AQA GCSE Chemistry | 8462

SPECIFICATION POINT 4.4.2.4

The pH scale and neutralisation

Past-paper questions

Tier	**Higher**
Question groups	**27**
Available paper years	**2007–2025**

Using this booklet

1. Answer the questions in order and show your working.
2. Original question numbers and marks are retained.
3. Print at actual size (100%) for measuring questions.
4. Use the companion answer booklet to check your work.

Name: _____ **Date:** _____

Whole questions are retained for context, so some parts assess other specification points. Current and legacy sources are labelled. Continue on extra paper if needed.

4.4.2.4 The pH scale and neutralisation

Question 01

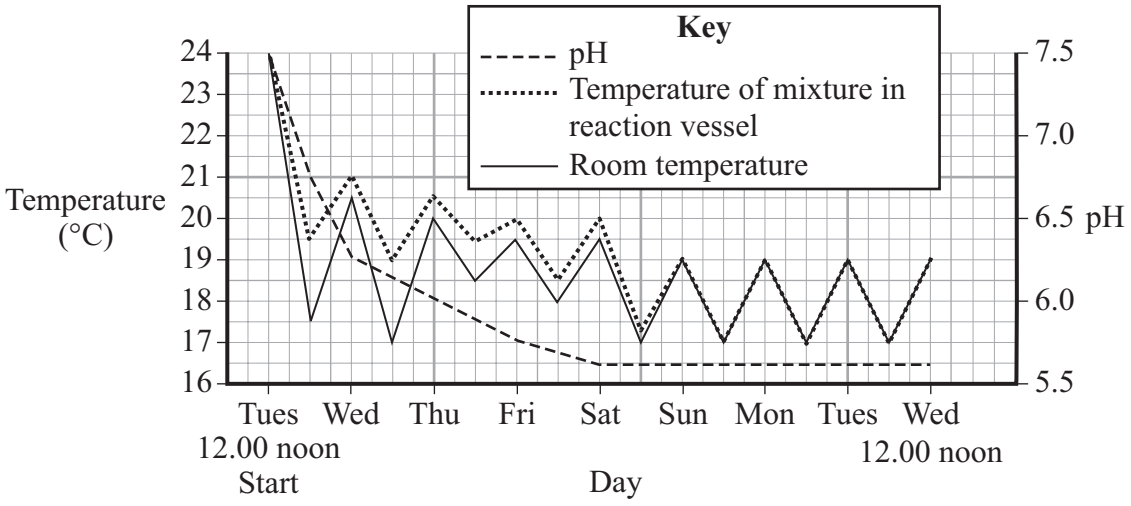
November 2007 | CHY1B | Original Q8 | Legacy

QUESTION EIGHT

Ethanol can be made by the action of yeast on a solution of sugar. This is called fermentation. The sugar is converted to ethanol and carbon dioxide. Carbon dioxide is a slightly acid gas. During fermentation, some of the energy is transferred as thermal energy.

A sugar solution and yeast were put into a reaction vessel.
The temperature of the mixture, the pH of the mixture and the room temperature were recorded over an eight-day period.

The results are shown on the graph.



8A There is a larger difference between the temperature of the mixture and the room temperature during the first few days than there is later.

The probable reason is that . . .

1 fermentation is quicker at the start.

2 the room temperature is steadily decreasing.

3 the pH value of the mixture is decreasing.

4 the room temperature fluctuates.

4.4.2.4 The pH scale and neutralisation

Question 01 · continued

8B From the information on the graph, . . .

1 fermentation is completed after 4 days.

2 fermentation is completed after 5 days.

3 fermentation is completed after 6 days.

4 fermentation continues after 8 days.

8C A general conclusion from the graph is that . . .

1 the yeast cannot survive for more than 8 days.

2 the acidity of the mixture increases in the first 4 days.

3 the acidity of the mixture is greater at the start than when fermentation is completed.

4 the temperature of the mixture does not fall below 18.0 °C.

8D One advantage of producing ethanol by fermentation rather than from ethene is that . . .

1 less carbon dioxide is produced in fermentation.

2 there are no waste products.

3 the raw materials are renewable.

4 the ethanol does not need further processing.

4.4.2.4 The pH scale and neutralisation

Question 02

5 Distress flares are used to attract attention in an emergency.



Flares often contain the element magnesium. Magnesium burns to form magnesium oxide.

(a) The distress flare burns with a bright flame because the reaction is very *exothermic*.

State the meaning of *exothermic*.

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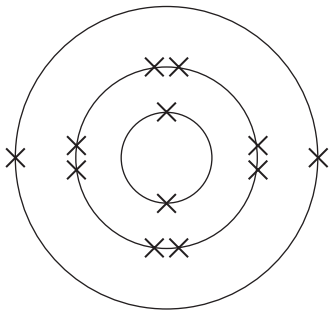
(1 mark)

(b) Write a balanced symbol equation for the reaction between magnesium (Mg) and oxygen (O_2) to form magnesium oxide (MgO).

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(1 mark)

(c) The diagram shows the electronic structure of a magnesium atom.
The atomic (proton) number of magnesium is 12.



Magnesium atom

Draw a similar diagram to show the electronic structure of an oxygen atom.
The atomic (proton) number of oxygen is 8.

(1 mark)

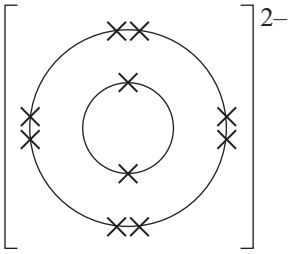
4.4.2.4 The pH scale and neutralisation

Question 02 · continued

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(d) Magnesium ions and oxide ions are formed when magnesium reacts with oxygen.

The diagram shows the electronic structure of an oxide ion.



Oxide ion

Draw a similar diagram to show the electronic structure of a magnesium ion.

(1 mark)

(e) Magnesium oxide is a white solid with a high melting point.

Explain how the ions are held together in solid magnesium oxide.

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(2 marks)

(f) Indigestion tablets can be made from magnesium oxide. The magnesium oxide neutralises some of the hydrochloric acid in the stomach.

Complete the word equation for the reaction between magnesium oxide and hydrochloric acid.

hydrochloric acid + magnesium oxide → ..... + water.

(1 mark)

7

4.4.2.4 The pH scale and neutralisation

Question 03

5 In 1916, during the First World War, a German U-boat sank a Swedish ship which was carrying a cargo of champagne. The wreck was discovered in 1997 and the champagne was brought to the surface and analysed.

(a) 25.0 cm^3 of the champagne were placed in a conical flask.

Describe how the volume of sodium hydroxide solution needed to react completely with the weak acids in 25.0 cm^3 of this champagne can be found by titration, using phenolphthalein indicator.

Name any other apparatus used.

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(4 marks)

(b) The acid in 25.0 cm^3 of the champagne reacted completely with 13.5 cm^3 of sodium hydroxide of concentration 0.10 moles per cubic decimetre.

Calculate the concentration in moles per cubic decimetre of acid in the champagne.

Assume that 1 mole of sodium hydroxide reacts completely with 1 mole of acid.

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Concentration = ... moles per cubic decimetre

(2 marks)

4.4.2.4 The pH scale and neutralisation

Question 03 · continued

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(c) Is analysis by titration enough to decide whether this champagne is safe to drink?

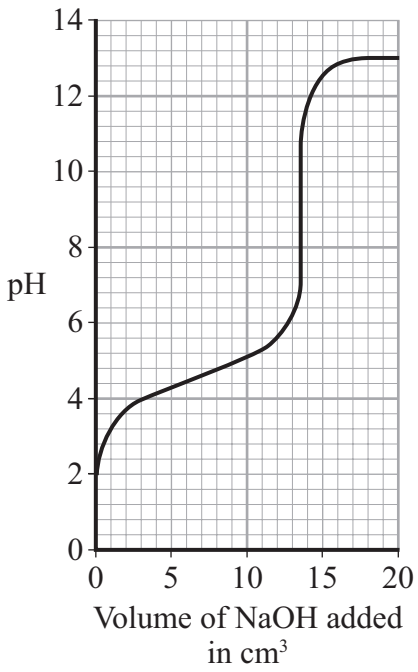
Explain your answer.

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(1 mark)

(d) The graph shows how the pH of the solution changes during this titration.



Phenolphthalein is the indicator used in this titration. It changes colour between pH 8.2 and pH 10.0.

Methyl orange is another indicator. It changes colour between pH 3.2 and pH 4.4.

Suggest why methyl orange is **not** a suitable indicator for this titration.

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(2 marks)

9

4.4.2.4 The pH scale and neutralisation

Question 04

5 Cosmetic powders were widely used in ancient Egypt.



Cosmetic powders that may have been used in face paints have been analysed. These powders contained compounds that are rare in nature. The compounds must have been made by the ancient Egyptians using chemical reactions.

4.4.2.4 The pH scale and neutralisation

Question 04 · continued

for mark

5 (a) One of these compounds is called phosgenite.
Analysis of this compound shows that it contains:

76.0% lead (Pb) 13.0% chlorine (Cl) 2.2% carbon (C) 8.8% oxygen (O)

Calculate the empirical formula of this compound.

To gain full marks you must show all your working.

Relative atomic masses: C = 12 ; O = 16 ; Cl = 35.5 ; Pb = 207

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(4 marks)

5 (b) Another compound that the ancient Egyptians used is laurionite.

The reaction used to make laurionite can be represented by this equation:

$PbO(s) + NaCl(aq) + H_2O(1) \rightarrow PbOHCl(s) + NaOH(aq)$
laurionite

5 (b) (i) Explain why the pH of the solution increases as the reaction takes place.

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(1 mark)

5 (b) (ii) How could laurionite be separated from the other product when the reaction is complete?

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(1 mark)

6

4.4.2.4 The pH scale and neutralisation

Question 05

June 2012 | CH2HP | Original Q2 | Legacy

2 (a) *In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.*

The salt called potassium chloride is made when potassium hydroxide solution reacts with hydrochloric acid.

potassium hydroxide solution + hydrochloric acid → potassium chloride solution + water

Describe a method for making **crystals** of potassium chloride from potassium hydroxide solution and hydrochloric acid.

In this method you should:

- describe how you will add the correct amount of the hydrochloric acid to neutralise the potassium hydroxide solution
- describe how you will get crystals of potassium chloride.

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(6 marks)

Question 2 continues on the next page

4.4.2.4 The pH scale and neutralisation

Question 05 · continued June 2012 | CH2HP | Original Q2 | Legacy

2 (b) Ammonium nitrate is another salt.
Ammonium nitrate is made when ammonia solution is neutralised with an acid.

Name the acid to complete the word equation.

ammonia + ... acid → ammonium nitrate

(1 mark)

2 (c) Read the information.

Ammonium nitrate – good or bad?

Some farmers put a lot of ammonium nitrate on their farmland.

Many people are worried about this use of ammonium nitrate.

Rain water can wash the ammonium nitrate off the farmland and into rivers and lakes. The ammonium nitrate may get into drinking water supplies and could be harmful to health.

2 (c) (i) Why do some farmers put ammonium nitrate on their farmland?

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.....

(1 mark)

4.4.2.4 The pH scale and neutralisation

Question 05 · continued

2 (c) (ii) Which **one** of the questions in the table cannot be answered by science alone?

Tick (✓) **one** question.

Question	Tick (✓)
How much ammonium nitrate is in drinking water?	
Should farmers stop using ammonium nitrate on their farmland?	
Is ammonium nitrate soluble in rain water?	

Give **two** reasons why this question **cannot** be answered by science alone.

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(3 marks)

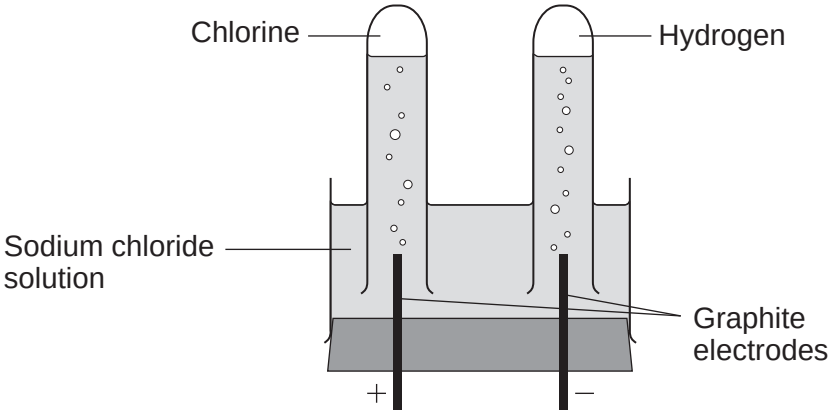
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4.4.2.4 The pH scale and neutralisation

Question 06

2 The electrolysis of sodium chloride solution is an industrial process.

The diagram shows the apparatus used in a school experiment.



2 (a) One of the products of the electrolysis of sodium chloride solution is hydrogen.

2 (a) (i) Why do hydrogen ions move to the negative electrode?

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(1 mark)

2 (a) (ii) How does a hydrogen ion change into a hydrogen atom?

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(1 mark)

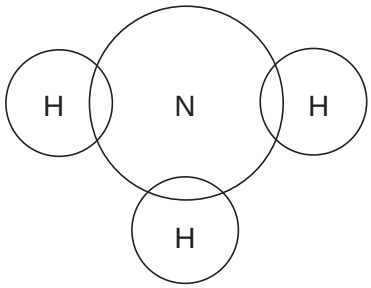
4.4.2.4 The pH scale and neutralisation

2 (b) Hydrogen is used to make ammonia (NH_3).

Complete the diagram to show the bonding in ammonia.

Use dots (●) and crosses (x) to show electrons.

Show only outer shell electrons.



(2 marks)

2 (c) The table shows the ions in sodium chloride solution.

Positive ions	Negative ions
hydrogen	chloride
sodium	hydroxide

In industry, some of the waste from the electrolysis of sodium chloride solution is alkaline and has to be neutralised.

2 (c) (i) Which ion makes the waste alkaline?

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(1 mark)

2 (c) (ii) This waste must be neutralised.

Write the ionic equation for the neutralisation reaction.

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(1 mark)

Question 2 continues on the next page

4.4.2.4 The pH scale and neutralisation

2 (d) *In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.*

The electrolysis of sodium chloride solution also produces chlorine and sodium hydroxide.

In industry, the electrolysis of sodium chloride solution can be done in several types of electrolysis cell.

Some information about two different types of electrolysis cell is given below.

	Mercury cell	**Membrane cell**
Cost of construction	Expensive	Relatively cheap
Additional substances used	Mercury, which is recycled. Mercury is toxic so any traces of mercury must be removed from the waste.	Membrane, which is made of a polymer. The membrane must be replaced every 3 years.
Amount of electricity used for each tonne of chlorine produced in kWh	3400	2950
Quality of chlorine produced	Pure	Needs to be liquefied and distilled to make it pure.
Quality of sodium hydroxide solution produced	50% concentration. Steam is used to concentrate the sodium hydroxide solution produced.	30% concentration. Steam is used to concentrate the sodium hydroxide solution produced.

Use the information and your knowledge and understanding to compare the environmental and economic advantages and disadvantages of these **two** types of electrolysis cell.

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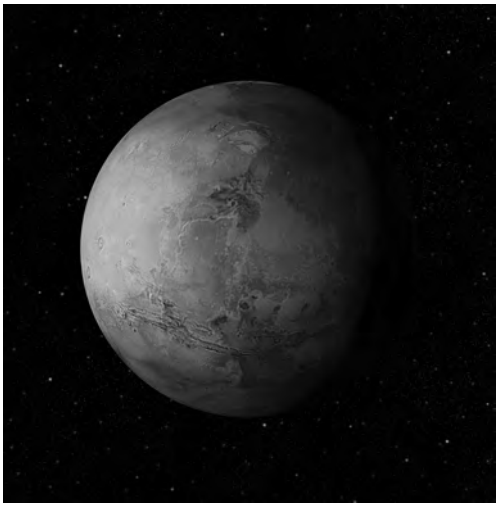
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4.4.2.4 The pH scale and neutralisation

Question 07

June 2013 | CH2HP | Original Q6 | Legacy

6 Spacecraft have been to the planets Venus and Mars. The spacecraft have sent back information about the atmosphere of each planet.



6 (a) The main gas in the atmosphere of Mars is carbon dioxide.

Explain why, in terms of structure, carbon dioxide is a gas, even at low temperatures.

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(3 marks)

4.4.2.4 The pH scale and neutralisation

Question 07 · continued June 2013 | CH2HP | Original Q6 | Legacy

6 (b) Gas chromatography linked to a mass spectrometer (GC-MS) is used to identify substances found on Mars.

6 (b) (i) What is the purpose of gas chromatography?

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(1 mark)

6 (b) (ii) What information do the molecular ion peaks from the mass spectrometer give about the substances?

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(1 mark)

6 (c) The atmosphere on Venus contains droplets of sulfuric acid solution.

6 (c) (i) Suggest a pH value for sulfuric acid solution.

pH = ...

(1 mark)

6 (c) (ii) Name the ion which makes sulfuric acid solution acidic.

.....

(1 mark)

6 (d) The atmosphere of Venus contains the isotopes $^{2}_{1}H$ and $^{1}_{1}H$

Describe the similarities and the differences in the isotopes $^{2}_{1}H$ and $^{1}_{1}H$

You should refer to the sub-atomic particles in each isotope.

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(3 marks)

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4.4.2.4 The pH scale and neutralisation

Question 08

June 2014 | CH2HP | Original Q1 | Legacy

1 The label shows the ingredients in a drink called Cola.

Cola

Ingredients:

Carbonated water
Sugar
Colouring
Phosphoric acid
Flavouring
Caffeine

1 (a) (i) The pH of carbonated water is 4.5.

The pH of Cola is 2.9.

Name the ingredient on the label that lowers the pH of Cola to 2.9.

[1 mark]

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1 (a) (ii) Which ion causes the pH to be 2.9?

[1 mark]

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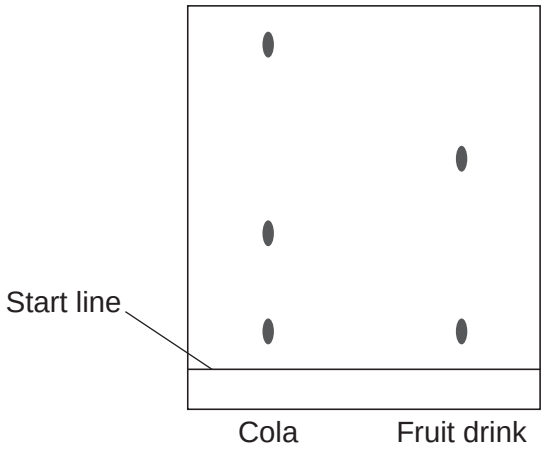
4.4.2.4 The pH scale and neutralisation

Question 08 · continued

1 (b) A student investigated the food colouring in Cola and in a fruit drink using paper chromatography.

The chromatogram in **Figure 1** shows the student's results.

Figure 1



1 (b) (i) Complete the sentence.

The start line should be drawn with a ruler and ..... .

Give a reason for your answer.

[2 marks]

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1 (b) (ii) Suggest **three** conclusions you can make from the student's results.

[3 marks]

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4.4.2.4 The pH scale and neutralisation

Question 08 · continued

1 (c) Caffeine can be separated from the other compounds in the drink by gas chromatography.

Why do different compounds separate in a gas chromatography column?

[1 mark]

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1 (d) Caffeine is a stimulant.

Large amounts of caffeine can be harmful.

1 (d) (i) Only **one** of the questions in the table **can** be answered by science alone.

Tick (✓) **one** question.

[1 mark]

Question	Tick (✓)
Should caffeine be an ingredient in drinks?	
Is there caffeine in a certain brand of drink?	
How much caffeine should people drink?	

1 (d) (ii) Give **two** reasons why the other questions **cannot** be answered by science alone.

[2 marks]

Reason 1 .....

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Reason 2 .....

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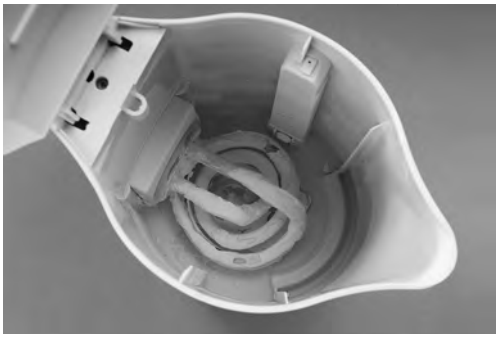
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4.4.2.4 The pH scale and neutralisation

Question 09

4 Hard water causes scale in kettles, as shown in **Figure 4**.

Figure 4



4 (a) Acids are used to remove scale.

4 (a) (i) Give the name of a carbonate in scale.

[1 mark]

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4 (a) (ii) When acids react with scale a gas is produced.

What is the name of the gas?

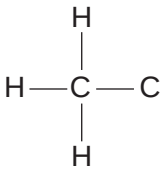
[1 mark]

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4 (b) Ethanoic acid is used to remove scale.

Complete the displayed structure of ethanoic acid (CH_3COOH).

[1 mark]



4.4.2.4 The pH scale and neutralisation

Question 09 · continued

4 (c) A student compared the rates at which ethanoic acid and hydrochloric acid react with scale.

Both acids had the same concentration.

4 (c) (i) The student found that hydrochloric acid reacts faster than ethanoic acid with scale.

Explain why hydrochloric acid reacts faster than ethanoic acid.

[2 marks]

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4 (c) (ii) Hydrochloric acid should **not** be used to dissolve scale in kettles.

Suggest why.

[1 mark]

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4 (d) A student does a titration to find the concentration of a solution of hydrochloric acid.

The student titrates 25.00 cm^3 of hydrochloric acid with sodium hydroxide solution of concentration 0.200 moles per dm^3. The equation for the reaction is:

$$HCl + NaOH \longrightarrow NaCl + H_2O$$

The student added 28.60 cm^3 of sodium hydroxide solution to neutralise the hydrochloric acid.

Calculate the concentration of the hydrochloric acid.

[3 marks]

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Concentration = ... moles per dm^3

9

4.4.2.4 The pH scale and neutralisation

Question 10

June 2015 | CH1HP | Original Q2 | Legacy

2 Limestone is used to make many different materials.

2 (a) Heating limestone produces calcium oxide and carbon dioxide.

Complete the sentences.

2 (a) (i) The main compound in limestone is calcium ..... .
[1 mark]

2 (a) (ii) The reaction to produce calcium oxide from limestone is thermal ..... .
[1 mark]

2 (a) (iii) Calcium hydroxide is produced when calcium oxide reacts with ..... .
[1 mark]

2 (a) (iv) Calcium hydroxide is used to neutralise acids because it is an ..... .
[1 mark]

Question 2 continues on the next page

Question 10 · continued

2 (b) Cement is made from limestone and clay.

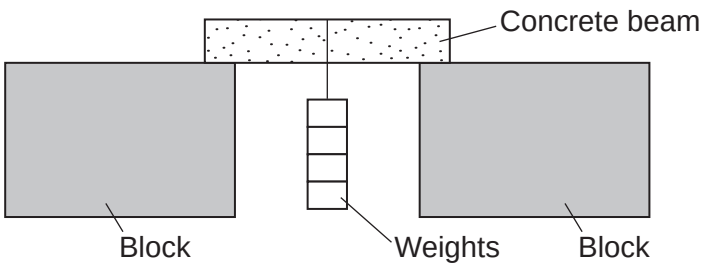
Concrete is made by mixing cement with water, sand and aggregate (small pieces of rock).

A group of students did an investigation on the amount of aggregate needed to make the strongest concrete beam.

The students used this method:

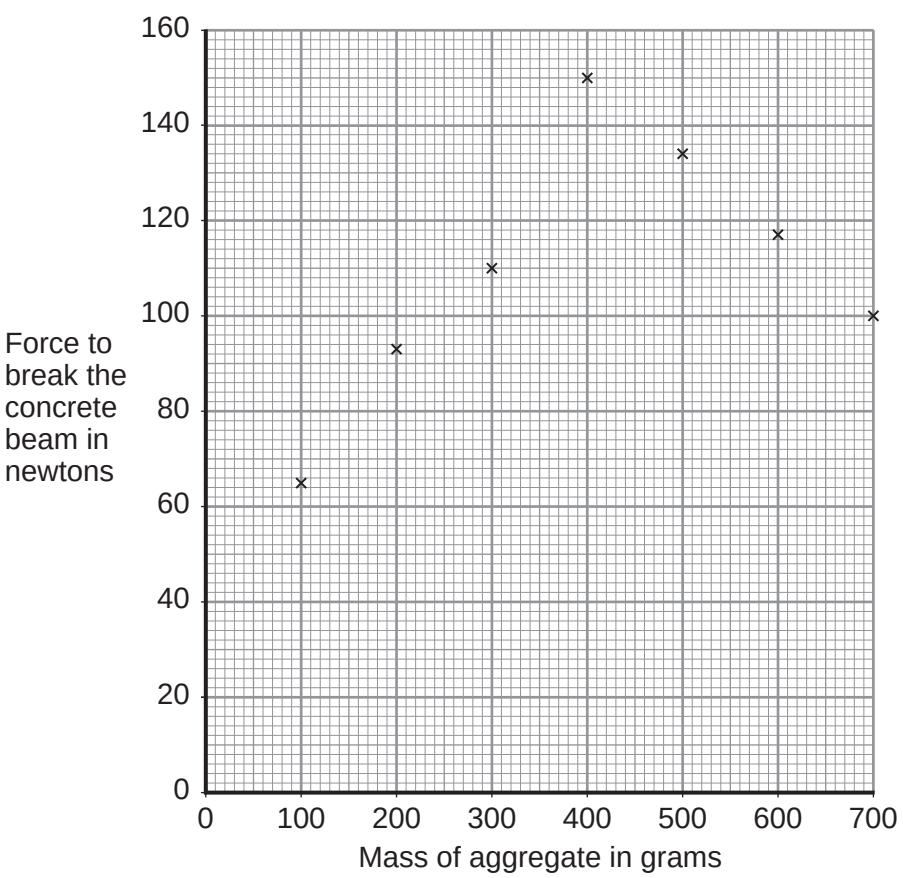
- use the same mass of cement and the same mass of sand but change the mass of aggregate to make seven different concrete mixtures
- use the different concrete mixtures to make beams of the same size
- add weights, as shown in **Figure 2**, until the concrete beam breaks.

Figure 2



The students' results are plotted on the graph in **Figure 3**.

Figure 3



4.4.2.4 The pH scale and neutralisation

Question 10 · continued

2 (b) (i) One of the points is anomalous.

Complete the graph in **Figure 3** by drawing **two** straight lines of best fit.

[2 marks]

2 (b) (ii) Describe **one** way the students could improve the method so that their results are more accurate for each graph point.

[2 marks]

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2 (b) (iii) What force is needed to break a concrete beam containing no aggregate?

Show your working on the graph.

[2 marks]

Force = ... newtons

2 (b) (iv) One of the students concluded that:

'The force needed to break a concrete beam increases as the mass of aggregate increases.'

The student's conclusion is **not completely** correct. Use values from the graph to explain why.

[3 marks]

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13

4.4.2.4 The pH scale and neutralisation

Question 11

June 2015 | CH3HP | Original Q5 | Legacy

5 This question is about organic compounds.

5 (a) Ethanol is an alcohol.
One use of ethanol is in alcoholic drinks.

Give **two** other uses of ethanol.

[2 marks]

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.....

5 (b) Which gas is produced when sodium reacts with ethanol?

[1 mark]

Tick (✓) **one** box.

Carbon dioxide ☐

Carbon monoxide ☐

Hydrogen ☐

Oxygen ☐

5 (c) Ethanoic acid (CH_3COOH) can be produced from ethanol (CH_3CH_2OH).

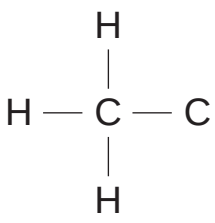
5 (c) (i) What type of reaction produces ethanoic acid from ethanol?

[1 mark]

.....

5 (c) (ii) Complete the displayed structure of ethanoic acid.

[1 mark]



4.4.2.4 The pH scale and neutralisation

Question 11 · continued June 2015 | CH3HP | Original Q5 | Legacy

5 (c) (iii) Solutions of ethanoic acid and hydrochloric acid with the same concentration have different pH values.

Explain why the solution of ethanoic acid has a higher pH than the solution of hydrochloric acid.

[2 marks]

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5 (d) Ethanol and ethanoic acid react in the presence of a catalyst to form an ester.

5 (d) (i) Name the ester made from ethanol and ethanoic acid.

[1 mark]

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5 (d) (ii) What type of chemical is used as a catalyst in this reaction?

[1 mark]

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5 (d) (iii) Esters are used in perfumes because they smell pleasant and are volatile.

What does volatile mean?

[1 mark]

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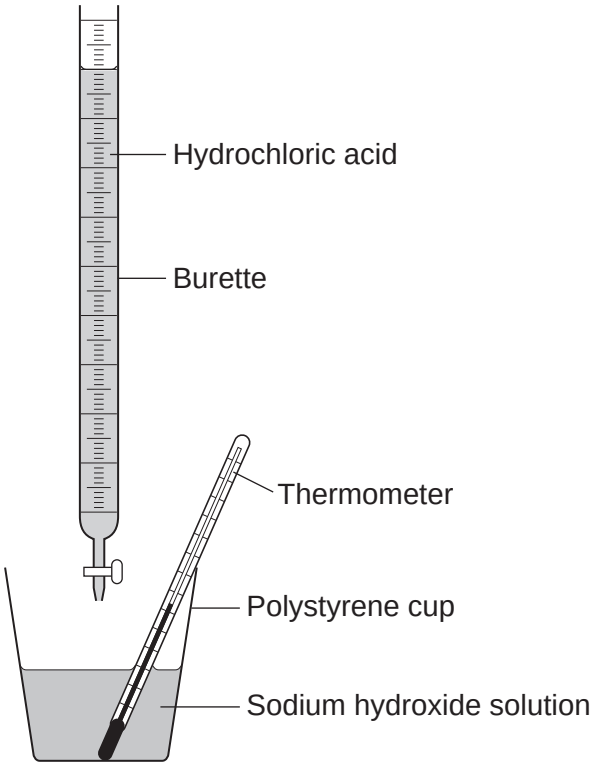
4.4.2.4 The pH scale and neutralisation

Question 12

June 2015 | CH3HP | Original Q8 | Legacy

8 A student investigates the energy released when hydrochloric acid completely neutralises sodium hydroxide solution.
The student uses the apparatus shown in **Figure 4**.

Figure 4



The student:

- measures 25 cm^3 sodium hydroxide solution into a polystyrene cup
- fills a burette with hydrochloric acid
- measures the temperature of the sodium hydroxide solution
- adds 5 cm^3 hydrochloric acid to the sodium hydroxide solution in the polystyrene cup
- stirs the mixture and measures the highest temperature of the mixture
- continues to add 5 cm^3 portions of hydrochloric acid, stirring and measuring the highest temperature of the mixture after each addition.

Question 8 continues on the next page

4.4.2.4 The pH scale and neutralisation

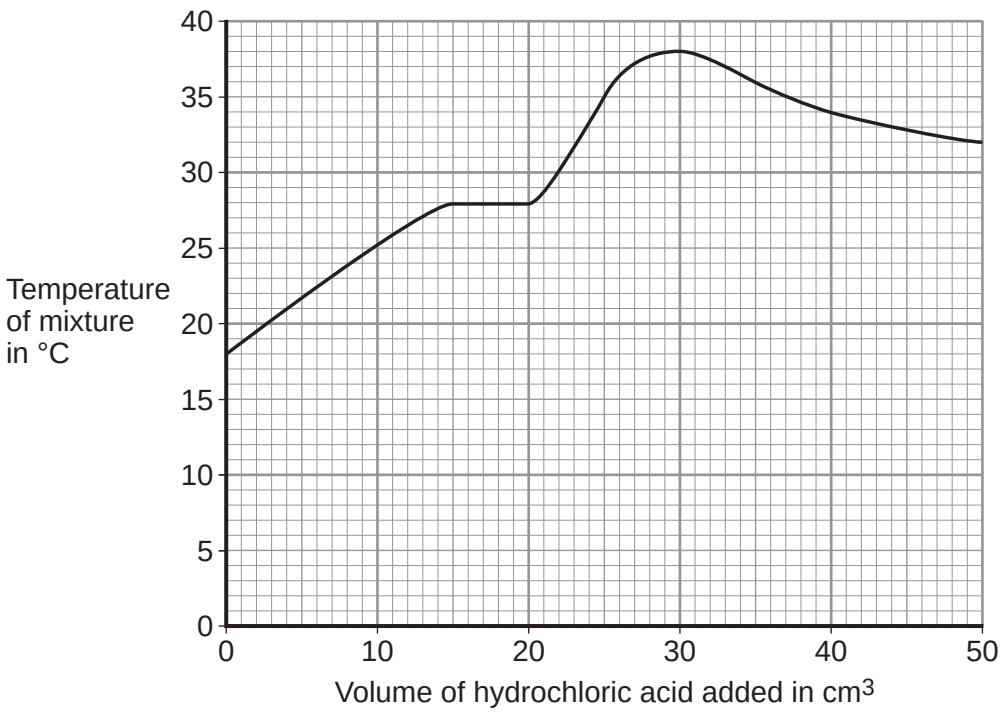
Question 12 · continued June 2015 | CH3HP | Original Q8 | Legacy

8 (a) The student has plotted a graph of the results.

The graph line has been incorrectly drawn by including an anomalous result.

The graph is shown in **Figure 5**.

Figure 5



8 (a) (i) Suggest a cause for the anomalous result when 20 cm^3 of hydrochloric acid is added.

[1 mark]

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.....

8 (a) (ii) Suggest the true value of the temperature of the anomalous point.

[1 mark]

Temperature = ... °C

8 (a) (iii) What was the **total** volume of the mixture when the maximum temperature was reached?

[1 mark]

.....

Total volume of the mixture = ... cm^3

4.4.2.4 The pH scale and neutralisation

Question 12 · continued June 2015 | CH3HP | Original Q8 | Legacy

8 (a) (iv) Calculate the overall temperature increase in this experiment.

[1 mark]

.....

Overall temperature increase = ... °C

8 (a) (v) Use your answers to **8(a)(iii)** and **8(a)(iv)** and the equation to calculate the energy released in the reaction. Give the unit.

[2 marks]

Assume the volume in cm^3 is equivalent to the mass of solution in grams.

Equation: $Q = mc\Delta T$

where:
Q = energy released
m = mass of solution (g)
c = 4.2 (J per g per °C)
ΔT = change in temperature (°C)

.....

.....

Energy released = ... Unit = ...

8 (b) The student did the experiment on page 19 again, starting with 50 cm^3 of sodium hydroxide solution instead of 25 cm^3.

Explain why this would make no difference to the overall temperature increase.

[2 marks]

.....

.....

.....

.....

8

4.4.2.4 The pH scale and neutralisation

Question 13

June 2016 | CH2HP | Original Q2 | Legacy

2 This question is about ammonia and fertilisers.

2 (a) Ammonia is produced by a reversible reaction.

The equation for the reaction is:

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

Complete the sentence.

[1 mark]

The forward reaction is exothermic, so the reverse reaction is _____ .

2 (b) Calculate the percentage by mass of nitrogen in ammonia (NH_3).
Relative atomic masses (A_r): H = 1; N = 14
You **must** show how you work out your answer.

[3 marks]

_____

_____

_____

_____

_____

_____

Percentage by mass of nitrogen = _____ %

4.4.2.4 The pH scale and neutralisation

Question 13 · continued June 2016 | CH2HP | Original Q2 | Legacy

2 (c) A neutral solution can be produced when ammonia reacts with an acid.

2 (c) (i) Give the pH of a neutral solution.

[1 mark]

pH _____

2 (c) (ii) Which of these ionic equations shows a neutralisation reaction?

[1 mark]

Tick (✓) **one** box.

$H^+ + OH^- \longrightarrow H_2O$ ☐

$NH_4^+ + OH^- \longrightarrow NH_4OH$ ☐

$H^+ + Cl^- \longrightarrow HCl$ ☐

$H^+ + H_2O \longrightarrow H_3O^+$ ☐

2 (c) (iii) Name the salt produced when ammonia reacts with hydrochloric acid.

[1 mark]

_____

Question 2 continues on the next page

4.4.2.4 The pH scale and neutralisation

Question 13 · continued

2 (d) **In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.**

Farmers use ammonium nitrate as a fertiliser for crops.

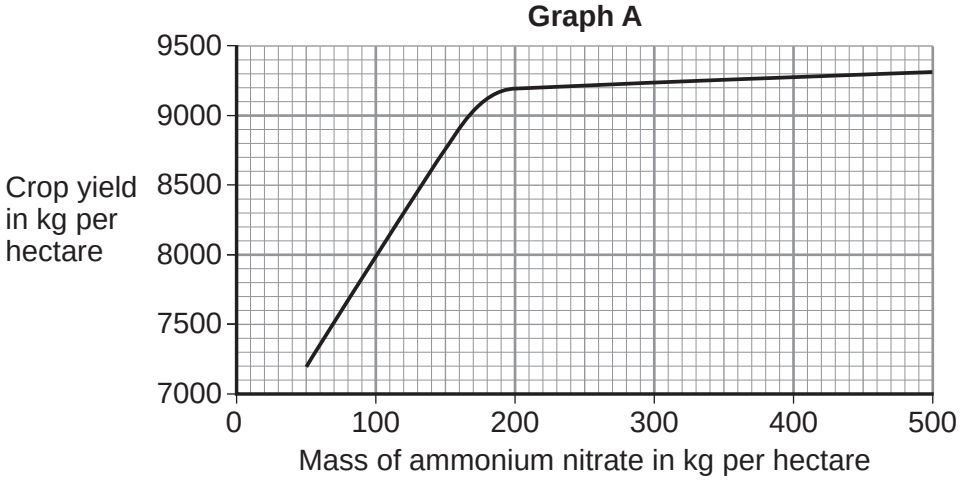
Rainwater dissolves ammonium nitrate in the soil.

Some of the dissolved ammonium nitrate runs off into rivers and lakes.

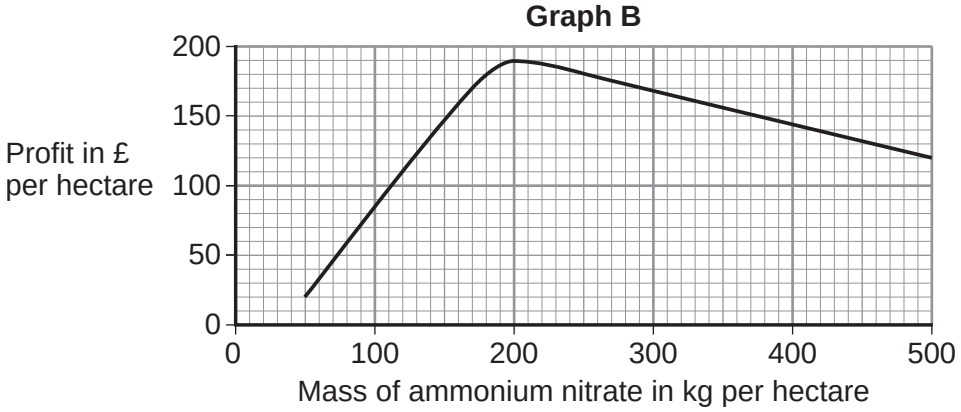
Figure 2 shows three graphs **A**, **B** and **C**. The graphs show information about the use of ammonium nitrate as a fertiliser. A hectare is a measurement of an area of land.

Figure 2

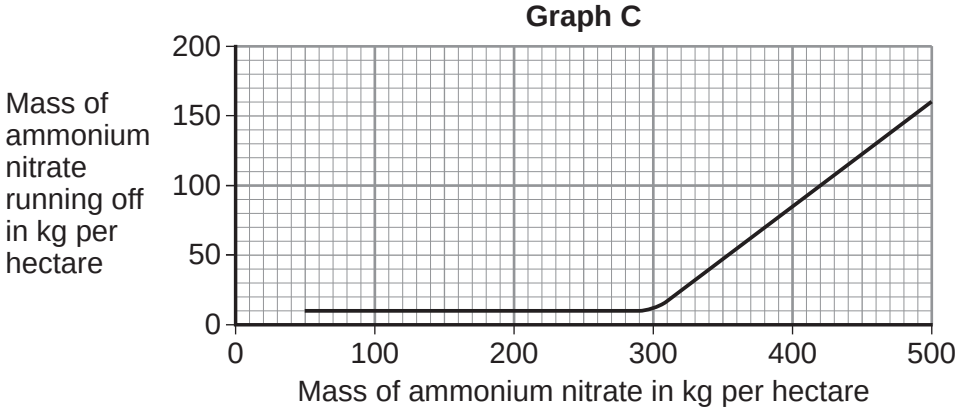
Graph A



Graph B



Graph C



4.4.2.4 The pH scale and neutralisation

Question 13 · continued

Suggest how much ammonium nitrate farmers should use per hectare.
Give reasons for your answer.
Use information from graphs **A**, **B** and **C**.

[6 marks]

Extra space

13

4.4.2.4 The pH scale and neutralisation

Question 14

June 2017 | CH2HP | Original Q6 | Legacy

6 This question is about sodium chloride.

6 (a) A student reacted hydrochloric acid and sodium hydroxide solution to produce sodium chloride solution.

The student:

- measured 50 cm^3 of hydrochloric acid into a glass beaker
- measured the initial temperature of the hydrochloric acid
- added 50 cm^3 of sodium hydroxide solution
- stirred the mixture and measured the highest temperature of the solution.

6 (a) (i) The hydrochloric acid and sodium hydroxide solution were the same concentration.

Suggest **one** reason why the temperature change could be greater than expected.

[1 mark]

Tick (✓) **one** box.

The volume of the sodium hydroxide solution was more than 50 cm^3. ☐

The volume of the hydrochloric acid was more than 50 cm^3. ☐

The initial temperature reading was too low. ☐

The highest temperature reading was too low. ☐

6 (a) (ii) The student did the investigation three times.

Table 2 shows the results.

Table 2

Experiment number	Initial temperature of the acid in °C	Highest temperature of solution in °C
1	20	33
2	19	30
3	20	32

4.4.2.4 The pH scale and neutralisation

Question 14 · continued

What conclusion can you make about the reaction from the results in **Table 2**?

[1 mark]

6 (b) The student electrolysed sodium chloride solution.

6 (b) (i) Explain what happens at the negative electrode and why sodium is **not** produced.

[3 marks]

6 (b) (ii) Chlorine gas is produced at the positive electrode.
Complete the half equation.

[1 mark]

$$____\ Cl^- \longrightarrow _____ + _____$$

6 (b) (iii) Explain why the pH of the solution after electrolysis was 14

[2 marks]

8

4.4.2.4 The pH scale and neutralisation

Question 15

June 2017 | CH3HP | Original Q3 | Legacy

3 This question is about elements and compounds.

3 (a) In 1869 Mendeleev produced an early version of the periodic table.

Figure 4 shows part of Mendeleev's periodic table.

Figure 4

H						
Li	Be	B	C	N	O	F
Na	Mg	Al	Si	P	S	Cl
K	Ca		Ti	V	Cr	Mn

3 (a) (i) Why did Mendeleev leave gaps in his periodic table?

[1 mark]

3 (a) (ii) Give **one** reason why the elements Ti, V, Cr and Mn should **not** be where Mendeleev placed them.

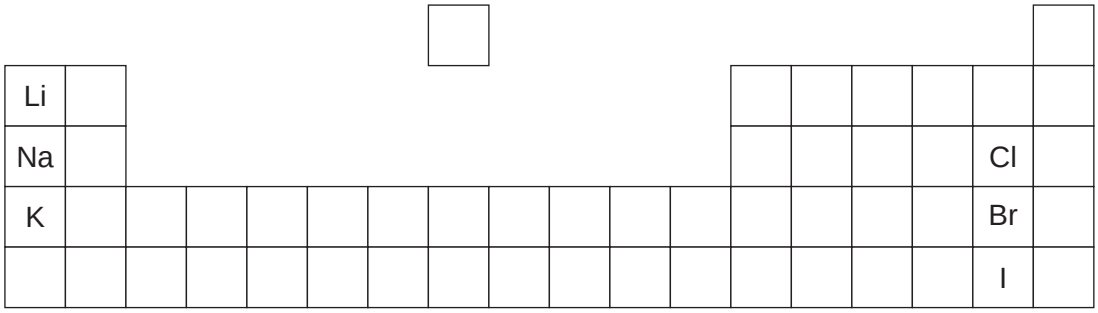
[1 mark]

4.4.2.4 The pH scale and neutralisation

Question 15 · continued

3 (b) **Figure 5** shows an outline of the modern periodic table.

Figure 5



3 (b) (i) Why, in terms of electrons, is bromine in Group 7?

[1 mark]

3 (b) (ii) Bromine reacts with sodium iodide.

The word equation for the reaction is:

bromine + sodium iodide ⟶ sodium bromide + iodine

This reaction shows that bromine is more reactive than iodine.

Explain why, in terms of electrons.

[3 marks]

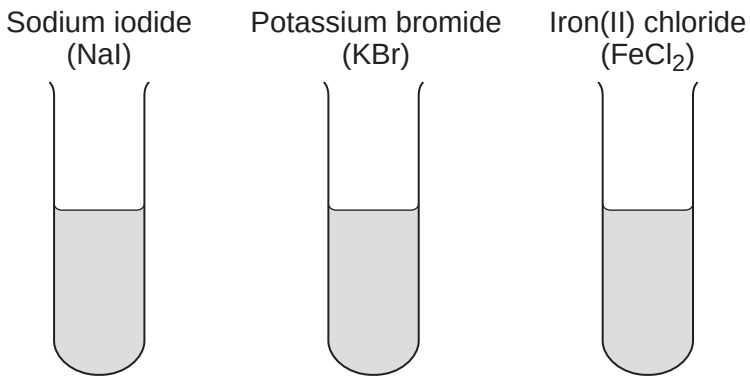
Question 3 continues on the next page

4.4.2.4 The pH scale and neutralisation

Question 15 · continued

3 (c) **Figure 6** shows test tubes containing solutions of sodium iodide, potassium bromide and iron(II) chloride.

Figure 6



3 (c) (i) A student tested each solution with silver nitrate in the presence of dilute nitric acid.

Write the result for sodium iodide solution in **Table 1**.

[1 mark]

Table 1

	Sodium iodide solution	**Potassium bromide solution**	**Iron(II) chloride solution**
Result of adding silver nitrate		Cream precipitate	White precipitate

3 (c) (ii) The student tested new samples of each solution with sodium hydroxide solution.

Write the result for iron(II) chloride solution in **Table 2**.

[1 mark]

Table 2

	Sodium iodide solution	**Potassium bromide solution**	**Iron(II) chloride solution**
Result of adding sodium hydroxide solution	No precipitate	No precipitate	

4.4.2.4 The pH scale and neutralisation

Question 15 · continued

3 (d) A flame test is done on a mixture of sodium iodide and potassium bromide.

Why would a flame test **not** show the presence of both sodium ions and potassium ions in the mixture?

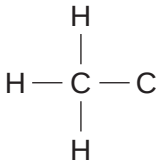
[1 mark]

3 (e) Carboxylic acids are compounds containing carbon.

3 (e) (i) Complete **Figure 7** to show the displayed structure of ethanoic acid.

[1 mark]

Figure 7



3 (e) (ii) Explain why ethanoic acid has a higher pH value than hydrochloric acid of the same concentration.

[2 marks]

12

4.4.2.4 The pH scale and neutralisation

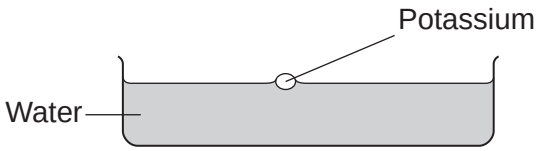
Question 16

4 This question is about potassium and its compounds.

4 (a) (i) Potassium reacts with water to produce potassium hydroxide solution and a gas.

Figure 8 shows the apparatus used for the reaction.

Figure 8



Complete and balance the equation for the reaction.

[2 marks]

____ K + ____ H_2O ⟶ ____ KOH + _____

4 (a) (ii) Potassium and lithium are in Group 1 of the periodic table.

Give **two** differences you would see between the reactions of potassium and lithium with water.

[2 marks]

_____

_____

_____

_____

4.4.2.4 The pH scale and neutralisation

Question 16 · continued

4 (b) Describe how a student could do titrations to find the mean volume of potassium hydroxide solution which would neutralise 25.00 cm^3 of nitric acid.

[5 marks]

4 (c) The student found that 26.25 cm^3 of potassium hydroxide solution with a concentration of 0.20 moles per dm^3 neutralises 25.00 cm^3 of nitric acid.

The equation for the reaction is:

$$KOH + HNO_3 \longrightarrow KNO_3 + H_2O$$

Calculate the concentration of the nitric acid.

[3 marks]

Concentration of nitric acid = _____ moles per dm^3

12

4.4.2.4 The pH scale and neutralisation

Question 17

June 2018 | 8462/1H | Original Q9

0 9 This question is about acids and alkalis.

0 9 . 1 Dilute hydrochloric acid is a strong acid.

Explain why an acid can be described as both strong and dilute.

[2 marks]

0 9 . 2 A 1.0×10^{-3} mol/dm^3 solution of hydrochloric acid has a pH of 3.0

What is the pH of a 1.0×10^{-5} mol/dm^3 solution of hydrochloric acid?

[1 mark]

pH = _____

Question 9 continues on the next page

4.4.2.4 The pH scale and neutralisation

Question 17 · continued

A student titrated 25.0 cm^3 portions of dilute sulfuric acid with a 0.105 mol/dm^3 sodium hydroxide solution.

0 9 . 3 **Table 4** shows the student's results.

Table 4

	Titration 1	Titration 2	Titration 3	Titration 4	Titration 5
Volume of sodium hydroxide solution in cm^3	23.50	21.10	22.10	22.15	22.15

The equation for the reaction is:

$$2\ NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2\ H_2O$$

Calculate the concentration of the sulfuric acid in mol/dm^3

Use only the student's concordant results.

Concordant results are those within 0.10 cm^3 of each other.

[5 marks]

Concentration of sulfuric acid = _____ mol/dm^3

4.4.2.4 The pH scale and neutralisation

Question 17 · continued

0 9 . 4 Explain why the student should use a pipette to measure the dilute sulfuric acid and a burette to measure the sodium hydroxide solution.

[2 marks]

0 9 . 5 Calculate the mass of sodium hydroxide in 30.0 cm^3 of a 0.105 mol/dm^3 solution.

Relative formula mass (M_r): NaOH = 40

[2 marks]

Mass of sodium hydroxide = _____ g

12

4.4.2.4 The pH scale and neutralisation

Question 18

June 2019 | 8462/1H | Original Q2

0 2 This question is about acids and alkalis.

0 2 . 1 Which ion do all acids produce in aqueous solution?

[1 mark]

Tick (✓) **one** box.

- H^+ ☐
- H^- ☐
- O^{2-} ☐
- OH^- ☐

0 2 . 2 Calcium hydroxide solution reacts with an acid to form calcium chloride.

Complete the word equation for the reaction.

[2 marks]

calcium hydroxide + _____ acid → calcium chloride + _____

Question 2 continues on the next page

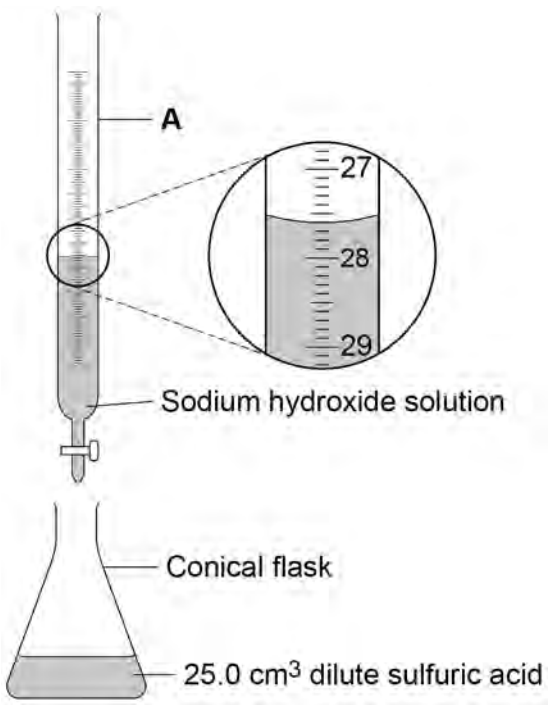
4.4.2.4 The pH scale and neutralisation

Question 18 · continued

A student investigates the volume of sodium hydroxide solution that reacts with 25.0 cm^3 of dilute sulfuric acid.

Figure 2 shows the apparatus the student uses.

Figure 2



Use **Figure 2** to answer Questions **02.3** and **02.4**

0 2 . 3 Name apparatus **A**.

[1 mark]

0 2 . 4 What is the reading on apparatus **A**?

[1 mark]

_____ cm^3

4.4.2.4 The pH scale and neutralisation

Question 18 · continued

0 2 . 5 The higher the concentration of a sample of dilute sulfuric acid, the greater the volume of sodium hydroxide needed to neutralise the acid.

The student tested two samples of dilute sulfuric acid, **P** and **Q**.

Describe how the student could use titrations to find which sample, **P** or **Q**, is more concentrated.

[6 marks]

11

4.4.2.4 The pH scale and neutralisation

Question 19

November 2020 | 8462/1H | Original Q9

0 9 This question is about citric acid ($C_6H_8O_7$).

Citric acid is a solid.

A student investigated the temperature change during the reaction between citric acid and sodium hydrogencarbonate solution.

This is the method used.

1. Pour 25 cm^3 of sodium hydrogencarbonate solution into a polystyrene cup.

2. Measure the temperature of the sodium hydrogencarbonate solution.

3. Add 0.20 g of citric acid to the polystyrene cup.

4. Stir the solution.

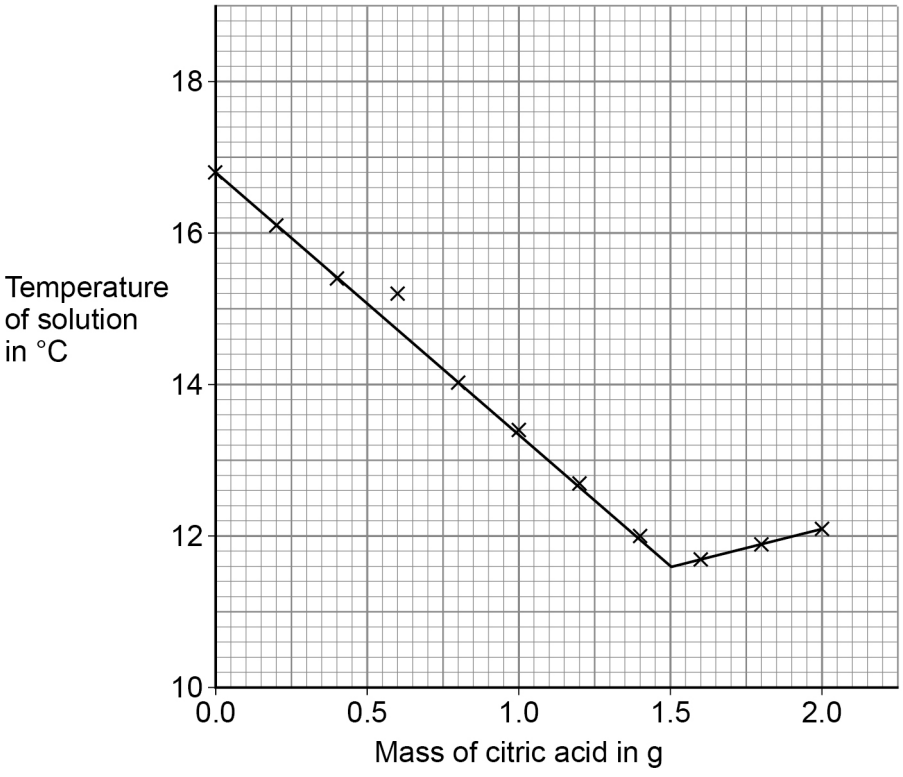
5. Measure the temperature of the solution.

6. Repeat steps 3 to 5 until a total of 2.00 g of citric acid has been added.

The student plotted the results on a graph.

Figure 6 shows the student's graph.

Figure 6



4.4.2.4 The pH scale and neutralisation

Question 19 · continued

0 9 . 1 **Figure 6** shows an anomalous point when 0.60 g of citric acid was added. This was caused by the student making an error.

The student correctly:

- measured the mass of the citric acid
- read the thermometer
- plotted the point.

Suggest **one** reason for the anomalous point.

[1 mark]

0 9 . 2 Explain the shape of the graph in terms of the energy transfers taking place.

You should use data from **Figure 6** in your answer.

[3 marks]

0 9 . 3 A second student repeated the investigation using a metal container instead of the polystyrene cup. The container and the cup were the same size and shape.

Sketch a line on **Figure 6** to show the second student's results until 1.00 g of citric acid had been added. The starting temperature of the solution was the same.

Explain your answer.

[3 marks]

4.4.2.4 The pH scale and neutralisation

Question 19 · continued

The student used a solution of citric acid to determine the concentration of a solution of sodium hydroxide by titration.

0 9 . 4 The student made 250 cm^3 of a solution of citric acid of concentration 0.0500 mol/dm^3

Calculate the mass of citric acid ($C_6H_8O_7$) required.

Relative atomic masses (A_r): H = 1 C = 12 O = 16

[3 marks]

Mass = _____ g

This is part of the method the student used for the titration.

1. Measure 25.0 cm^3 of the sodium hydroxide solution into a conical flask using a pipette.
2. Add a few drops of indicator to the flask.
3. Fill a burette with citric acid solution.

0 9 . 5 Describe how the student would complete the titration.

[3 marks]

4.4.2.4 The pH scale and neutralisation

Question 19 · continued

0 9 . 6 Give **two** reasons why a burette is used for the citric acid solution.

[2 marks]

1 _____

_____

2 _____

_____

0 9 . 7 13.3 cm^3 of 0.0500 mol/dm^3 citric acid solution was needed to neutralise 25.0 cm^3 of sodium hydroxide solution.

The equation for the reaction is:

$$3\,NaOH + C_6H_8O_7 \rightarrow C_6H_5O_7Na_3 + 3\,H_2O$$

Calculate the concentration of the sodium hydroxide solution in mol/dm^3

[3 marks]

_____

_____

_____

_____

_____

_____

Concentration = _____ mol/dm^3

18

4.4.2.4 The pH scale and neutralisation

Question 20

November 2020 | 8462/2H | Original Q7

0 7 This question is about carboxylic acids.

Carboxylic acids belong to a homologous series.

Table 3 shows information about the first three carboxylic acids in this homologous series.

Table 3

Name	Formula	pH of a 0.01 mol/dm^3 solution
Methanoic acid		2.91
Ethanoic acid	CH_3COOH	3.39
	CH_3CH_2COOH	3.44

0 7 . 1 Complete **Table 3**.

[2 marks]

0 7 . 2 Ethanoic acid ionises in water.

The equation for the reaction is:

$$CH_3COOH(aq) \rightleftharpoons CH_3COO^-(aq) + H^+(aq)$$

Explain how the equation shows that ethanoic acid is a weak acid.

[2 marks]

4.4.2.4 The pH scale and neutralisation

Question 20 · continued

0 7 . 3 A student adds a solution of ethanoic acid to zinc carbonate in an open flask on a balance.

Explain what happens to the mass of the flask and its contents during the reaction.

[3 marks]

0 7 . 4 The student compares the rates of the reaction of zinc carbonate with:

- 0.01 mol/dm^3 methanoic acid
- 0.01 mol/dm^3 ethanoic acid.

The rate of the reaction with methanoic acid is greater than the rate of the reaction with ethanoic acid.

Explain why.

You should refer to ions in your answer.

Use **Table 3**.

[3 marks]

4.4.2.4 The pH scale and neutralisation

Question 20 · continued

Ethanoic acid reacts with ethanol to produce an ester.

0 7 . 5 Give the name of the ester produced when ethanoic acid reacts with ethanol.

[1 mark]

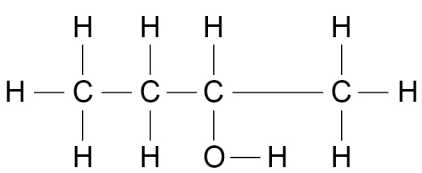
0 7 . 6 Hexanedioic acid and ethanediol join together to produce a polyester.

Ethanoic acid and ethanol join together in the same way to produce an ester.

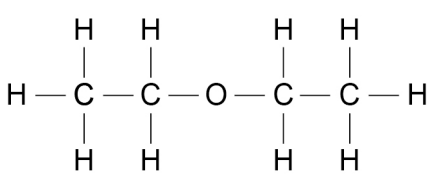
Which is the displayed structural formula of the ester produced when ethanoic acid reacts with ethanol?

[1 mark]

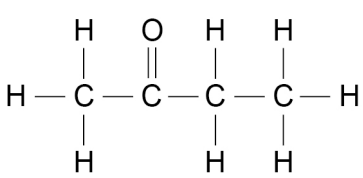
Tick (✓) **one** box.



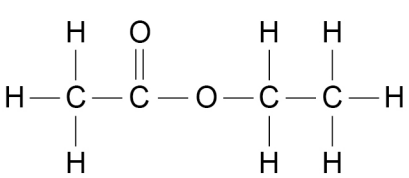
☐



☐



☐



☐

12

4.4.2.4 The pH scale and neutralisation

Question 21

November 2021 | 8462/1H | Original Q5

0 5 This question is about salts.

0 5 . 1 Name the salt produced by the neutralisation of hydrochloric acid with potassium hydroxide.

[1 mark]

_____

0 5 . 2 Write an ionic equation for the neutralisation of hydrochloric acid with potassium hydroxide.

[1 mark]

_____ + _____ → _____

0 5 . 3 Soluble salts can be produced by reacting dilute hydrochloric acid with an insoluble solid.

Copper, copper carbonate and copper oxide are insoluble solids.

Which of these insoluble solids can be used to make a copper salt by reacting the solid with dilute hydrochloric acid?

[1 mark]

Tick (✓) **one** box.

- Copper and copper carbonate only ☐
- Copper and copper oxide only ☐
- Copper carbonate and copper oxide only ☐
- Copper, copper carbonate and copper oxide ☐

4.4.2.4 The pH scale and neutralisation

Question 21 · continued November 2021 | 8462/1H | Original Q5

A student makes crystals of magnesium sulfate.

This is the method used.

1. Add sulfuric acid to a beaker.
2. Warm the sulfuric acid.
3. Add a spatula of magnesium oxide to the beaker.
4. Stir the mixture.
5. Repeat steps 3 and 4 until there is magnesium oxide remaining in the beaker.
6. Filter the mixture.
7. Evaporate the filtrate gently until crystals start to form.
8. Leave the solution to finish crystallising.

0 5 . 4 Give **one** reason for:

- step 2
- step 5
- step 6.

[3 marks]

Step 2 _____

_____

Step 5 _____

_____

Step 6 _____

_____

0 5 . 5 How should the filtrate be evaporated gently in **step 7**?

[1 mark]

_____

_____

4.4.2.4 The pH scale and neutralisation

Question 21 · continued

0 5 . 6 Iron chloride is produced by heating iron in chlorine gas.

The equation for the reaction is:

$$2\,Fe + 3\,Cl_2 \rightarrow 2\,FeCl_3$$

Calculate the volume of chlorine needed to react with 14 g of iron.

You should calculate:

- the number of moles of iron used
- the number of moles of chlorine that react with 14 g of iron
- the volume of chlorine needed.

Relative atomic mass (A_r): Fe = 56

The volume of 1 mole of gas = 24 dm^3

[3 marks]

Volume of chlorine = _____ dm^3

10

4.4.2.4 The pH scale and neutralisation

Question 22

November 2021 | 8462/1H | Original Q9

0 9 This question is about acids.

Hydrogen chloride and ethanoic acid both dissolve in water.

All hydrogen chloride molecules ionise in water.

Approximately 1% of ethanoic acid molecules ionise in water.

0 9 . 1 A solution is made by dissolving 1 g of hydrogen chloride in 1 dm^3 of water.

Which is the correct description of this solution?

[1 mark]

Tick (✓) **one** box.

- A concentrated solution of a strong acid ☐
- A concentrated solution of a weak acid ☐
- A dilute solution of a strong acid ☐
- A dilute solution of a weak acid ☐

0 9 . 2 Which solution would have the lowest pH?

[1 mark]

Tick (✓) **one** box.

- 0.1 mol/dm^3 ethanoic acid solution ☐
- 0.1 mol/dm^3 hydrogen chloride solution ☐
- 1.0 mol/dm^3 ethanoic acid solution ☐
- 1.0 mol/dm^3 hydrogen chloride solution ☐

4.4.2.4 The pH scale and neutralisation

Question 22 · continued

A student investigated the concentration of a solution of sodium hydroxide by titration with a 0.0480 mol/dm^3 ethanedioic acid solution.

This is the method used.

1. Measure 25.0 cm^3 of the sodium hydroxide solution into a conical flask using a 25.0 cm^3 pipette.

2. Add two drops of indicator to the sodium hydroxide solution.

3. Fill a burette with the 0.0480 mol/dm^3 ethanedioic acid solution to the 0.00 cm^3 mark.

4. Add the ethanedioic acid solution to the sodium hydroxide solution until the indicator changes colour.

5. Read the burette to find the volume of the ethanedioic acid solution used.

0 9 . 3 Suggest **two** improvements to the method that would increase the accuracy of the result.

[2 marks]

1 _____

_____

2 _____

_____

Question 9 continues on the next page

4.4.2.4 The pH scale and neutralisation

Question 22 · continued

0 9 . 4 Ethanedioic acid is a solid at room temperature.

Calculate the mass of ethanedioic acid ($H_2C_2O_4$) needed to make 250 cm^3 of a solution with concentration 0.0480 mol/dm^3

Relative formula mass (M_r): $H_2C_2O_4 = 90$

[2 marks]

Mass = _____ g

0 9 . 5 The student found that 25.0 cm^3 of the sodium hydroxide solution was neutralised by 15.00 cm^3 of the 0.0480 mol/dm^3 ethanedioic acid solution.

The equation for the reaction is:

$$H_2C_2O_4 + 2\,NaOH \rightarrow Na_2C_2O_4 + 2\,H_2O$$

Calculate the concentration of the sodium hydroxide solution in mol/dm^3

[3 marks]

Concentration = _____ mol/dm^3

9

4.4.2.4 The pH scale and neutralisation

Question 23

June 2022 | 8462/1H | Original Q8

0 8 This question is about acids and alkalis.

0 8 . 1 Explain why the pH of an acid depends on:

- the strength of the acid
- the concentration of the acid.

[4 marks]

0 8 . 2 A student titrated 25.00 cm^3 of hydrochloric acid with 0.100 mol/dm^3 barium hydroxide solution.

Table 2 shows the results.

Table 2

Titration number	1	2	3	4	5
Volume of barium hydroxide solution used in cm^3	23.90	23.45	23.55	23.55	23.45

The student calculated the volume of barium hydroxide solution to be used in the titration calculation as 23.50 cm^3.

Explain why the student used a volume of 23.50 cm^3 of barium hydroxide solution in the titration calculation.

[2 marks]

4.4.2.4 The pH scale and neutralisation

Question 23 · continued

0 8 . 3 25.00 cm^3 of the hydrochloric acid reacted with 23.50 cm^3 of the 0.100 mol/dm^3 barium hydroxide solution.

The equation for the reaction is:

$$2\,HCl(aq) + Ba(OH)_2(aq) \rightarrow BaCl_2(aq) + 2\,H_2O(l)$$

Calculate the concentration of the hydrochloric acid in mol/dm^3.

[4 marks]

Concentration of the hydrochloric acid = _____ mol/dm^3

Question 8 continues on the next page

4.4.2.4 The pH scale and neutralisation

Question 23 · continued

Another student titrated sulfuric acid with barium hydroxide solution.

The equation for the reaction is:

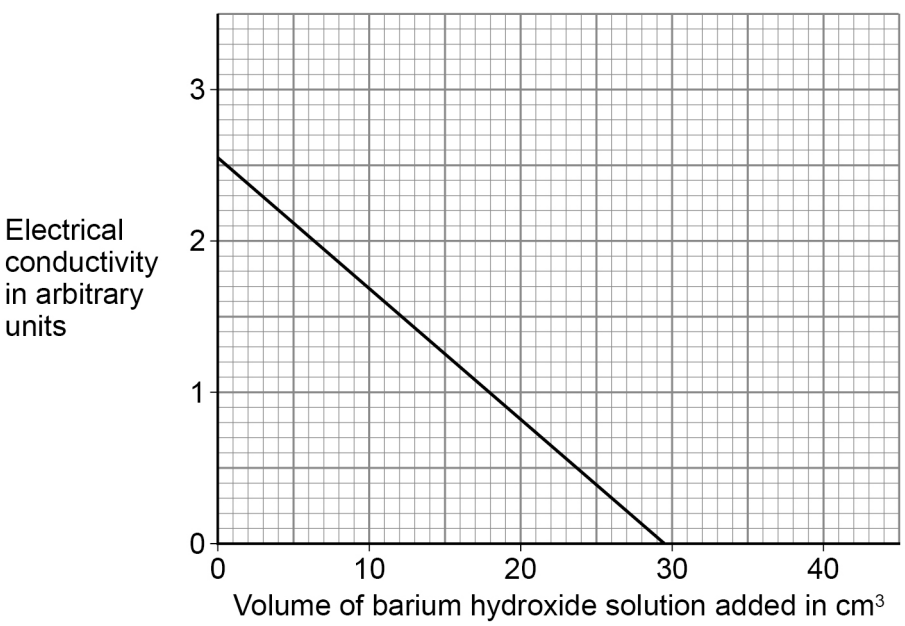
$$H_2SO_4(aq) + Ba(OH)_2(aq) \rightarrow BaSO_4(s) + 2H_2O(l)$$

The student measured the electrical conductivity of the mixture during the titration.

The better a conductor, the higher the electrical conductivity value.

Figure 10 shows the results.

Figure 10



0 8 . 4 Explain why the electrical conductivity of the mixture was zero when the sulfuric acid had just been neutralised.

Use the equation for the reaction.

Refer to ions in your answer.

[3 marks]

4.4.2.4 The pH scale and neutralisation

Question 23 · continued

0 8 . 5 The student then added a further 10 cm^3 of barium hydroxide solution.

The electrical conductivity of the mixture increased.

Give **one** reason why.

[1 mark]

_____

_____

14

4.4.2.4 The pH scale and neutralisation

Question 24

June 2023 | 8462/1H | Original Q5

0 5 This question is about acids and alkalis.

0 5 . 1 Ethanoic acid is a weak acid.

What is meant by 'weak acid'?

Answer in terms of ionisation.

[1 mark]

_____

_____

0 5 . 2 The concentration of an acid can be measured in mol/dm^3.

Which combination of changes **increases** the concentration of an acid?

[1 mark]

Tick (✓) **one** box.

- The mass of acid dissolved is halved and the volume of the solution is halved. ☐
- The mass of acid dissolved is halved and the volume of the solution is doubled. ☐
- The mass of acid dissolved is doubled and the volume of the solution is halved. ☐
- The mass of acid dissolved is doubled and the volume of the solution is doubled. ☐

0 5 . 3 The concentration of an acid can be determined by titration.

An indicator is added to an alkali in a flask.

Name an indicator that can be used in this titration.

Give the colour change of the indicator when acid from a burette is added to the alkali in the flask.

[2 marks]

Name of indicator _____

Colour change from _____ to _____

4.4.2.4 The pH scale and neutralisation

Question 24 · continued

0 5 . 4 Sodium carbonate dissolves in water to produce an alkaline solution.

Give the formula of the ion that makes a solution alkaline.

[1 mark]

_____

0 5 . 5 A student does a titration using sodium carbonate solution and nitric acid.

The equation for the reaction is:

$$Na_2CO_3 + 2\,HNO_3 \rightarrow 2\,NaNO_3 + CO_2 + H_2O$$

25.0 cm^3 of 0.124 mol/dm^3 sodium carbonate solution is neutralised by 23.6 cm^3 of nitric acid.

Calculate the concentration of the nitric acid.

Give your answer to 3 significant figures.

You should calculate:

- the number of moles of sodium carbonate in 25.0 cm^3 of the solution
- the number of moles of nitric acid in 23.6 cm^3 of the nitric acid
- the concentration of the nitric acid in mol/dm^3.

[5 marks]

Concentration (3 significant figures) = _____ mol/dm^3

4.4.2.4 The pH scale and neutralisation

Question 24 · continued

When hydrochloric acid dissolves in water, hydrogen ions (H^+) and chloride ions (Cl^-) are produced.

0 5 . 6 A solution of hydrochloric acid with pH 4.5 has a concentration of H^+ ions of 3.16×10^{-5} mol/dm^3.

What is the concentration of H^+ ions in a solution of hydrochloric acid with pH 2.5?

[1 mark]

Concentration of H^+ ions = _____ mol/dm^3

0 5 . 7 Which element has atoms that have the same electronic structure as the chloride ion?

Use the periodic table.

[1 mark]

_____

12

4.4.2.4 The pH scale and neutralisation

Question 25

June 2024 | 8462/1H | Original Q2

0 2 This question is about the periodic table.

Sodium and potassium are in Group 1 of the periodic table.

0 2 . 1 Give **one** similarity and **one** difference between the electronic structures of sodium and potassium.

[2 marks]

Similarity _____

_____

Difference _____

_____

Group 1 elements react with water.

0 2 . 2 Give **two** observations made when potassium reacts with water.

[2 marks]

1 _____

_____

2 _____

_____

0 2 . 3 Potassium hydroxide solution is produced when potassium reacts with water.

What is the colour of universal indicator when added to potassium hydroxide solution?

Give **one** reason for your answer.

[2 marks]

Colour of universal indicator _____

Reason _____

_____

4.4.2.4 The pH scale and neutralisation

Question 25 · continued

Table 1 shows the densities of some of the elements in Group 0 of the periodic table.

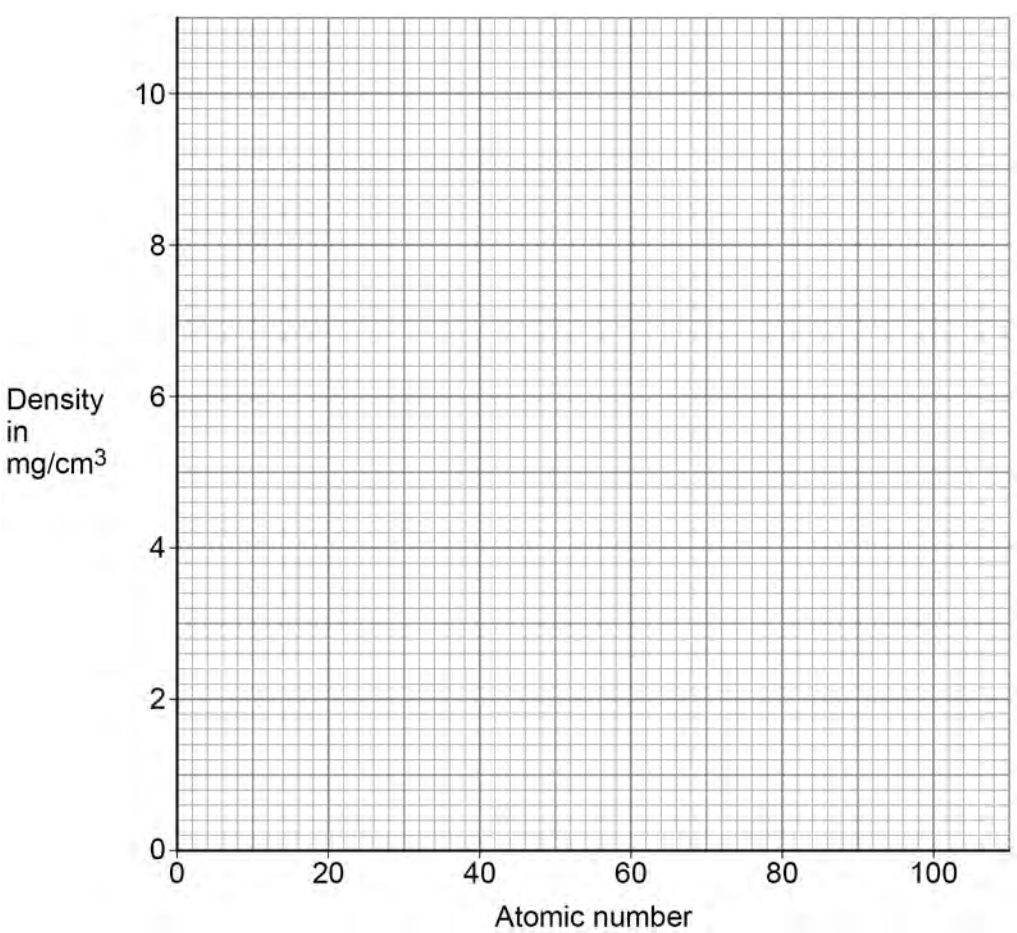
Table 1

Element	Atomic number	Density in mg/cm^3
Helium	2	0.2
Neon	10	0.8
Argon	18	1.6
Krypton	36	**X**
Xenon	54	5.4
Radon	86	9.1

0 2 . 4 Plot the data from **Table 1** on **Figure 1**.

[2 marks]

Figure 1



4.4.2.4 The pH scale and neutralisation

Question 25 · continued

0 2 . 5 Estimate the density (**X**) of krypton.

Use **Figure 1** and **Table 1**.

[1 mark]

Density = _____ mg/cm^3

0 2 . 6 The elements in Group 7 are called the halogens.

A more reactive halogen can displace a less reactive halogen from a solution of its salt.

Which combination of solutions will produce a reaction when mixed?

[1 mark]

Tick (✓) **one** box.

- Chlorine and potassium fluoride ☐
- Chlorine and potassium bromide ☐
- Bromine and potassium fluoride ☐
- Bromine and potassium chloride ☐

0 2 . 7 Which of the following describes the trends going down Group 7?

[1 mark]

Tick (✓) **one** box.

- Relative molecular mass decreases and boiling point decreases. ☐
- Relative molecular mass decreases and boiling point increases. ☐
- Relative molecular mass increases and boiling point decreases. ☐
- Relative molecular mass increases and boiling point increases. ☐

11

4.4.2.4 The pH scale and neutralisation

Question 26

June 2024 | 8462/1H | Original Q9

0 9 This question is about acids and their reactions.

Acids can be either weak or strong.

0 9 . 1 What is meant by 'a **weak** acid'?

[2 marks]

0 9 . 2 Explain what happens to the pH of an acid as the acid is diluted with water.

[2 marks]

Question 9 continues on the next page

4.4.2.4 The pH scale and neutralisation

Question 26 · continued

0 9 . 3 A student does a titration to find the volume of acid needed to neutralise an alkali.

The student fills a burette with the acid.

Give **three** more steps the student must do before adding the acid to the alkali from the burette.

You should name any equipment used.

[3 marks]

1 _____

_____

2 _____

_____

3 _____

_____

0 9 . 4 The student titrated a solution containing 0.0045 moles of sodium hydroxide with 0.15 mol/dm^3 hydrochloric acid.

The equation for the reaction is:

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

Calculate the volume of hydrochloric acid in cm^3 needed in the titration.

[2 marks]

_____

_____

_____

Volume of acid = _____ cm^3

4.4.2.4 The pH scale and neutralisation

Question 26 · continued

June 2024 | 8462/1H | Original Q9

0 9 . 5 A calcium atom is larger than a magnesium atom.

Explain why calcium reacts more vigorously than magnesium with hydrochloric acid of the same concentration.

[3 marks]

12

4.4.2.4 The pH scale and neutralisation

Question 27

June 2025 | 8462/1H | Original Q8

0 8 This question is about alkalis and acids.

0 8 . 1 What is the formula of the ion that **all** alkalis contain when in solution?

[1 mark]

_____

A student planned a titration experiment to determine the concentration of a sodium hydroxide solution.

This is the student's plan.

1. Measure 25.0 cm^3 of sulfuric acid of known concentration using a pipette.
2. Add the sulfuric acid to a conical flask.
3. Add 3 drops of universal indicator to the conical flask.
4. Place the conical flask on a white tile.
5. Fill a burette with sodium hydroxide solution to the 0.00 cm^3 mark.
6. Add sodium hydroxide solution to the conical flask and swirl the flask.
7. Stop adding sodium hydroxide solution when there is a colour change.
8. Record the volume of sodium hydroxide solution used.
9. Repeat steps 1 to 8 until consistent results are obtained.

0 8 . 2 Suggest **two** improvements to the plan.

Give **one** reason for each improvement.

[4 marks]

Improvement 1 _____

_____

Reason _____

_____

Improvement 2 _____

_____

Reason _____

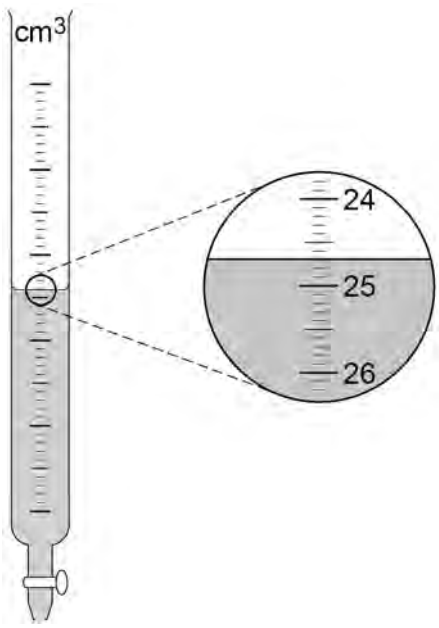
_____

4.4.2.4 The pH scale and neutralisation

Question 27 · continued

0 8 . 3 **Figure 9** shows the burette after one titration.

Figure 9



What is the reading on the burette?

[1 mark]

_____ cm^3

4.4.2.4 The pH scale and neutralisation

Question 27 · continued

0 8 . 4 In a different titration, 25.0 cm^3 of 0.216 mol/dm^3 sulfuric acid needed 11.25 cm^3 of sodium hydroxide solution for neutralisation.

The equation for the reaction is:

$$2\ NaOH + H_2SO_4 \longrightarrow Na_2SO_4 + 2\ H_2O$$

Calculate the concentration of the sodium hydroxide solution.

[4 marks]

Concentration = _____ mol/dm^3

Question 8 continues on the next page

Question 27 · continued

Table 4 gives information about solutions of two acids.

Table 4

Formula of acid	Concentration of solution in mol/dm^3	Percentage (%) of acid molecules that are ionised
HCl	0.1	100
HCN	2.0	0.01

0 8 . 5 Which is a correct statement about the solutions of HCl and HCN in **Table 4**?

[1 mark]

Tick (✓) **one** box.

The HCl is a more concentrated and stronger acid than the HCN. ☐

The HCl is a more concentrated and weaker acid than the HCN. ☐

The HCl is a more dilute and stronger acid than the HCN. ☐

The HCl is a more dilute and weaker acid than the HCN. ☐

0 8 . 6 In **Table 4**, the solution of HCl has a lower pH than the solution of HCN.

Explain why.

Use the data in **Table 4**.

[2 marks]

13