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5070/32

May/June 2022

1 hour 30 minutes

You must answer on the question paper.

You will need: The materials and apparatus listed in the confidential instructions

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

- The total mark for this paper is 40.
- The number of marks for each question or part question is shown in brackets [].
- Notes for use in qualitative analysis are provided in the question paper.

For Examiner's Use	
1	
2	
Total	

This document has **8** pages. Any blank pages are indicated.

- 1 **P** is a mixture of equal volumes of dilute hydrochloric acid, HCl , and dilute sulfuric acid, H_2SO_4 .

The concentration of hydrogen ions in **P** is determined by titrating this solution with aqueous sodium carbonate, **Q**.

Q is 0.275 mol/dm^3 sodium carbonate, Na_2CO_3 .

- (a) Put **P** into the burette.

Pipette 25.0 cm^3 of **Q** into a flask and titrate with **P**, using methyl orange indicator.

Record your results in the table, repeating the titration as many times as you consider necessary to achieve consistent results.

Results

Burette readings

titration number	1	2	
final reading / cm^3			
initial reading / cm^3			
volume of P used / cm^3			
best titration results (✓)			

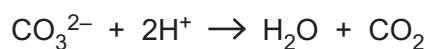
Summary

Tick (✓) the best titration results.

Using the best titration results the average volume of **P** required is cm^3 . [12]

- (b) **Q** is 0.275 mol/dm^3 sodium carbonate.

The ionic equation for the reaction is shown.



Use your results from (a) to calculate the concentration, in mol/dm^3 , of hydrogen ions in **P**.

Give your answer to three significant figures.

..... mol/dm^3 [2]

P is a mixture of dilute hydrochloric acid, HCl , and dilute sulfuric acid, H_2SO_4 .

The concentration of hydrochloric acid in **P** is 0.135 mol/dm^3 .

- (c) Use your answer from (b) to calculate the number of moles of hydrogen ions from sulfuric acid in 1.00 dm^3 of **P**.

..... mol [1]

- (d) Use your answer from (c) to calculate the concentration, in mol/dm^3 , of sulfuric acid in **P**.

..... mol/dm^3 [1]

- (e) **P** is a mixture of equal volumes of dilute hydrochloric acid, HCl , and dilute sulfuric acid, H_2SO_4 .

Calculate the concentration, in mol/dm^3 , of the dilute hydrochloric acid used to make **P**.

..... mol/dm^3 [1]

- (f) Write the formulae of the **two** salts formed during this titration.

..... and [1]

[Total: 18]

2 You are provided with two solutions, **R** and **S**.

(a) Do the following tests on **R** and record your observations in the table.

test no.	test	observations
1	(i) To 1 cm depth of R in a test-tube, add an equal volume of aqueous silver nitrate and leave to stand. (ii) To the mixture from (i), add 1 cm depth of dilute nitric acid.	
2	(i) To 1 cm depth of R in a test-tube, add aqueous sodium hydroxide until a change is seen. (ii) To the mixture from (i), add excess aqueous sodium hydroxide.	
3	(i) To 1 cm depth of R in a test-tube, add a small amount of ascorbic acid and mix well. (ii) To the mixture from (i), add aqueous sodium hydroxide until no further change is seen.	
4	(i) To 1 cm depth of R in a test-tube, add an equal volume of aqueous potassium iodide. (ii) To the mixture from (i), add 1 or 2 drops of starch indicator.	

[9]

(b) Conclusion

The cation in **R** responsible for the observations in test 2 is

[1]

(c) Do the following tests on **S** and record your observations in the table.

Test and name any gas evolved.

test no.	test	observations
1	(i) To 1 cm depth of S in a test-tube, add an equal volume of aqueous barium nitrate.	
	(ii) To the mixture from (i), add 1 cm depth of dilute nitric acid.	
2	(i) To 1 cm depth of S in a test-tube, add aqueous ammonia until a change is seen.	
	(ii) To the mixture from (i), add excess aqueous ammonia.	
3	(i) To 1 cm depth of S in a boiling tube, add aqueous sodium hydroxide until a change is seen.	
	(ii) To the mixture from (i), add excess aqueous sodium hydroxide.	
	(iii) Warm the mixture from (ii) in the boiling tube.	

[9]

(d) **Conclusions**

The solid used to prepare solution **S** contains two cations and one anion.

Identify these ions.

cations and

anion

[3]

[Total: 22]

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QUALITATIVE ANALYSIS NOTES

Tests for anions

<i>anion</i>	<i>test</i>	<i>test result</i>
carbonate (CO_3^{2-})	add dilute acid	effervescence, carbon dioxide produced
chloride (Cl^-) [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	white ppt.
iodide (I^-) [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	yellow ppt.
nitrate (NO_3^-) [in solution]	add aqueous sodium hydroxide, then add aluminium foil; warm carefully	ammonia produced
sulfate (SO_4^{2-}) [in solution]	acidify with dilute nitric acid, then add aqueous barium nitrate	white ppt., insoluble in excess dilute nitric acid

Tests for aqueous cations

<i>cation</i>	<i>effect of aqueous sodium hydroxide</i>	<i>effect of aqueous ammonia</i>
aluminium (Al^{3+})	white ppt., soluble in excess, giving a colourless solution	white ppt., insoluble in excess
ammonium (NH_4^+)	ammonia produced on warming	—
calcium (Ca^{2+})	white ppt., insoluble in excess	no ppt.
chromium(III) (Cr^{3+})	green ppt., soluble in excess, giving a green solution	green ppt., insoluble in excess
copper(II) (Cu^{2+})	light blue ppt., insoluble in excess	light blue ppt., soluble in excess, giving a dark blue solution
iron(II) (Fe^{2+})	green ppt., insoluble in excess	green ppt., insoluble in excess
iron(III) (Fe^{3+})	red-brown ppt., insoluble in excess	red-brown ppt., insoluble in excess
zinc (Zn^{2+})	white ppt., soluble in excess, giving a colourless solution	white ppt., soluble in excess, giving a colourless solution

Tests for gases

<i>gas</i>	<i>test and test result</i>
ammonia (NH_3)	turns damp red litmus paper blue
carbon dioxide (CO_2)	turns limewater milky
chlorine (Cl_2)	bleaches damp litmus paper
hydrogen (H_2)	'pops' with a lighted splint
oxygen (O_2)	relights a glowing splint

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