Worksheet 12.3

Finding the formula of an organic acid by titration

A titration analysis of a compound can produce some very useful information. A student was given a sample of an organic acid, **A**, and asked to determine its relative molecular mass, and then suggest its molecular formula.

A sample of the acid was placed in a previously weighed beaker and the following results obtained:

mass of the container and the acid = 10.27 g
mass of container = 8.76 g

1 Calculate the mass of the acid used in the experiment.

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The student then worked through the following procedure:

- The sample was transferred to a beaker and 50.0 cm^3 of 1.00 mol/dm^3 sodium hydroxide were added.
- The contents of the beaker were allowed to react and were then washed into a volumetric flask. The solution was made up to 250 cm^3 with distilled water. This was solution **B**.
- 25.0 cm^3 of **B** was transferred to a conical flask.

2 What piece of apparatus was used to measure this volume of **B**?

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- Then a few drops of phenolphthalein were added to the conical flask as indicator. A solution of 0.100 mol/dm^3 hydrochloric acid was placed in a burette and titrated with the sample of solution **B** until an end-point was reached.

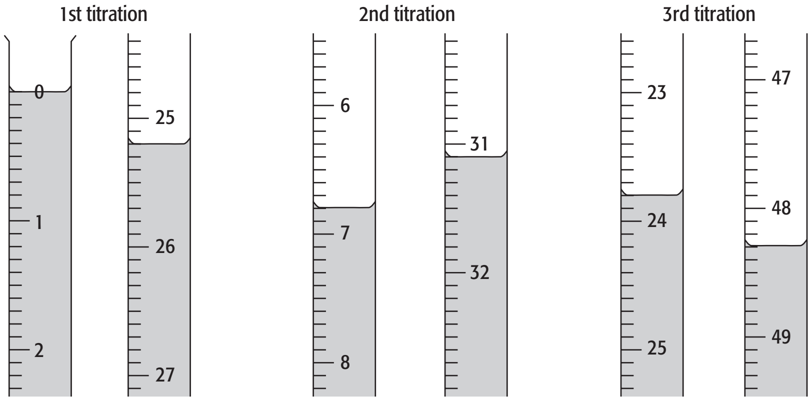
3 Phenolphthalein is colourless in acidic solution and pink in alkaline solution.

What was the colour of the solution in the conical flask:

a before the acid was added? ....

b at the end-point? ....

- Three titrations were done. The following diagrams show parts of the burette with the liquid levels at the beginning and the end of each titration.



4 Use the values from the diagrams to complete the following table.

Titration number	1	2	3
Final reading / cm^3			
Initial reading / cm^3			
Volume of hydrochloric acid used / cm^3			
Best titration results (✔)			

Conclusions

Place a tick (✔) against the best titration results in the table.

Using these results, the calculated average volume of hydrochloric acid required = ... cm^3.

5 Calculate the number of moles of hydrochloric acid in this average volume of 0.100 mol/dm^3 hydrochloric acid.

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6 Hydrochloric acid reacts with sodium hydroxide according to the following equation:

$$HCl + NaOH \rightarrow NaCl + H_2O$$

Deduce the number of moles of sodium hydroxide present in 25.0 cm^3 of solution **B**.

....

....

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7 From this answer, calculate the number of moles of sodium hydroxide in 250 cm^3 of solution **B**.

....

....

8 Calculate the number of moles of sodium hydroxide in the original 50.0 cm^3 of 1.00 mol/dm^3 sodium hydroxide.

....

....

9 Subtract the answer in **7** from the answer in **8**. This is the number of moles of sodium hydroxide that reacted with the original sample of the organic acid, **A**.

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10 Given the fact that **one** mole of **A** reacts with **two** moles of sodium hydroxide, calculate the number of moles of **A** in the sample.

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11 Using your answers to **1** and **10,** calculate the relative molecular mass of the acid **A**.

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The acid **A** contains two carboxylic acid groups and has the formula $HOOCC_xH_yCOOH$ where x and y are whole numbers.

12 Hence deduce the values of x and y in the formula.

(A_r: C = 12; O = 16; H = 1)

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