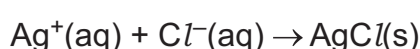


1 The concentration of aqueous chloride ions can be found by titration with aqueous silver nitrate,  $\text{AgNO}_3(\text{aq})$ .



The indicator used is aqueous potassium chromate(VI),  $\text{K}_2\text{CrO}_4(\text{aq})$ .

As  $\text{AgNO}_3(\text{aq})$  is added to aqueous chloride ions, a white precipitate of  $\text{AgCl}(\text{s})$  is formed.

When all the chloride ions have reacted, further addition of  $\text{AgNO}_3(\text{aq})$  leads to the formation of a red precipitate of silver chromate(VI),  $\text{Ag}_2\text{CrO}_4(\text{s})$ . The first appearance of the red precipitate shows the end-point of the titration.

A student carries out an experiment to determine the number of molecules of water of crystallisation,  $x$ , in hydrated barium chloride,  $\text{BaCl}_2 \cdot x\text{H}_2\text{O}(\text{s})$ .

(a) The student makes  $250.0 \text{ cm}^3$  of  $0.0500 \text{ mol dm}^{-3}$   $\text{AgNO}_3(\text{aq})$  to use for the titration.

(i) Calculate the mass of solid silver nitrate,  $\text{AgNO}_3(\text{s})$ , needed to make  $250.0 \text{ cm}^3$  of  $0.0500 \text{ mol dm}^{-3}$   $\text{AgNO}_3(\text{aq})$ .

Give your answer to **two** decimal places.

mass of  $\text{AgNO}_3(\text{s}) = \dots\dots\dots \text{g}$  [1]

(ii) Describe how the student should make  $250.0 \text{ cm}^3$  of  $0.0500 \text{ mol dm}^{-3}$   $\text{AgNO}_3(\text{aq})$  starting from the mass of  $\text{AgNO}_3(\text{s})$  calculated in (a)(i) in a  $50 \text{ cm}^3$  beaker.

Give the name and size of any key apparatus used.

Write your answer using a series of numbered steps.

.....  
 .....  
 .....  
 .....  
 .....  
 ..... [3]

(b) The student uses the following method.

step 1 Dissolve  $1.58 \text{ g}$  of  $\text{BaCl}_2 \cdot x\text{H}_2\text{O}(\text{s})$  to form  $250 \text{ cm}^3$  of aqueous solution. Label this solution **A**.

step 2 Transfer  $20.0 \text{ cm}^3$  of solution **A** into a conical flask.

step 3 Add aqueous sodium sulfate,  $\text{Na}_2\text{SO}_4(\text{aq})$ , to the flask and swirl the mixture to remove barium ions from the solution.

step 4 Add 2–3 drops of  $\text{K}_2\text{CrO}_4(\text{aq})$  indicator to the flask.

step 5 Titrate the contents of the flask against  $0.0500 \text{ mol dm}^{-3}$   $\text{AgNO}_3(\text{aq})$ .

step 6 Repeat steps 2 to 5 to collect sufficient data for analysis.

(i) Suggest a suitable piece of apparatus for transferring  $20.0 \text{ cm}^3$  of solution **A** in step 2.

..... [1]

(ii) Suggest why barium ions are removed in step 3 before performing the titration.

.....  
 ..... [1]

(iii) Suggest why chemically resistant gloves should be worn to carry out step 4.

..... [1]

(c) The student's results are shown in Table 1.1.

**Table 1.1**

	rough titration	titration 1	titration 2	titration 3
burette reading (final)/ $\text{cm}^3$	20.10	40.55	20.75	20.90
burette reading (initial)/ $\text{cm}^3$	0.00	20.25	0.05	0.30
titre/ $\text{cm}^3$	20.10	20.30	20.70	20.60

The student uses the titres from titrations 2 and 3 shown in Table 1.1 to calculate a mean titre value of  $20.65 \text{ cm}^3$ .

(i) Explain why only these two values are used.

..... [1]

(ii) Calculate the percentage error in the titre volume for titration 3. Show your working.

percentage error = ..... [1]

(d) The equation for the reaction of silver nitrate with barium chloride is shown.



(i) Calculate the amount, in mol, of  $\text{AgNO}_3(\text{aq})$  in the mean titre of  $20.65 \text{ cm}^3$ .

amount of  $\text{AgNO}_3 = \dots\dots\dots \text{mol}$  [1]

(ii) Calculate the amount, in mol, of  $\text{BaCl}_2(\text{aq})$  in  $250 \text{ cm}^3$  of solution **A**.

amount of  $\text{BaCl}_2 = \dots\dots\dots \text{mol}$  [1]

(iii) Calculate the value of  $x$  in the formula  $\text{BaCl}_2 \cdot x\text{H}_2\text{O}$ .

$x = \dots\dots\dots$  [2]

(e) Another student uses a different experimental method to check the value of  $x$  obtained by the method described in (b).

Give a **brief** description of another method, not involving titration, that could be used to determine the value of  $x$  in the formula  $\text{BaCl}_2 \cdot x\text{H}_2\text{O}(\text{s})$ . Write your answer using a series of numbered steps.

Your plan should include details of the following:

- the apparatus and method you would use
- the measurements you would make.

You are provided with standard laboratory apparatus.

.....  
 .....  
 .....  
 .....  
 .....  
 ..... [3]