75	76	77	78	79	80	31	32	33	34	35	36
85.5	87.6	138.9	178.5	180.9	183.8	186.2	190.2	192.2	195.1	197.0	200.6	69.7	72.6	74.9	79.0	79.9	83.8
Rb	Sr	La*	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	In	Sn	Sb	Te	I	Xe
rubidium	strontium	lanthanum	hafnium	tantalum	tungsten	rhenium	osmium	iridium	platinum	gold	mercury	indium	tin	antimony	tellurium	iodine	xenon
37	38	57	72	73	74	75	76	77	78	79	80	49	50	51	52	53	54
132.9	137.3	138.9	178.5	180.9	183.8	186.2	190.2	192.2	195.1	197.0	200.6	114.8	118.7	121.8	127.6	126.9	131.3
Cs	Ba	La*	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
caesium	barium	lanthanum	hafnium	tantalum	tungsten	rhenium	osmium	iridium	platinum	gold	mercury	thallium	lead	bismuth	polonium	astatine	radon
55	56	57	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86
[223]	[226]	[227]	[261]	[262]	[266]	[264]	[277]	[268]	[271]	[272]	[272]	204.4	207.2	209.0	[209]	[210]	[222]
Fr	Ra	Ac*	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Rg	Pb	Pb	Bi	Po	At	Rn
francium	radium	actinium	rutherfordium	dubnium	seaborgium	bohrium	hassium	meitnerium	darmstadtium	roentgenium	roentgenium	lead	lead	bismuth	polonium	astatine	radon
87	88	89	104	105	106	107	108	109	110	111	111	82	82	83	84	85	86

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

* Lanthanide series

* Actinide series

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