

Acids and Alkalis Mark Scheme

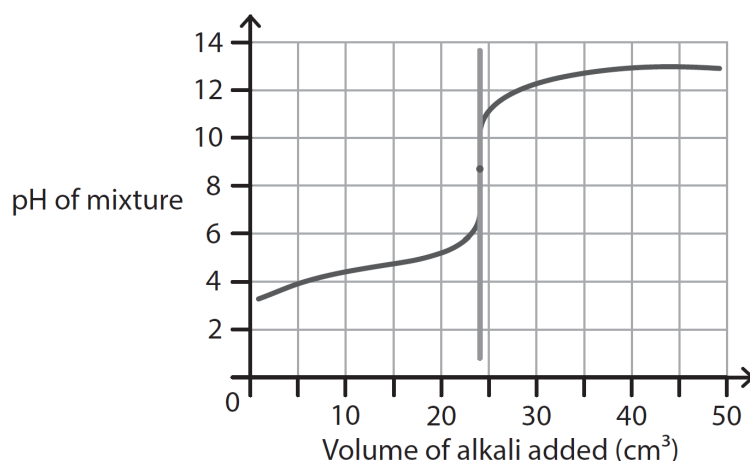


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1. A pH curve is a graph that shows how the pH of a solution changes during a neutralisation reaction.

Circle the letter of the correct answer for each of the following questions.

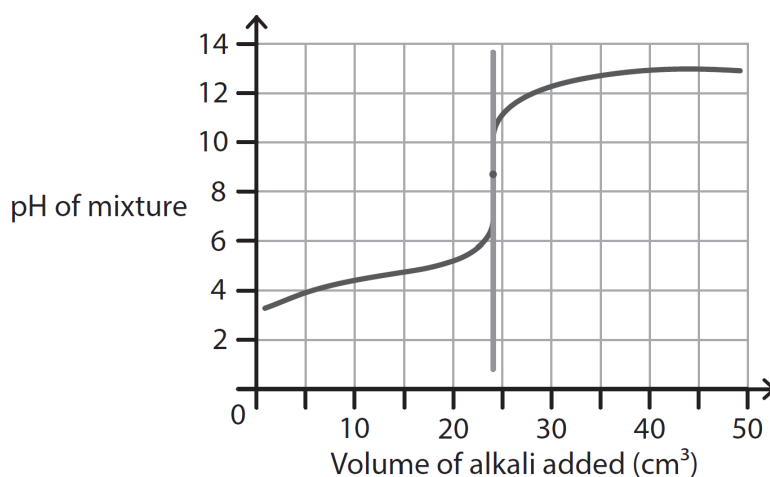
a. The graph below shows the change in pH when a strong alkali is added to an acid.



Which statement correctly describes the reactants?

B – is the only correct answer.	1 mark
	Total: 1 mark

b. The graph below shows the pH curve for the titration of 25.0 cm³ of a strong acid with a strong alkali.

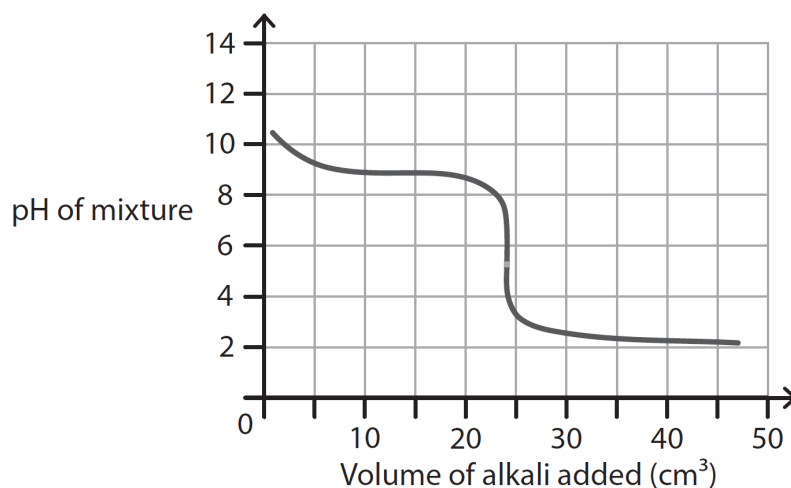


What is the volume of alkali needed to exactly neutralise the acid?

C – is the only correct answer.	1 mark
	Total: 1 mark

- c. The graph below shows the results of a different titration.

A student needs to select a suitable indicator for this titration. The table shows the pH range for three common indicators.

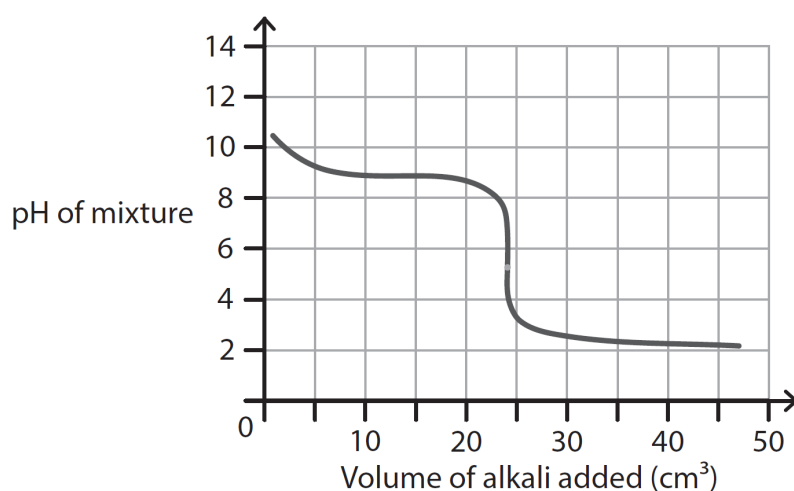


Indicator	pH range of colour change
Methyl orange	3.1 – 4.4
Phenolphthalein	8.3 – 10.0
Universal indicator	1 – 14

Which indicator should the student use?

A – is the only correct answer.	1 mark
	Total: 1 mark

- d. A student carries out the titration shown in the graph below.
They add 0.20 mol/dm^3 sodium hydroxide (NaOH) to 25.0 cm^3 of hydrochloric acid (HCl).



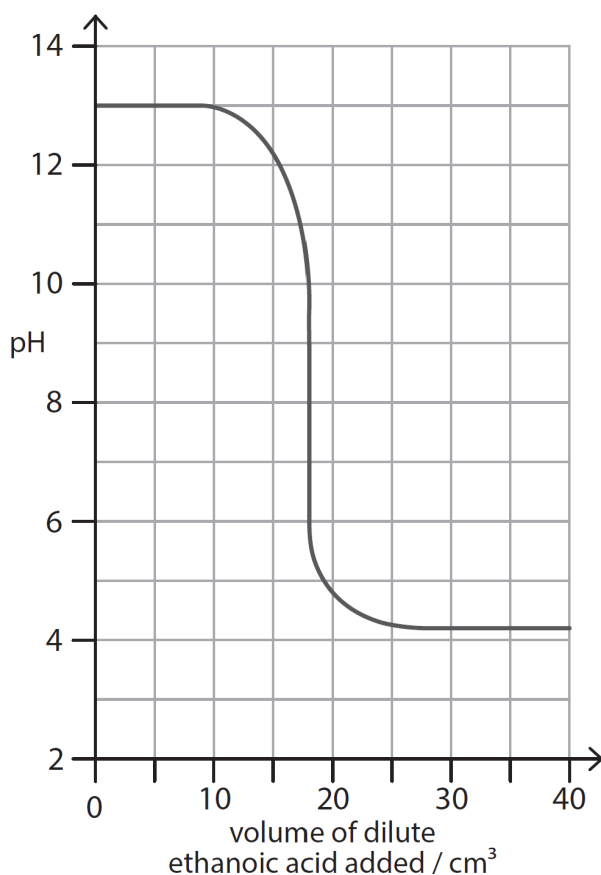
What is the concentration of the hydrochloric acid?

B – is the only correct answer.	1 mark
	Total: 1 mark

(Total for Question 1 is 4 marks)

2. This question is about pH graphs.

The graph shows how the pH changes when dilute ethanoic acid is added slowly to a solution of sodium hydroxide.



a. Determine the pH of the aqueous sodium hydroxide **before** the addition of dilute ethanoic acid.

13	Allow answers in range 12.8 – 13.2 based on graph reading.	1 mark
		Total: 1 mark

b. Deduce the volume of dilute ethanoic acid added when the pH is neutral.

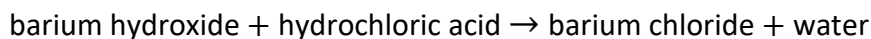
20 (cm³)	Allow 19.5 – 20.5	1 mark
		Total: 1 mark

c. Sodium hydroxide, NaOH, is a strong alkali.
Explain what is meant by a strong alkali?

Strong: Fully ionised / dissociated (in aqueous solution).	1 mark
Alkali: Produces hydroxide ions (OH ⁻) OR Is a soluble base.	1 mark
Total: 2 marks	

(Total for Question 2 is 4 marks)

3. Barium hydroxide reacts with dilute hydrochloric acid to form barium chloride and water.
The word equation for this reaction is:



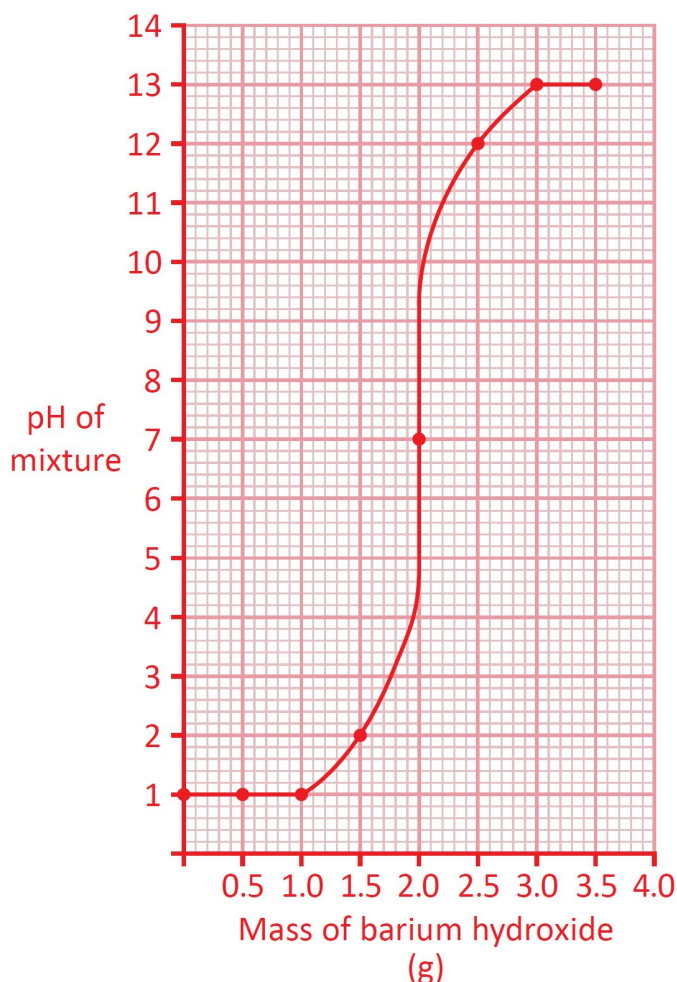
- a. Write the balanced chemical equation for this reaction.

$\text{Ba}(\text{OH})_2 + 2\text{HCl} \rightarrow \text{BaCl}_2 + 2\text{H}_2\text{O}$	
Allow multiples.	
Award 1 mark for the correct chemical formulas.	1 mark
Award 1 mark for the correctly balanced reactants.	1 mark
Award 1 mark for the correctly balanced products.	1 mark
	Total: 3 marks

A student wanted to investigate how the pH of the mixture changes as barium hydroxide is added to dilute hydrochloric acid.

- b. On the grid below:

- Include a suitable scale to the x and y axes of the graph.
- Plot a graph of the pH of the mixture against the mass of barium hydroxide.

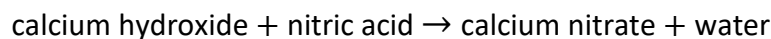


Scale: axes labelled correctly with a scale that covers more than 50% of grid.	1 mark
Points: all points plotted correctly to within $\pm \frac{1}{2}$ small square.	1 mark
Line: Smooth curve of best fit.	1 mark
	Total: 3 marks

(Total for Question 3 is 6 marks)

4. A student investigates the neutralisation reaction between an acid and an alkali.
The student adds hydrochloric acid to a beaker containing calcium hydroxide solution.

The word equation for this reaction is:



- a. Write the balanced chemical equation for this reaction.

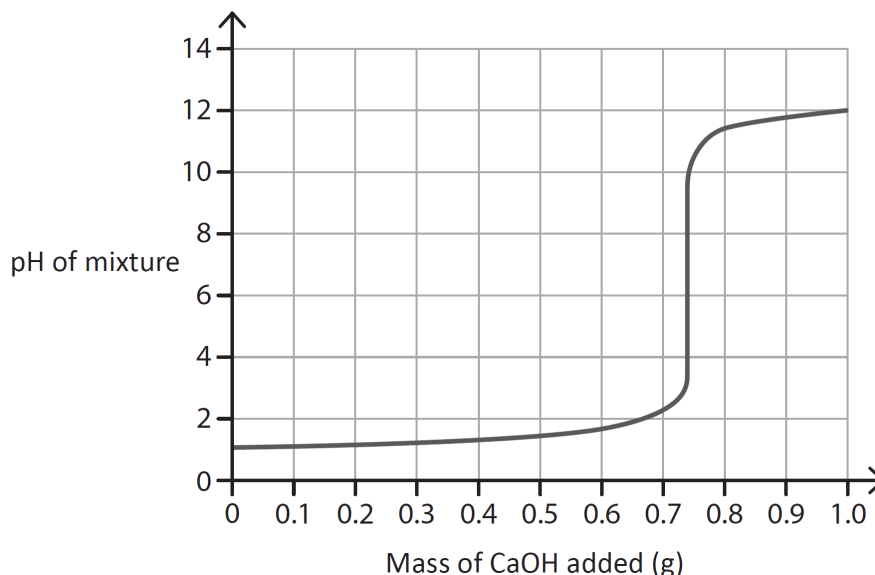
$\text{Ca(OH)}_2 + 2\text{HNO}_3 \rightarrow \text{Ca(NO}_3)_2 + 2\text{H}_2\text{O}$	
Allow multiples.	
Award 1 mark for the correct chemical formulas.	1 mark
Award 1 mark for the correctly balanced reactants.	1 mark
Award 1 mark for the correctly balanced products.	1 mark
	Total: 3 marks

- b. A student plans to investigate the change in pH when calcium hydroxide solution is added to dilute hydrochloric acid.
She will add the calcium hydroxide 0.1 g at a time and measure the pH after each addition.

Identify the **independent** and the **dependent** variable in this investigation.

Independent: Volume / Amount of calcium hydroxide added.	1 mark
Dependent: pH (of the mixture).	1 mark
	Total: 2 marks

The graph of the pH curve below shows the results of her measurements.



- c. Use the graph above, state the pH of the solution at the beginning of the experiment.

pH = 1	1 mark
	Total: 1 mark

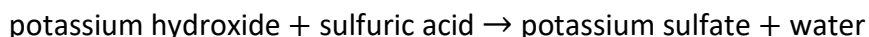
- d. Use the graph above, determine the mass of calcium hydroxide required to neutralise the acid.

0.75 (g)	1 mark
	Total: 1 mark

(Total for Question 4 is 7 marks)

5. Potassium hydroxide reacts with dilute sulfuric acid to form potassium sulfate solution and water.
- a. Complete the balanced equation for the reaction by adding a number in front of KOH(aq).

The word equation for this reaction is:



Write the balanced chemical equation for this reaction.

$2\text{KOH} + \text{H}_2\text{SO}_4 \rightarrow \text{K}_2\text{SO}_4 + 2\text{H}_2\text{O}$	
Allow multiples.	
Award 1 mark for the correct chemical formulas.	1 mark
Award 1 mark for the correctly balanced reactants.	1 mark
Award 1 mark for the correctly balanced products.	1 mark
	Total: 3 marks

- b. State **one** observation you would make during this reaction, other than a change in pH.

Any one from:	
The solid / spatula powder dissolves.	
The solid disappears.	
Temperature increases / beaker gets warm.	
	Total: 1 mark

- **Step 1:** measure out 50 cm³ of dilute sulfuric acid into a beaker using a measuring cylinder.
- **Step 2:** use a glass rod to place a drop of the acid onto a piece of universal indicator paper and record the pH.
- **Step 3:** add one spatula measure of solid potassium hydroxide to the acid in the beaker and stir.
- **Step 4:** use the glass rod to place a drop of the mixture onto a new piece of universal indicator paper and record the pH again.
- **Step 5:** repeat steps 3 and 4 until there is no further change in the pH.

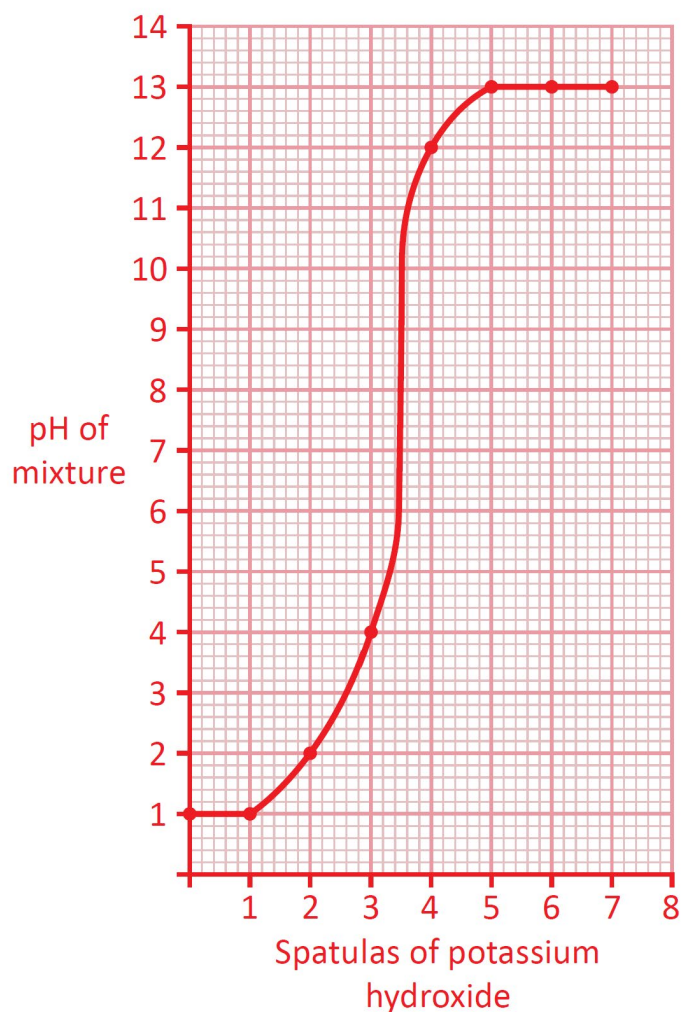
- c. Name a piece of equipment that could be used to measure the pH of a substance more accurately than universal indicator paper.

Equipment: pH probe / pH meter / digital pH reader.	1 mark
Allow removes human error in judging colour.	
Reason: It provides a more accurate / precise reading OR It gives a numerical value (decimal) rather than a subjective colour judgement.	1 mark
	Total: 2 marks

- d. Explain why, in step 3, the mixture was stirred **after** adding the potassium hydroxide.

To ensure the reactants are fully mixed / reacted.	1 mark
Allow to ensure the reaction is complete.	
To ensure the pH is consistent throughout the mixture before measuring.	1 mark
Allow so the pH probe measures the average pH.	
	Total: 2 marks

- e. Plot a graph of the pH of the mixture against the number of spatula measures of potassium hydroxide.
- Include a suitable scale to the x and y axes of the graph.
 - Plot a graph of the pH of the mixture against the number of spatulas potassium hydroxide.



Scale: axes labelled correctly with a scale that covers more than 50% of grid.	1 mark
Points: all points plotted correctly to within $\pm \frac{1}{2}$ small square.	1 mark
Line: Smooth curve of best fit.	1 mark
	Total: 3 marks

- f. Use the graph to find the pH of the mixture when 3.5 spatula measures of potassium hydroxide are added.

Value read from student's graph at $x = 3.5$.	1 mark
	Total: 1 mark

(Total for Question 5 is 12 marks)