

- 1 Ethanedioic acid, $\text{H}_2\text{C}_2\text{O}_4$, forms crystals which are hydrated and have the formula $\text{H}_2\text{C}_2\text{O}_4 \cdot x\text{H}_2\text{O}$.

For
Examiner's
Use

P is a solution containing 9.45 g of $\text{H}_2\text{C}_2\text{O}_4 \cdot x\text{H}_2\text{O}$ in 1.00 dm^3 of solution.

Q is 0.150 mol/dm^3 sodium hydroxide, NaOH .

You are to determine the value of **x** in the formula $\text{H}_2\text{C}_2\text{O}_4 \cdot x\text{H}_2\text{O}$ by titrating **Q** with **P**.

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

Pipette a 25.0 cm^3 (or 20.0 cm^3) portion of **Q** into a flask and titrate with **P**, using the indicator provided.

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 these results, the average volume of **P** required was cm^3 .

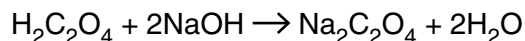
Volume of **Q** used was cm^3 .

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- (b) **Q** is 0.150 mol/dm³ sodium hydroxide.

Using your results from (a), calculate the concentration, in mol/dm³, of the ethanedioic acid, H₂C₂O₄, in **P**.

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concentration of ethanedioic acid in **P** mol/dm³ [2]

- (c) Using your answer from (b), calculate the concentration, in g/dm³, of ethanedioic acid, H₂C₂O₄, in **P**.

[The relative formula mass of ethanedioic acid is 90.]

concentration of ethanedioic acid in **P** g/dm³ [1]

- (d) Using your answer from (c), calculate the mass of water in 9.45 g of hydrated ethanedioic acid, H₂C₂O₄·xH₂O.

mass of water g [1]

- (e) Calculate the value of **x** in the formula H₂C₂O₄·xH₂O.
[The relative formula mass of H₂O is 18.]

value of **x** [2]

[Total: 18]

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

Carry out the following tests and record your observations in the table. You should test and name any gas evolved.

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test no.	test	observations
1	<p>(a) To 1 cm depth of R in a test-tube, add a few drops of aqueous silver nitrate.</p> <p>(b) Add dilute nitric acid to the mixture from (a).</p>	
2	To 1 cm depth of aqueous iron(III) chloride in a test-tube, add an equal volume of R .	
3	<p>(a) To 1 cm depth of R in a test-tube, add an equal volume of aqueous acidified potassium dichromate(VI).</p> <p>(b) Add aqueous sodium thiosulfate to the mixture from (a) until no further change is seen.</p>	
4	<p>(a) To 1 cm depth of S in a test-tube, add an equal volume of dilute sulfuric acid and then one or two drops of R.</p> <p>(b) To the mixture from (a) add an equal volume of R and allow to stand for a few minutes.</p>	

test no.	test	observations
5	<p>(a) To 1 cm depth of aqueous iron(II) sulfate in a test-tube, add an equal volume of S.</p> <p>(b) Add aqueous sodium hydroxide to the mixture from (a).</p>	
6	To 2 cm depth of aqueous acidified potassium manganate(VII) in a test-tube, add an equal volume of S .	
7	<p>(a) To 1 cm depth of S in a test-tube, add a small amount of copper powder.</p> <p>(b) Add aqueous ammonia to the mixture from (a).</p>	

For
Examiner's
Use

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ConclusionsIdentify the anion present in **R**.The anion in **R** isIn test **5(a)**, **S** is acting asIn test **6**, **S** is acting as

[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.

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., or very slight white ppt.
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 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
sulfur dioxide (SO_2)	turns acidified aqueous potassium dichromate(VI) from orange to green