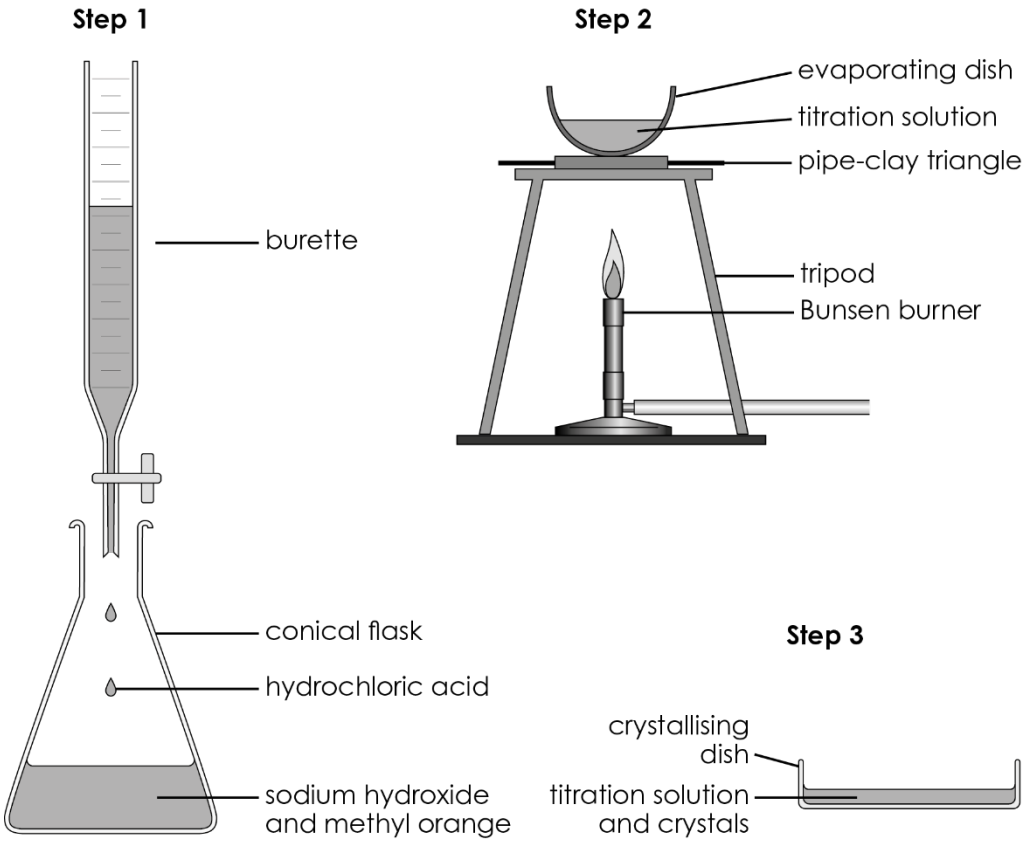
# Solubility

Some students are preparing the soluble salt sodium chloride using hydrochloric acid and sodium hydroxide solution. The image shows some of the apparatus they use.




**1** (a) What is the method in **Step 1** called?

_____

(b) The students' first step is to accurately measure 25 $cm^3$ sodium hydroxide solution into the conical flask. Circle the most accurate piece of equipment to use to measure this volume.

**A** beaker

**B** conical flask

**C** measuring cylinder

**D** volumetric pipette

(c) The concentration of the sodium hydroxide solution is $4.00\ \text{g/dm}^3$. Calculate the mass of sodium hydroxide dissolved in $25\ \text{cm}^3$ of the solution.

*Hint*: $\text{concentration} = \frac{\text{mass}}{\text{volume}}$

(d) What is the role of methyl orange?

(e) Methyl orange is red in acidic solution and yellow in alkaline solution. What colour is methyl orange in sodium hydroxide solution?

**2** The students add the dilute hydrochloric acid, $1\ \text{cm}^3$ at a time, to the conical flask until the methyl orange starts to turn orange. They then continue to add the acid drop by drop until the orange colour just persists.

(a) What is contained in the flask when the orange colour just persists? Circle the correct answer.

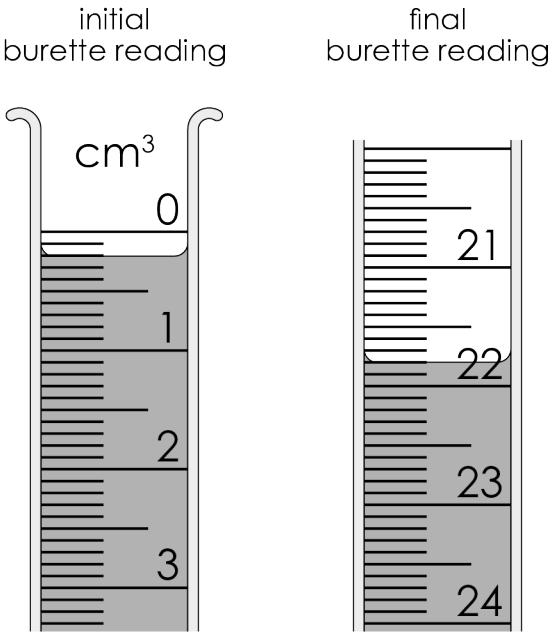
**A** sodium hydroxide solution and sodium chloride solution

**B** methyl orange and sodium chloride solution

**C** dilute hydrochloric acid, sodium hydroxide solution and methyl orange

**D** dilute hydrochloric acid, sodium chloride solution and methyl orange

(b) The image shows the initial and final burette readings observed by the students.




i. What was the initial burette reading?

ii. What was the final burette reading?

iii. What volume of acid was used?

**3** (a) The students then repeated the process, adding the same volume of acid to 25 $cm^3$ sodium hydroxide solution, but omitting the methyl orange.

Describe how the students use the resulting solution to prepare crystals of sodium chloride.
*Hint*: look back at **Step 2** in the apparatus at the start of the sheet.

(b) Which best explains why the students omitted the methyl orange? Circle the correct answer.

**A** Methyl orange would contaminate the sodium chloride.

**B** Methyl orange is insoluble.

**C** Methyl orange is soluble.

**D** This was an error and methyl orange was added later.

(c) The students weighed their sodium chloride crystals.

Mass of sodium chloride crystals = 0.07 g

Their teacher tells them the maximum mass of sodium chloride crystals they could make is 0.15 g.

Calculate the percentage yield to three significant figures.

*Hint*: $\text{percentage yield} = \frac{\text{mass of product actually made}}{\text{maximum theoretical mass of product}} \times 100$

Percentage yield = _____ × 100

= _____%

(d) The reaction between sodium hydroxide and hydrochloric acid used to prepare sodium chloride can be represented by the chemical equation:

$$NaOH(aq) + HCl(aq) \longrightarrow NaCl(aq) + H_2O(l)$$

Calculate the percentage atom economy to produce sodium chloride. Give your answer to three significant figures.

$A_r$ sodium 23 $A_r$ chlorine 35.5 $A_r$ oxygen 16 $A_r$ hydrogen 1

*Hint*: $\text{percentage atom economy} = \frac{\text{total } M_r \text{ of the desired product}}{\text{total } M_r \text{ of all reactants}} \times 100$

$M_r$ NaCl _____ +_____=_____ (the total $M_r$ of the desired product)

$M_r$ NaOH_____ +_____+_____=_____

$M_r$ HCl_____+_____=_____

$M_r$ NaOH + $M_r$ HCl _____+_____=_____ (the total $M_r$ of all reactants)

percentage atom economy = —— × 100

percentage atom economy =_____%

**Which question(s) did you get wrong? Why?**

**What will you do next time you're asked a similar question?**