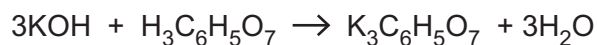


- 1 Citric acid is a carboxylic acid found in lemon juice.

The equation for the reaction between citric acid, $\text{H}_3\text{C}_6\text{H}_5\text{O}_7$, and potassium hydroxide, KOH , is shown.



The mass of citric acid dissolved in 500 cm^3 of an aqueous solution can be determined by titration with KOH(aq) .

Thymolphthalein is used to determine the end-point of the titration.

P is $0.100\text{ mol/dm}^3\text{ KOH(aq)}$.

Q is aqueous citric acid.

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

Pipette 25.0 cm^3 of **Q** into a flask and titrate with **P** using three drops of thymolphthalein as the indicator.

The end-point is the first appearance of a blue colour that remains for 30 seconds.

Record your results in the table.

Repeat the titration as many times as 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 in the table.

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

[12]

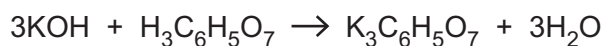
(b) **P** is $0.100 \text{ mol/dm}^3 \text{ KOH(aq)}$.

Use your results from (a) to calculate the number of moles of KOH in the average volume of **P** used.

Give your answer to **three** significant figures.

number of moles of KOH [1]

(c) Use your answer from (b) to calculate the number of moles of citric acid in 25.0 cm^3 of **Q**.



number of moles of citric acid in 25 cm^3 of **Q** [1]

(d) Use your answer from (c) to calculate:

(i) the concentration of citric acid in **Q**.

concentration of citric acid in **Q** mol/dm^3 [1]

(ii) the number of moles of citric acid in 500 cm^3 of **Q**.

number of moles of citric acid in 500 cm^3 of **Q** [1]

- (e) Citric acid is available in hydrated form.

The formula of hydrated citric acid is $\text{H}_3\text{C}_6\text{H}_5\text{O}_7 \cdot \text{H}_2\text{O}$

Use your answer from (d)(ii) to calculate the mass of hydrated citric acid crystals needed to make 500 cm^3 of **Q**.

[A_r : H, 1; C, 12; O, 16]

mass of hydrated citric acid in 500 cm^3 of **Q** g [2]

[Total: 18]

2 You are provided with solution **R** and solid **S**.

(a) (i) Do the tests on **R** shown in the table.

Record your observations in the table.

You should test and name any gases evolved.

test no.	test	observations
1	To 1 cm depth of R in a test-tube, add a few drops of universal indicator solution. Keep the solution for use in test 2.	
2	To the solution from test 1, add dilute nitric acid drop by drop until a change is seen.	
3	To 1 cm depth of R in a boiling tube, add 1 cm depth of aqueous sodium hydroxide. Gently warm the mixture. Keep the solution for use in test 4.	
4	To the solution from test 3, add 3 cm depth of dilute nitric acid and then add 1 cm depth of aqueous silver nitrate.	

[6]

(ii) Identify the cation responsible for the colour seen in test 1.

cation

[1]

(iii) Identify the cation responsible for the observations in test 3.

cation

[1]

(iv) Identify the anion responsible for the observation in test 4.

anion

[1]

(b) (i) Do the tests on **S** shown in the table.

Record your observations in the table.

You should test and name any gases evolved.

test no.	test	observations
1	To the sample of S in a boiling tube, add 2 cm depth of dilute nitric acid. Keep the solution for use in tests 2 , 3 and 4 .	
2	To 1 cm depth of the solution from test 1 in a test-tube, add aqueous sodium hydroxide drop by drop until a change is seen. Add excess aqueous sodium hydroxide.	
3	To 1 cm depth of the solution from test 1 in a test-tube, add aqueous ammonia drop by drop until a change is seen. Add excess aqueous ammonia.	
4	To 1 cm depth of the solution from test 1 in a test-tube, add a few drops of dilute nitric acid and then add 1 cm depth of aqueous barium nitrate.	

[11]

(ii) Identify solid **S**.

solid **S**

[2]

[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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