Questions

Q1.

A student carried out an investigation to determine the order of reactivity of four metals, W, X, Y and Z.
A piece of metal W was added to a test tube containing excess dilute hydrochloric acid.
This was repeated with the other three metals, X, Y and Z.
In each case, the size of each piece of metal was the same.
The student recorded observations on each reaction for three minutes.
The observations obtained are shown in Figure 8.

metal	observations with dilute hydrochloric acid
W	Bubbles formed quickly with some metal remaining after three minutes.
X	A few bubbles were seen to form. The metal looked unchanged after three minutes.
Y	Bubbles formed quickly. After three minutes all the metal had reacted.
Z	Bubbles formed very quickly with no metal remaining after three minutes.

Figure 8

(i) Use the information in Figure 8 to place the metals in order of reactivity from the least reactive to the most reactive.

(2)

least reactive → most reactive

(ii) The experiment was repeated using an excess of dilute sulfuric acid in place of the dilute hydrochloric acid.

metal + sulfuric acid → metal sulfate + hydrogen

When metal Y reacts with dilute sulfuric acid, bubbles form quickly at first and then the reaction stops.
Most of the solid metal remains.
Explain why the reaction between metal Y and excess dilute sulfuric acid stopped even though there was solid metal Y left.

(2)

.....

.....

.....

.....

(iii) The reactions between metals and dilute ethanoic acid are slower than reactions between metals and dilute hydrochloric acid.
This is because ethanoic acid is a weak acid.

Explain the meaning of the term weak acid.

(2)

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(Total for question = 6 marks)

Q2.

A titration is to be carried out to find the concentration of a solution of sodium hydroxide.

The sodium hydroxide solution is titrated with dilute sulfuric acid.

The available apparatus includes a burette, a pipette, a funnel, a conical flask and an indicator.

(a) State one safety precaution that must be taken when using sodium hydroxide solution and dilute sulfuric acid.

(1)

.....

.....

.....

(b) The sodium hydroxide solution is made by dissolving 4.3 g of sodium hydroxide in water and making the solution up to 250 cm3 with water.

Calculate the concentration of the solution in g dm−3.

(2)

concentration = ... g dm−3

(c) Write the balanced equation for the reaction of dilute sulfuric acid, H_2SO_4, with sodium hydroxide.

(2)

.....

(d) The results of titrations to determine how much of an acid is required to neutralise a given volume of an alkaline solution are shown in Figure 14.

	titration 1	titration 2	titration 3	titration 4
final burette reading (cm^3)	27	27.40	29.20	29.30
initial burette reading (cm^3)	0	2.10	4.00	3.50
volume of acid used (cm^3)	27	25.30	25.20	25.80

Figure 14

Two of the titrations in Figure 14 should not be used to calculate the mean volume of acid required.
Identify each titration and give a reason why it should not be used in the calculation of the mean.

(2)

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.....

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.....

(Total for question = 7 marks)

Q3.

An experiment is planned to record the change in pH as a powdered base is added to 50 cm3 dilute hydrochloric acid.

The method suggested is

step 1 add dilute hydrochloric acid up to the 50 cm3 mark on a beaker;
step 2 add one spatula of the base and stir;
step 3 measure the pH of the mixture;
step 4 repeat steps 2 and 3 until the pH stops changing.

(i) State how you could change the method so that the amounts of dilute hydrochloric acid and of the base can be measured more accurately.

(2)

dilute hydrochloric acid

.....

.....

base

.....

.....

(ii) During the experiment the pH changes from 2 to 10.

If phenolphthalein indicator is added at the beginning of the experiment, a colour change occurs as the base is added.

State the colour change that occurs.

(1)

colour at start .....

colour at end .....

(iii) Explain, in terms of the particles present, why the pH increases during the experiment.

(2)

.....

.....

.....

.....

(Total for question = 5 marks)

Q4.

The reactivity of copper, magnesium and zinc was investigated.
Each metal was placed separately in dilute hydrochloric acid.
The amount of effervescence was observed.

(i) The same mass of metal was used in each experiment.
Which piece of apparatus should be used to find the mass of metal used?

(1)

☒ A a balance

☒ B a pipette

☒ C a stopwatch

☒ D a thermometer

(ii) State two variables, apart from the mass of the metals, that should be controlled in this investigation.

(2)

1 .....

.....

2 .....

.....

(iii) Magnesium produces the most vigorous effervescence.
Copper does not produce any effervescence.

Give the reason why copper does not produce any effervescence.

(1)

.....

(iv) The magnesium reacts with dilute hydrochloric acid to form magnesium chloride solution and hydrogen gas.

The equation for the reaction is

$$Mg(s) + 2HCl(aq) \rightarrow MgCl2(.....) + H2(.....)$$

Fill in the missing state symbols in the spaces provided.

(2)

(Total for question = 6 marks)

Q5.

When burnt completely in air, butene forms carbon dioxide and water.

(i) Balance the equation for this reaction by putting numbers in the spaces provided.

(2)

$$C_4H_8 + 6O_2 \rightarrow \ldots\ldots\ldots\ldots CO_2 + \ldots\ldots\ldots\ldots H_2O$$

(ii) Describe the test to show that a gas is carbon dioxide.

(2)

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.....

.....

.....

(Total for question = 4 marks)

Q6.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

The word equation for the reaction between copper carbonate and dilute sulfuric acid is

$$\text{copper carbonate} + \text{sulfuric acid} \rightarrow \text{copper sulfate} + \text{carbon dioxide} + \text{water}$$

(i) Complete the balanced equation for this reaction.

(2)

$$CuCO_3 + \text{.....} \rightarrow \text{.....} + CO_2 + H_2O$$

(ii) Calculate the relative formula mass of copper carbonate, CuCO3.
(relative atomic masses: C = 12.0, O = 16.0, Cu = 63.5)

(2)

.....

.....

.....

relative formula mass of CuCO3 = ...

(iii) What is the chemical test to show that a gas is carbon dioxide?

(1)

- ☒ A bubble the gas through limewater, limewater turns cloudy
- ☒ B put damp blue litmus paper in the gas, litmus paper turns red
- ☒ C put a lighted splint into the gas, splint is extinguished
- ☒ D measure the pH of the gas, pH = 4

(Total for question = 5 marks)

Q7.

The scientist John Dalton lived over 200 years ago.

Another gas that Dalton investigated was chlorine.

Chlorine gas reacts with water.
The two products are a solution of hydrogen chloride and the substance HClO.

(i) Complete the balanced equation for this reaction, including the three missing state symbols.

(3)

..... (.....) + ... (.....) ↔
.....(.....) + HClO (aq)

(ii) Hydrogen chloride solution is acidic.

The formulae of four ions are shown in Figure 9.

H^+	H^-	Cl^+	Cl^-

Figure 9

Give the formula of the ion in Figure 9 that causes the hydrogen chloride solution to be acidic.

(1)

formula .....

(iii) An acid reacts with an alkali.

Give the name of this type of reaction.

(1)

.....

(iv) Describe what you would see when some copper carbonate powder is added to a beaker of dilute sulfuric acid.

(2)

.....

.....

.....

(Total for question = 7 marks)

Q8.

Magnesium carbonate has the formula $MgCO_3$.

Magnesium carbonate reacts with dilute hydrochloric acid.
Water and carbon dioxide are two of the products of the reaction.
Complete the balanced equation for this reaction.

(1)

$$MgCO_3 + 2HCl \rightarrow \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots + H_2O + CO_2$$

(Total for question = 1 mark)

Q9.

The fertiliser ammonium phosphate was made by reacting ammonia solution with dilute phosphoric acid.

(i) In the first step, 25 cm3 of dilute phosphoric acid was placed in a beaker.

Give the name of a piece of apparatus that could be used to measure out the 25 cm3 dilute phosphoric acid.

(1)

.....

(ii) Complete the word equation for this reaction.

(1)

ammonia + ... → .....

(iii) Some ammonium phosphate solution was made.

Describe how pure, dry crystals of ammonium phosphate are obtained from the ammonium phosphate solution.

(2)

.....

.....

.....

.....

(Total for question = 4 marks)

Q10.

A sample of rock salt contains a mixture of sodium chloride and some insoluble substances.

The rock salt is added to water and the mixture stirred.

The mixture is then filtered to obtain a filtrate of sodium chloride solution.

(i) Draw a labelled diagram of the apparatus used to filter the mixture and collect the sodium chloride solution.

(2)

(ii) Describe how a sample of pure, dry sodium chloride crystals can be obtained from the filtrate.

(3)

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.....

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.....

.....

.....

(Total for question = 5 marks)

Q11.

The word equation for the reaction between copper carbonate and dilute sulfuric acid is

$$\text{copper carbonate} + \text{sulfuric acid} \rightarrow \text{copper sulfate} + \text{carbon dioxide} + \text{water}$$

Figure 12 shows a conical flask containing dilute sulfuric acid.
Copper carbonate is added to the acid in the flask.
The copper carbonate is added one spatula measure at a time until the reaction has finished.

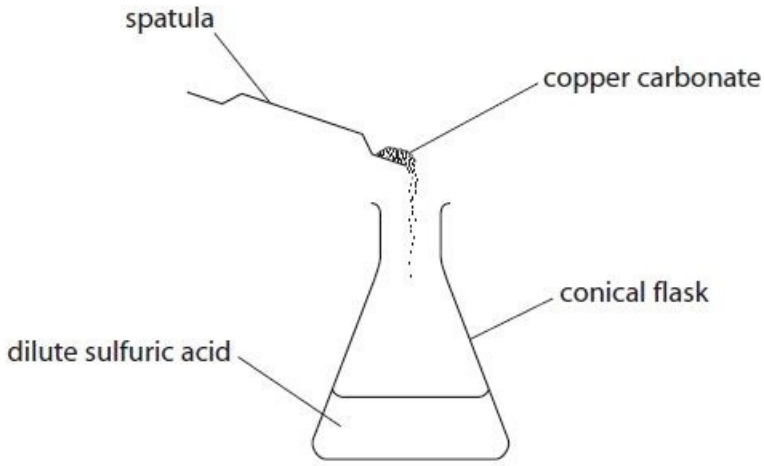

Figure 12

(i) State two observations that would show the reaction has finished.

(2)

1 .....

.....

2 .....

..... *(ii)

Describe how you would obtain a solution of copper sulfate from the mixture and how you would obtain pure,
dry copper sulfate crystals from this solution.

Your description should include the apparatus you would use.
You may wish to use diagrams in your answer.

(6)

(Total for question = 8 marks)

Q12.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Figure 11 shows the apparatus that can be used to electrolyse sodium sulfate solution using inert electrodes.

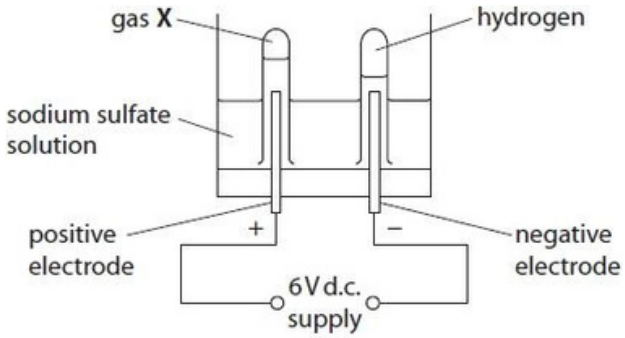

Figure 11

Hydrogen is produced at the negative electrode during electrolysis.

(i) Describe the test to show the gas is hydrogen.

(2)

.....

.....

.....

.....

(ii) What is the name of gas X that forms at the positive electrode?

(1)

- ☒ A ammonia
- ☒ B oxygen
- ☒ C nitrogen
- ☒ D sulfur dioxide

(iii) State what is meant by the term electrolysis.

(2)

.....

.....

.....

.....

(Total for question = 5 marks)

Q13.

Using different reactants, a solution of copper sulfate was prepared.

Describe what should be done to obtain copper sulfate crystals from this copper sulfate solution.

(2)

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(Total for question = 2 marks)

Q14.

The volume of dilute sulfuric acid required to neutralise 25.0 cm3 of ammonia solution can be found by titration.
In the titration, a few drops of methyl orange indicator were added to the ammonia solution in a conical flask before adding the dilute sulfuric acid.
The mean volume of dilute sulfuric acid required to neutralise the ammonia solution was determined from the results of the titration.
This volume of dilute sulfuric acid was added to 25.0 cm3 of ammonia solution in a conical flask.
Devise a plan to produce a sample of dry ammonium sulfate from the contents of the conical flask.

(3)

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.....

.....

.....

.....

.....

(Total for question = 3 marks)

Q15.

Magnesium carbonate has the formula $MgCO_3$.

* A student has two separate test tubes containing sulfuric acid.

The student adds a spatula measure of magnesium carbonate, $MgCO_3$, to the first test tube and a piece of magnesium to the second test tube.
Explain what the student would see in each test tube and the tests that they should carry out to identify the gases produced.
Your answer should include word equations for the reactions that would take place.

(6)

(Total for question = 6 marks)

Q16.

Dilute hydrochloric acid is a strong acid.

(i) Explain why dilute hydrochloric acid is described as a strong acid.

(2)

.....

.....

.....

.....

(ii) 1 cm^3 of hydrochloric acid of pH 2 is made up to a volume of 10 cm^3 with distilled water.
State the pH of the new solution.

(1)

pH = ...

(Total for question = 3 marks)

Q17.

Figure 2 shows a label from a bottle of drinking water.

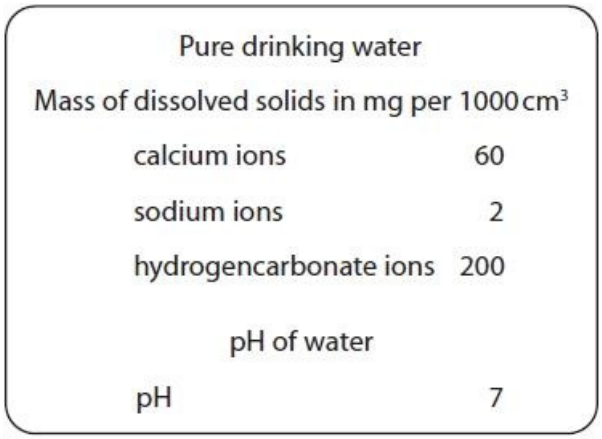


Figure 2

(i) Explain why this drinking water should not be described as pure water.

(2)

.....

.....

(ii) State the information from Figure 2 that shows that the drinking water is neutral.

(1)

.....

(iii) Calculate the mass of calcium ions in 250 cm3 of this drinking water.

(2)

.....

.....

mass = ... mg

(Total for question = 5 marks)

Q18.

Potassium hydroxide reacts with hydrochloric acid to form potassium chloride and water.

potassium hydroxide + hydrochloric acid → potassium chloride + water

A student carried out a titration to find the exact volume of dilute hydrochloric acid that reacted with 25.0 cm3 of potassium hydroxide solution.
There were five steps in the titration.
The steps shown are not in the correct order.

step J pour the potassium hydroxide solution into a conical flask and add a few drops of indicator to this solution

step K fill a burette with the dilute hydrochloric acid and record the initial reading from the burette

step L use a measuring cylinder to obtain 25 cm3 of potassium hydroxide solution

step M take a final reading from the burette and calculate the volume of the dilute hydrochloric acid reacted

step N run the dilute hydrochloric acid from the burette into the conical flask until the indicator changes colour

A student was then asked to produce a pure sample of solid potassium chloride.

After finding the volume of acid reacted in step M, the student added this volume of acid to a fresh 25.0 cm3 sample of the potassium hydroxide solution.
This mixture was then evaporated.

(i) Explain why this new mixture was evaporated rather than the original mixture from the titration, to produce a pure sample of solid potassium chloride.

(2)

.....

.....

.....

.....

.....

(ii) After evaporation, the mass of the potassium chloride was determined.

The theoretical yield of the experiment was 0.70 g.
The actual yield was 0.84 g.
This gave a percentage yield greater than 100%.
Calculate the percentage yield of this experiment.

(2)

.....

.....

percentage yield = ...

(iii) Suggest a reason why the actual yield was greater than the theoretical yield.

(1)

.....

.....

.....

(iv) The equation for the reaction between potassium hydroxide solution and dilute hydrochloric acid is

$KOH + HCl \rightarrow KCl + H_2O$

Calculate the atom economy for the production of potassium chloride from potassium hydroxide and hydrochloric acid.
(relative formula masses: KOH = 56.0, HCl = 36.5, KCl = 74.5, H_2O = 18.0)
Give your answer to one decimal place.

(4)

.....

.....

.....

.....

.....

.....

atom economy = ... %

(Total for question = 9 marks)

Q19.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Hydrochloric acid reacts with solid B.
Solid B is an alkali.

A student carries out an experiment to see how the pH changes when different masses of solid B are added to dilute hydrochloric acid.
The student uses the following method.

step 1 use a measuring cylinder to measure out 100 cm3 of dilute hydrochloric acid

step 2 pour the acid into a beaker

step 3 measure the pH with a pH probe

step 4 add half a spatula of solid B and stir

step 5 repeat steps 3 and 4 until the pH stops changing.

(i) Give a safety precaution that should be taken during the experiment.

(1)

.....

.....

(ii) Give an improvement to step 4 that would produce more accurate results.

(1)

.....

.....

(iii) What is the most likely change in pH during the experiment?

(1)

- ☐ A from 1 to 7
- ☐ B from 1 to 12
- ☐ C from 7 to 12
- ☐ D from 12 to 1

(iv) If some methyl orange indicator is added to the acid in step 2, the mixture changes colour during the experiment.
State the colour change.

(2)

colour at start in acid ..... colour at end .....

(Total for question = 5 marks)

Q20.

In an experiment magnesium hydroxide powder is added in 0.1 g portions to 25 cm3 of dilute hydrochloric acid until the magnesium hydroxide is just in excess.
Universal indicator paper can be used to test the pH of the solution after each addition of magnesium hydroxide.
(i) Give the name of an alternative piece of equipment that can be used to measure pH.

(1)

.....

(ii) State and explain how the pH changes as the magnesium hydroxide is added to the dilute hydrochloric acid.

(4)

.....

.....

.....

.....

.....

.....

.....

.....

(Total for question = 5 marks)

Q21.

The hydrogen ion concentration in a solution is decreased by a factor of 10.

State how the pH of this solution changes.

(1)

.....

(Total for question = 1 mark)

Q22.

The method used to prepare a salt depends on its solubility in water.

Complete Figure 9 by placing one tick in each row to show whether the salt is soluble or insoluble.

(2)

salt	soluble	insoluble
ammonium chloride		
lithium sulfate		
magnesium carbonate		

Figure 9

(Total for question = 2 marks)

Q23.

Some questions must be answered with a cross in a box (☒). If you change your mind about an answer, put a line through the box (☒) and then mark your new answer with a cross (☒).

Barium hydroxide reacts with dilute hydrochloric acid to form barium chloride and water.

Figure 15 shows a hazard symbol placed on a container of barium hydroxide.

Figure 15

What is the meaning of the hazard symbol in Figure 15?

(1)

- ☐ A flammable
- ☐ B health hazard
- ☐ C oxidising
- ☐ D toxic

(ii) Barium hydroxide is also corrosive.

Give one precaution that the student should take when using barium hydroxide.

(1)

.....

.....

(Total for question = 2 marks)

Q24.

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

They followed this method.

step 1 measure out 50.0 cm3 of dilute hydrochloric 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 0.2 g of barium 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 3–4 until there is no further change in the pH.

(i) Name a piece of equipment which could be used to measure out 50.0 cm3 of dilute hydrochloric acid more accurately than the measuring cylinder.

(1)

.....

(ii) Describe how the pH of the mixture is determined when a drop of it is placed on the universal indicator paper.

(2)

.....

.....

.....

.....

(iii) In the method, universal indicator paper is used to determine the pH.

Explain why litmus paper would not be a suitable indicator to use in this experiment.

(2)

.....

.....

.....

.....

(iv) Figure 2 shows the student's results.

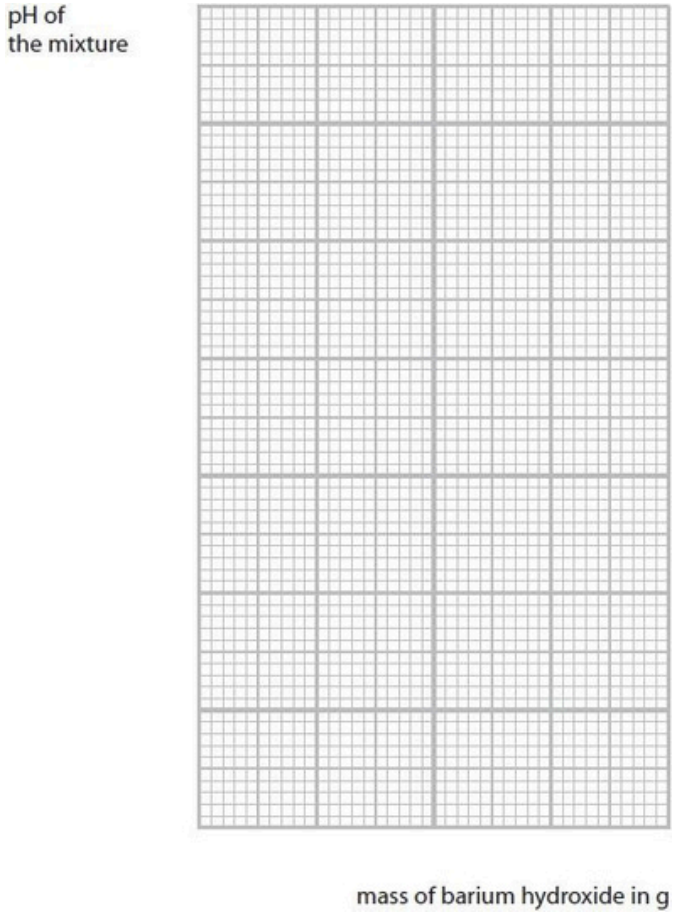
mass of barium hydroxide in g	pH of mixture
0.0	1
0.2	1
0.4	1
0.6	1
0.8	2
1.0	7
1.2	12
1.4	13
1.6	13

Figure 2

On the grid opposite:

- Add suitable scales to the vertical and horizontal axes.
- Plot a graph of the pH of the mixture against the mass of barium hydroxide.

(3)



(Total for question = 8 marks)

Q25.

Excess solid nickel carbonate is added to dilute sulfuric acid in a beaker.

$$\text{nickel carbonate} + \text{sulfuric acid} \rightarrow \text{nickel sulfate} + \text{carbon dioxide} + \text{water}$$

Nickel sulfate is formed in solution.

Describe how a sample of pure, dry nickel sulfate crystals can be obtained from the mixture of nickel sulfate solution and excess solid nickel carbonate in the beaker.

(3)

.....

.....

.....

.....

.....

.....

(Total for question = 3 marks)

Q26.

Universal indicator solution is not a suitable indicator for an acid-alkali titration.

(i) Give the name of an indicator that is suitable for use in the titration of sodium hydroxide solution with hydrochloric acid.

(1)

.....

(ii) Universal indicator goes through a series of gradual colour changes as the pH changes in a solution.

Give a reason why universal indicator is not a suitable indicator to use in an acid-alkali titration.

(1)

.....

.....

(Total for question = 2 marks)

Q27.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Three different metals are added to separate test tubes of acid.

The observations are shown in Figure 4.

metal	observation
silver	no change is seen
iron	very slow bubbling
magnesium	steady bubbling

Figure 4

(i) Place the metals in order of reactivity from most to least reactive.

(1)

most reactive .....

.....

least reactive .....

(ii) Hydrogen is given off when magnesium reacts with acid.
The hydrogen is tested by collecting the gas in a test tube and igniting it.

What is the safest way to ignite the gas?

(1)

- ☒ A add fuel to the test tube
- ☒ B heat the test tube with a Bunsen burner
- ☒ C put a lighted splint at the open end of the test tube
- ☒ D put the test tube in an oven

(iii) State the observation made in this test that shows that the gas is hydrogen.

(1)

.....

.....

(Total for question = 3 marks)

Q28.

Sodium hydroxide solution was added to a solution of copper sulfate.
A precipitate of copper hydroxide and a solution of sodium sulfate were formed.

(i) State what would be seen in the reaction.

(1)

.....

(ii) Complete the balanced equation for the reaction by adding a number in front of NaOH.

(1)

.....NaOH + $CuSO_4$ → $Cu(OH)_2$ + Na_2SO_4

(iii) Describe how to obtain a pure, dry sample of the precipitate of copper hydroxide from the reaction mixture.

(3)

.....

.....

.....

.....

.....

.....

(Total for question = 5 marks)

Q29.

X and Y are solutions of two different acids.
The concentration of acid in each solution, in mol dm−3, is the same.
Solution X has a pH of 3.40 and solution Y has a pH of 4.40.

(i) State what could be used to measure these pH values of 3.40 and 4.40.

(1)

.....

.....

(ii) What is the concentration of hydrogen ions in solution X compared with that in solution Y?

(1)

☒ A ten times lower

☒ B lower by a factor of 3.30/4.40

☒ C higher by a factor of 4.40/3.30

☒ D ten times higher

(Total for question = 2 marks)

Q30.

Fertilisers contain compounds that promote plant growth.

(i) State the name of an element in these compounds that promotes plant growth.

(1)

.....

(ii) Potassium nitrate is present in some fertilisers.

Potassium nitrate is formed by the reaction of potassium hydroxide solution with nitric acid.
Complete the balanced equation for this reaction.

(2)

KOH + HNO_3 → ..... +

.....

(Total for question = 3 marks)

Q31.

Aluminium oxide reacts with hydrochloric acid to form a salt and water.

(i) State the name of the salt formed.

(1)

.....

(ii) In this reaction aluminium oxide is a base.

State the type of reaction that takes place when an acid reacts with a base.

(1)

.....

(Total for question = 2 marks)

Q32.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Sodium reacts with hydrochloric acid to form sodium chloride and hydrogen.

(i) Write the word equation for this reaction.

(2)

..... →
.....

(ii) The hazard symbol shown in Figure 1 is used on containers of sodium.

Figure 1

What is the meaning of this hazard symbol?

(1)

- ☒ A corrosive
- ☒ B flammable
- ☒ C oxidising
- ☒ D toxic

(iii) Hydrogen has one electron in its electron shell.

Figure 2 shows the incomplete dot and cross diagram of a hydrogen molecule.
Complete Figure 2 to show the electrons in the covalent bond between the two atoms of hydrogen.

(1)

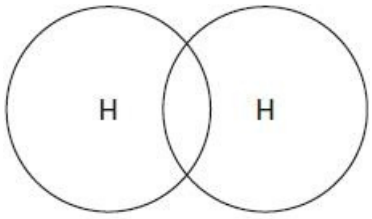


Figure 2

(Total for question = 4 marks)

Q33.

Nitric acid can be titrated with a solution of ammonia.

(i) State the type of reaction occurring when nitric acid reacts with ammonia.

(1)

.....

(ii) What salt is formed in this reaction?

(1)

- ☒ A ammonia nitric
- ☒ B ammonia nitrate
- ☒ C ammonium nitric
- ☒ D ammonium nitrate

(Total for question = 2 marks)

Q34.

The word equation for the reaction between copper carbonate and dilute sulfuric acid is

$$\text{copper carbonate} + \text{sulfuric acid} \rightarrow \text{copper sulfate} + \text{carbon dioxide} + \text{water}$$

Figure 4 shows a conical flask containing dilute sulfuric acid.
Copper carbonate is added to the acid in the flask.
The copper carbonate is added one spatula measure at a time until the reaction has finished.

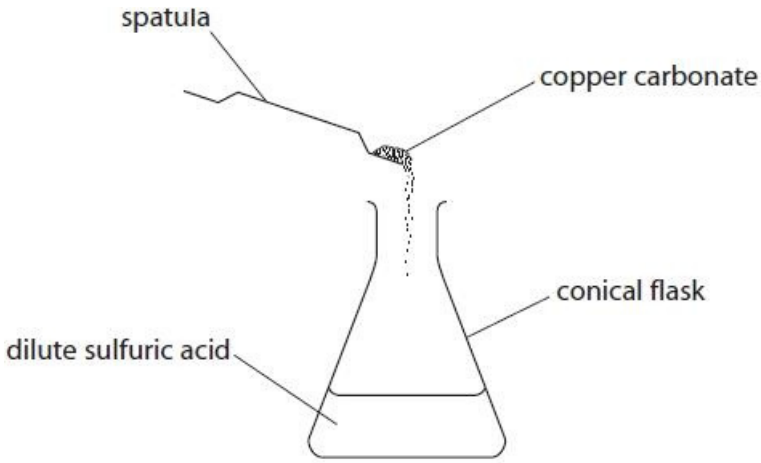


Figure 4

State two observations that would show the reaction has finished.

(2)

1 .....

.....

2 .....

.....

(Total for question = 2 marks)

Q35.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Copper carbonate reacts with dilute nitric acid.

(i) During the reaction the copper carbonate powder completely disappears.

State what can be deduced about the amount of acid used.

(1)

.....

.....

(ii) During the reaction, the pH of the mixture changed from 2 to 6.

By what factor has the concentration of the hydrogen ions in the mixture changed?

(1)

☐ **A** × 10 000

☐ **B** × 4

☐ **C** × ¼

☐ **D** $\times \frac{1}{10000}$

(Total for question = 2 marks)

Q36.

The pH of a sodium chloride solution was measured.

(i) State what could be used to measure the pH of a solution.

(1)

.....

(ii) Sodium chloride solution is neutral.

Give the pH of this solution.

(1)

.....

(Total for question = 2 marks)

Q37.

Water, acidified with sulfuric acid, is decomposed by electrolysis. The water is decomposed to produce hydrogen and oxygen.

(i) A sample of hydrogen is mixed with air and ignited.

State what would happen.

(1)

.....

.....

.....

(ii) Throughout the experiment the volume of hydrogen and the volume of oxygen are measured at two-minute intervals.

The results are shown in Figure 2.

time in minutes	volume of hydrogen in cm^3	volume of oxygen in cm^3
0	0	0
2	4	2
4	8	4
6	12	6
8	16	8

Figure 2

Describe, using the data in Figure 2, what the results show about the volumes of hydrogen and of oxygen produced in this experiment.

(2)

.....

.....

.....

.....

(Total for question = 3 marks)

Q38.

Acids are used to make salts.

Give the name of the acid used to make chlorides.

(1)

.....

(Total for question = 1 mark)

Q39.

Ammonia solution is alkaline.

Which of the following could be used to show that ammonia solution is alkaline?

(1)

- ☒ A conical flask
- ☒ B pH meter
- ☒ C pipette
- ☒ D thermometer

(Total for question = 1 mark)

Q40.

Some questions must be answered with a cross in a box (☒). If you change your mind about an answer, put a line through the box (☒) and then mark your new answer with a cross (☒).

A student wanted to find the volume of dilute hydrochloric acid that would react with 25.0 cm3 of lithium hydroxide solution.
They used the equipment in Figure 7 to carry out a rough titration and then a further two accurate titrations.

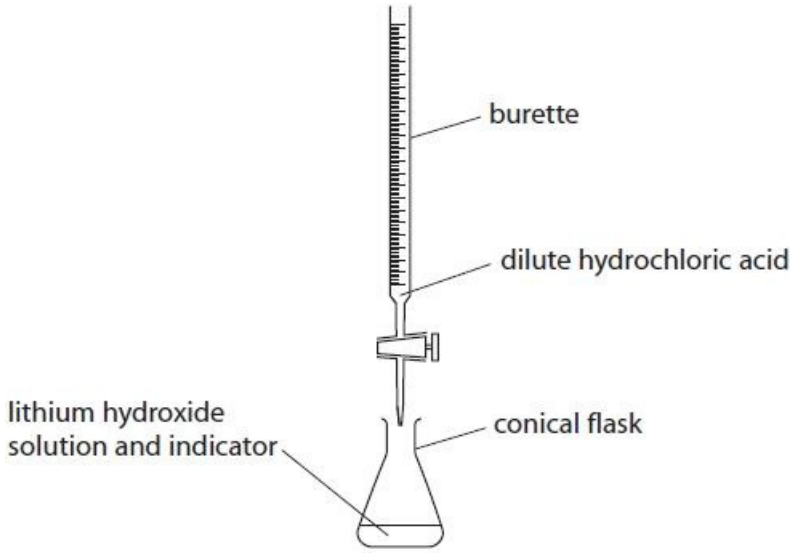


Figure 7

Which is the name of an indicator that is suitable to use in this titration?

(1)

- ☒ A limewater
- ☒ B litmus paper
- ☒ C methyl orange
- ☒ D universal indicator

(Total for question = 1 mark)

Q41.

Potassium carbonate reacts with dilute sulfuric acid to form potassium sulfate.

(i) Potassium sulfate contains potassium ions, K+, and sulfate ions, SO_4^{2-}.

Write the formula of potassium sulfate.

(1)

.....

(ii) Equal volumes of a solution of potassium carbonate were reacted separately with an excess of dilute sulfuric acid solution.
Pure dry samples of potassium sulfate were obtained from the resulting solutions.

The experiment was repeated three times using the same conditions.
The masses of potassium sulfate obtained were
experiment 1 = 5.22 g
experiment 2 = 5.24 g
experiment 3 = 5.21 g

Calculate the mean mass of potassium sulfate obtained, giving your answer to two decimal places.

(2)

.....

.....

.....

.....

mean mass of potassium sulfate = ... g

(Total for question = 3 marks)

Mark Scheme

Q1.

Question number	Answer	Additional guidance	Mark
(i)	least most X – W – Y – Z (2)	X – Y – W – Z (1)	(2) AO3-1

Question number	Answer	Additional guidance	Mark
(ii)	An explanation linking • metal sulfate {insoluble / coats the metal / forms a barrier} (1) • prevents further reaction of metal with acid (1)	ignore tarnish	(2) AO2-2

Question number	Answer	Additional guidance	Mark
(iii)	An explanation linking • partially {dissociated / ionised} (1) • {concentration of H^+ ions lower / fewer H^+ ions} than expected (1)	concentration of H^+ ions lower than concentration of acid (1) ignore references to pH	(2) AO1-1

Q2.

Question number	Answer	Mark
(a)	any **one** precaution from: • wear gloves to prevent contact with skin/safety (1) • spectacles to prevent contact with eyes (1)	(1)

Question number	Answer	Additional guidance	Mark
(b)	1000 cm^3 contain $\frac{4.3 \times 1000}{250}$ (1) 1 dm^3 contains 17.1 ($g\,dm^{-3}$) (1)	Award full marks for correct numerical answer without working.	(2)

Question number	Answer	Additional guidance	Mark
(c)	$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$ • correct formulae (1) • balancing (1)	Do not award 2 if incorrect balancing added.	(2)

Question number	Answer	Mark
(d)	• {titration 1/27 cm^3} should not be used because burette readings {not precise/not accurate/not read to 2 d.p.} (1) • {titration 4/25.80 cm^3} should not be used because volume of used (25.80 cm^3) not concordant with other two (1)	(2)

Q3.

Question number	Answer	Additional guidance	Mark
(i)	ACID use measuring cylinder / pipette / burette (1) BASE balance / scales / weigh out amount (1)	must name apparatus ignore weigh the liquid allow use portion of known mass / use measured amount **in g** / specific mass given [from 0.1 to 10g] allow weight for mass	**(2)**
(ii)	START colourless END pink / magenta	**both** START **and** END required for mark ignore clear	**(1)**
(iii)	An explanation linking • {hydrogen **ions**/ H^+} {reacted / neutralised} (1) • {concentration falls/ fewer} H^+ / {concentration rises/ more} OH^- (1)	allow $H^+ + OH^- \; H_2O$ (1) for MP1	**(2)**

Q4.

Question number	Answer	Mark
(i)	A a balance The only correct answer is A. B is incorrect because a pipette is used to measure out a volume of liquid and is not used to find the mass of a metal. C is incorrect because a stopwatch is used to measure time and is not used to find the mass of a metal. D is incorrect because a thermometer is used to measure temperature and is not used to find the mass of a metal.	(1)

Question number	Answer	Additional guidance	Mark
(ii)	Any two from the following • (same) volume of acid (1) • (same) concentration of acid (1) • (same) size of metal (pieces) (1) • (same) temperature (1)	 allow amount / mass of acid allow strength / pH allow surface area ignore references to time	(2)
(iii)	copper is {not reacting / no reaction / unreactive / low in reactivity series / not reactive enough}	allow less reactive (than hydrogen) ignore inert (alone)	(1)
(iv)	$MgCl_2$ (aq) (1) H_2 (g) (1) $Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$	allow AQ allow G	(2)

Q5.

Question Number	Answer	Additional guidance	Mark
(i)	$C_4H_8 + 6O_2 \rightarrow \mathbf{4}CO_2 + \mathbf{4}H_2O$ $4CO_2$ (1) $4H_2O$ (1)		(2) AO 2 1

Question Number	Answer	Additional guidance	Mark
(ii)	A description linking • (bubble gas through) limewater (1) • (limewater) turns {milky / cloudy / white precipitate} (1)	second mark dependent on first ignore lit splint goes out	(2) AO 1 1

Q6.

Question number	Answer	Additional guidance	Mark
(i)	Left : H_2SO_4 (1) Right : $CuSO_4$ (1)	reject superscript numbers reject superscript numbers incorrect balancing max 1	(2)

Question number	Answer	Mark
(ii)	63.5 + 12 + 3x16 (1) = 123.5 (1)	(2)

Question number	Answer	Mark
(iii)	**A** bubble the gas through limewater, limewater turns cloudy **The only correct answer is A** **B** is not correct because test shows only an acidic gas **C** is not correct because test shows only that the gas does not support combustion **D** is not correct because test shows only an acidic gas	(1)

Q7.

Question number	Answer	Additional guidance	Mark
(i)	$Cl_2(g) + H_2O(l) \rightleftharpoons HCl(aq) + HClO(aq)$ (3)	all three formulae (only) on correct sides of equation with no incorrect balancing (2) two formulae correct regardless of any other error (1) all three state symbols (1) Do not allow incorrect symbols or non subscripts eg CL^2	(3) AO2

Question number	Answer	Additional guidance	Mark
(ii)	H^+	if any other ions included 0 marks	(1) AO1

Question number	Answer	Additional guidance	Mark
(iii)	neutralisation	allow exothermic reject endothermic	(1) AO1

Question number	Answer	Additional guidance	Mark
(iv)	A description including any two from: • powder disappears (1) • effervescence/ bubbles/ fizzing (1) • blue solution forms (1)	allow dissolves	(2) AO2

Q8.

Question number	Answer	Additional guidance	Mark
	$MgCO_3 + 2HCl \rightarrow MgCl_2 + H_2O + CO_2$ (1)	reject any number in front of $MgCl_2$ reject upper case {G / L} / lower case m allow non-subscript 2 but reject superscript 2. ignore correct charges	(1) AO2-1

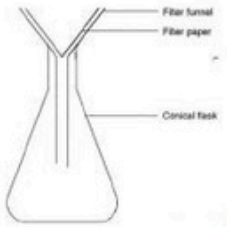
Q9.

Question number	Answer	Additional guidance	Mark
(i)	measuring cylinder	allow burette or pipette	(1)

Question number	Answer	Mark
(ii)	(ammonia) + phosphoric acid → ammonium phosphate	(1)

Question number	Answer	Mark
(iii)	An answer that combines the following points of application of knowledge and understanding to provide a logical description: • first heat the solution/leave water to evaporate (1) • and then filter off/dry crystals formed (1)	(2)

Q10.

Question number	Answer	Additional guidance	Mark
(i)	 (2) OR diagram: funnel with separate filter paper and (conical) flask (1) labels: (filter) **funnel and filter paper and** (conical) flask (1)	reject diagram with funnel 'closed' at bottom/top but can score MP2 allow 'closed' filter paper allow any suitable apparatus for conical flask e.g. beaker 'flask' label should be appropriate to apparatus drawn ignore labelling of filtrate/residue etc	(2)

Question number	Answer	Additional guidance	Mark
(ii)	a description including any three from: • heat solution (to concentrate) (1) then either • leave solution {in warm place / to crystallise} (1) • scrape crystals (from container) / pat dry between filter papers (1) OR • leave solution {to crystallise / to cool} (1) • filter off crystals / decant liquid from the crystals / pat dry between filter papers / dry in oven (1)	if no other marks are scored , allow max 1 for crystallisation (1)	(3)

Q11.

Question number	Answer	Additional guidance	Mark
(i)	Any TWO from • no more bubbles / fizzing (1) • no further change in colour (1) • {solid / copper carbonate} remains at bottom of flask / no more {solid / copper carbonate} dissolves (1)	 ignore references to pH allow cloudy/opaque liquid ignore no more copper carbonate will react	(2)

Question number	Indicative content	Mark
(ii)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material that is indicated as relevant. Additional content included in the response must be scientific and relevant. **AO2 and A03 (6 marks)** • filter mixture • using filter funnel and paper • collect filtrate / copper sulfate solution • in conical flask / suitable (named) container • pour into an evaporating basin • heat on water bath / on tripod over Bunsen • until half volume / concentrated / partially evaporated / crystals start to appear around the edge • remove from heat and cover with filter paper • allow to cool • and crystallise • separate crystals using a suitable method • put/place crystals onto absorbent/filter paper • dry in a warm place	(6)

Level	Mark	Additional Guidance	General additional guidance – the decision within levels Eg - At each level, as well as content, the scientific coherency of what is stated backed up by planning detail will help place the answer at the top, or the bottom, of that level.
	0	No rewardable material.	
Level 1	1–2	Additional guidance Identifies relevant practical operations	Possible candidate responses • filter the mixture (alone) • allow solution to crystallise (alone) • filter mixture using filter paper - upper part of level
Level 2	3–4	Additional guidance Some correct sequencing of correct operations	Possible candidate responses • filter mixture and collect solution/liquid • evaporate solution and leave to cool • sequence with detail – upper part of level
Level 3	5–6	Additional guidance Sequence of operations to include two from filter to remove excess copper carbonate, crystallise (includes heating & cooling), separate crystals & dry	Possible candidate responses • filter mixture then cool and crystallise • evaporate/heat solution then allow to cool and crystallise • sequence with detail – upper part of level

Q12.

Question number	Answer	Additional guidance	Mark
(i)	A description including • apply lighted splint (1) • gas burns / (squeaky) pop (1)	 allow flame / ignite gas ignore 'squeaky pop test' / glowing splint second mark is dependent on first	(2)

Question number	Answer	Mark
(ii)	**B** oxygen **The only correct answer is B** **A**, **C** & **D** these gases are not produced in the electrolysis of sodium sulfate solution	(1)

Question number	Answer	Additional guidance	Mark
(iii)	• electrical energy / electricity (1) • {decomposes / breaks down / splits} {electrolytes / (ionic) compounds / substances} (1)	allow electric current allow **separates** ions reject decomposing elements for MP2	(2)

Q13.

Question number	Answer	Additional guidance	Mark
	A description to include • heat solution (to evaporate water and concentrate the salt solution) (1) • leave to cool (1)	evaporating all water loses MP1 allow leave {in warm place/on window sill} (for water to evaporate slowly) (1) for several days (1)	(2) AO1

Q14.

Question number	Answer	Additional guidance	Mark
	A plan to include (stand alone marks) • heat solution (in an evaporating basin) (to concentrate) (1) • (cool and) crystallise (1) • **dry** ammonium sulfate crystals (between filter papers) (1)	do not accept crucible reject heat to dryness allow leave in a warm place (to crystallise) allow other suitable methods of drying, e.g. **warm** in an oven to **dry**	(3) AO3-3a

Q15.

Question number	Indicative content	Mark
*	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material that is indicated as relevant. Additional content included in the response must be scientific and relevant. **AO1 (3 marks) AO3 (3 marks)** **magnesium carbonate** • bubbles / fizzing / effervescence • magnesium carbonate gets smaller / disappears (allow 'dissolves') • metal carbonate + acid → metal salt + carbon dioxide + water • magnesium carbonate + sulfuric acid → magnesium sulfate + carbon dioxide + water • therefore, gas is carbon dioxide • test using limewater • limewater will turn cloudy **magnesium** • bubbles / fizzing / effervescence • metal gets smaller / disappears (allow 'dissolves') • gas is hydrogen • metal + acid → salt + hydrogen • test gas with a lit splint • (lit splint) burns with a squeaky pop • magnesium + sulfuric acid → magnesium sulfate + hydrogen Credit symbol equations. Incorrect/ incomplete equations could be partially credited for identifying product(s).	**(6)** **AO1** **AO3**

Level	Mark	Descriptor
	0	• No rewardable material.
Level 1	1-2	• Demonstrates elements of chemical understanding, some of which is inaccurate. Understanding of scientific, enquiry, techniques and procedures lacks detail. (AO1) • Analyses the scientific information but understanding and connections are flawed. (AO3)
Level 2	3-4	• Demonstrates chemical understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas, enquiry, techniques and procedures is not fully detailed and/or developed. (AO1) • Analyses the scientific information and provides some logical connections between scientific enquiry, techniques and procedures. (AO3)
Level 3	5-6	• Demonstrates accurate and relevant chemical understanding throughout. Understanding of the scientific ideas, enquiry, techniques and procedures is detailed and fully developed. (AO1) • Analyses the scientific information and provide logical connections between scientific enquiry, techniques and procedures throughout. (AO3)

Level	Mark	Descriptor	Possible candidate response
Read whole answer. Ignore all incorrect material and discard any contradictory material.			
	0	No rewardable material.	
Level 1	1–2	Candidate gives about one substance: brief description of observations / an observation and gas test /identification of two products for one reaction OR two bare facts about one or both substances	Possible candidate responses One / both bubble (1) Magnesium fizzes (1) Magnesium gives off hydrogen (1) Magnesium gives off hydrogen which gives a squeaky pop when lit (2) One correct word equation (2) Magnesium gives hydrogen and magnesium carbonate gives carbon dioxide (2) Test hydrogen: lit splint, squeaky pop; test carbon dioxide: limewater milky (2)
Level 2	3–4	Candidate gives about both substances: brief description of observations / an observation and gas test / the word equation OR Candidate gives about one substance: detailed description of observations with either gas test or the word equation	Possible candidate responses Magnesium gives hydrogen and magnesium carbonate gives carbon dioxide which turns limewater milky (3) Magnesium bubbles and disappears. The test for hydrogen is a lit splint which gives a squeaky pop. (3) Magnesium bubbles and disappears, the bubbles are hydrogen, the test for hydrogen is a lit splint which gives a squeaky pop. (4) magnesium produces hydrogen because metal + acid → salt + hydrogen, test hydrogen with lit splint which will give a squeaky pop (4) Two fully complete word equations (4)
Level 3	5–6	Candidate gives about both substances: at least two from: two observations gas test complete word equation OR a detailed description of observations with either gas test or the word	Possible candidate responses magnesium produces hydrogen and fizzes, magnesium + sulfuric acid → magnesium sulfate + hydrogen ; Magnesium carbonate produces carbon dioxide because it is a carbonate, so test the carbon dioxide with limewater and the limewater will turn cloudy (5) magnesium produces hydrogen and fizzes, magnesium + sulfuric acid → magnesium sulfate + hydrogen ; Magnesium carbonate disappears and
		equation for one and observations, gas test or word equation for the other	produces carbon dioxide because it is a carbonate, so test the carbon dioxide with limewater and the limewater will turn cloudy (6)

Q16.

Question number	Answer	Additional guidance	Mark
(i)	an explanation linking • fully dissociates (1) • to form {H^+/hydrogen} ions (1)	 allow ionises/splits up	(2)

Question number	Answer	Mark
(ii)	3 / pH 3	(1)

Q17.

Question number	Answer	Additional guidance	Mark
(i)	An explanation linking • pure water contains {only water (molecules)/ only one substance} / impure water contains more than one substances (1) • identification <u>from label</u> of impurity: dissolved solids/ calcium (ions) / sodium (ions) / hydrogencarbonate (ion) / ions	ignore all references to pH	(2) AO3

Question number	Answer	Mark
(ii)	pH (=7)	(1) AO2

Question number	Answer	Mark
(iii)	15 mg with or without working scores 2 • 250/1000 (1) (=0.250) • 60 x 250/1000 (1) (=15) OR • 1000/250 (1) = 4 • 60/4 (1) (=15)	(2) AO2

Q18.

Question number	Answer	Additional guidance	Mark
(i)	An explanation linking • solution from titration contains an indicator (1) • therefore second solution used with no indicator / indicator would contaminate salt (1)	MP2 dependent on MP1 allow original mixture was contaminated by indicator so doesn't form a pure salt (2)	(2)

Question number	Answer	Additional guidance	Mark
(ii)	final answer of 120% with or without working (2) OR $\frac{0.84}{0.70}$ (=1.2) (1) $\frac{0.84}{0.70}$ x 100 (=120(%)) (1)	allow any fraction x100 (1)	(2)

Question number	Answer	Additional guidance	Mark
(iii)	{the salt/solid/potassium chloride} was still wet/ not all of the water had been evaporated off		(1)

Question number	Answer	Additional guidance	Mark
(iv)	final answer of 80.5 with or without working (4) OR total mass: 56 + 36.5 (=92.5) / 74.5 + 18 (=92.5) (1) $\frac{74.5}{92.5}$ (= 0.8054) (1) $\frac{74.5}{92.5}$ x 100 (=80.540) (1) = 80.5 (1)	allow ECF throughout 92.5 seen (1) incorrect answer with working to 1 decimal place (1) 50.0/100.0 does not score MP4	(4)

Q19.

Question number	Answer	Mark
(i)	wear safety goggles/ gloves	(1) AO3

Question number	Answer	Additional guidance	Mark
(ii)	Measure mass of solid/ use a specified mass of solid	ignore changes to stirring ignore use a full spatula	(1) AO3

Question number	Answer	Mark
(iii)	**B** from 1 to 12 is the only correct answer. **A** and **C** are incorrect because the mixture does not start or end neutral **D** is incorrect because the pH is changing in the reverse direction	(1) AO2

Question number	Answer	Additional guidance	Mark
(iv)	start: red/pink (1) end: yellow (1)	allow (1) if colours reversed	(2) AO1

Q20.

Question number	Answer	Additional guidance	Mark
(i)	pH meter/ pH probe	ignore data logger alone reject litmus / phenolphthalein / universal indicator solution / pH paper	(1)

Question number	Answer	Additional guidance	Mark
(ii)	• increases pH (1) • until pH above 7 (1) and an explanation linking REACTION • {magnesium hydroxide / base / alkali / OH^- ions} {reacts with / neutralises} {the acid / the H^+ ions} IONS REMAINING • so the hydrogen ions concentration is reduced / **all** hydrogen ions reacted / there is an excess of hydroxide ions (1)	allow until pH = 7 ignore until neutral ignore there is an excess of magnesium hydroxide	(4)

Q21.

Question Number	Answer	Additional guidance	Mark
	pH {increases / goes up} by <u>one</u> / moves <u>1</u> closer to neutral	ignore {increases / goes up} alone	(1) AO 1 1

Q22.

Question number	Answer	Mark
	<table><tr><th>salt</th><th>soluble</th><th>insoluble</th></tr><tr><td>ammonium chloride</td><td>✓</td><td></td></tr><tr><td>lithium sulfate</td><td>✓</td><td></td></tr><tr><td>magnesium carbonate</td><td></td><td>✓</td></tr></table> • All three correct (2) • Any two correct (1)	(2)

Q23.

Question number	Answer	Mark
(i)	**B** health hazard is the only correct answer **A**, **C** and **D** are incorrect as this is the symbol for a health hazard	**(1)** **AO1-1**

Question number	Answer	Additional guidance	Mark
(ii)	(safety) goggles / gloves	allow safety glasses / eye protection ignore glasses and all other suggestions	**(1)** **AO1-1**

Q24.

Question number	Answer	Additional guidance	Mark
(i)	burette / (volumetric/graduated) pipette	allow syringe ignore any form of measuring cylinder / volumetric flask / dropping pipette	**(1)** AO3-3b

Question number	Answer	Additional guidance	Mark
(ii)	A description to include • (observe / look at) colour produced on (universal indicator) paper (1) • compare to pH {chart / scale} (1)	allow (paper/solution/mixture) changes colour / specific colours given of UI ignore incorrect linking colour to acidity ignore reference to other indicators ignore reference to pH meters	**(2)** AO2-2

Question number	Answer	Additional guidance	Mark
(iii)	An explanation linking • litmus paper only shows if the solution is {acidic / alkaline} (1) • does not show <u>how</u> acidic or alkaline the solution is (1)	allow litmus goes red in acid, blue in alkali / litmus only has 2 colours / only UI gives a wide range of colours / litmus paper does not have a gradual change in **colour** ignore references to purple and neutral ignore litmus is not {precise / accurate} allow does not give the pH / litmus does not give accurate pH allow litmus paper does not show a gradual change in **pH** / ORA allow litmus does not give 'strength' of acid/alkali allow litmus paper is qualitative not quantitative (1) reject answers referring to use in test for chlorine	**(2)** AO3-2a 2b

Question number	Answer	Additional Guidance	Mark
(iv)	• linear scales on both axes (1) • {plotted points / best fit line} must cover at least half graph paper in both directions (1) • 7 or more points plotted correctly (□ half a square) (1)	axes must be numbered (pH can start at 1) allow MP2 and MP3 if axes reversed must have numbered scale to score MP3 allow MP1 only for bar chart / histogram reject plotting on scale that uses the values from the table on Y axis (1, 1, 1, 1, 2, 7, 12, 13, 13)	**(3)** AO2-1

Q25.

Question Number	Answer	Additional guidance	Mark
	A description to include • filter (1) and two in a logical order from • **crystallisation** (1) • heat solution (to concentrate) (1) • allow to cool (1) • dry crystals between filter papers (1)	if filtration not first stage, ignore it and give maximum 2 marks allow description of filtration ignore filtration to obtain nickel sulfate (crystals) allow 'leave until water evaporates' / use of water bath / evaporate {water/the solution} allow leave {until crystals form / for a few hours / in a warm place / on a window sill} allow 'dry crystals in (warm) oven' if alternative methods of making nickel sulfate solution described, max 1 mark from last four marking points	**(3)** AO 2 2

Q26.

Question Number	Answer	Additional guidance	Mark
(i)	phenolphthalein /methyl orange	allow litmus / screened methyl orange / methyl red ignore litmus paper ignore pH meter/probe	**(1)** AO 2 2

Question Number	Answer	Additional guidance	Mark
(ii)	it does not show sharp colour change at end point / not known which colour change gives correct end point	ignore goes through a series of gradual colour changes allow does not have a definite end point	(1) AO 3 1b

Q27.

Question number	Answer	Mark
(i)	magnesium iron silver	(1) AO3

Question number	Answer	Mark
(ii)	**C** put a lighted splint at the open end of the test tube is the only correct answer **A**, **B** and **D** are incorrect because they would not work	(1) AO2

Question number	Answer	Additional guidance	Mark
(iii)	(squeaky) pop / flame	ignore references to ignites reject references to relights	(1) AO1

Q28.

Question number	Answer	Additional guidance	Mark
(i)	solid (forms) / (goes) cloudy / {solution/ liquid/ mixture} will go **colourless**	ignore crystals ignore any colour given for solid ignore liquid changes colour / colour change ignore precipitate reject any answer including fizzing/ bubbles/ effervescence	(1) AO2-2

Question number	Answer	Additional guidance	Mark
(ii)	$2NaOH + CuSO_4 \rightarrow Cu(OH)_2 + Na_2SO_4$	reject answer if numbers before any other substance	(1) AO2-1

Question number	Answer	Additional guidance	Mark
(iii)	A description to include: • filter (1) • (residue is) rinsed / washed / has distilled water added (1) • leave in warm place / put in oven (1)	if heating with Bunsen to evaporate all water **before** filtration, score 0 for whole answer if heating to warm reaction mixture ignore if no filtering score 0 marks for whole answer allow leave for water to evaporate / pat dry (with filter paper/ paper towel) / leave on windowsill allow heat (with Bunsen) ignore just 'leave' / leave to dry ignore 'crystallisation'	(3) AO2-2

Q29.

Question number	Answer	Additional Guidance	Mark
(i)	use pH meter/ pH probe (1)	allow pH paper / Universal indicator **reject** other named indicators / 'just 'indicator'	(1)

Question number	Answer	Mark
(ii)	**D** ten times higher **A** is incorrect because a pH difference in 1 reflects a 10 fold difference in $[H^+]$ **B** is incorrect because a pH difference in 1 reflects a 10 fold difference in $[H^+]$ **C** is incorrect because a lower pH means a higher $[H^+]$	(1)

Q30.

Question number	Answer	Additional guidance	Mark
(i)	phosphorus /potassium /nitrogen	accept phonetically correct spellings allow P / K / N	(1)
(ii)	$KOH + HNO_3 \rightarrow$ KNO_3 (1) + H_2O (1)	incorrect balancing of correct species 1 mark max allow OH_2 / HOH / NO_3K	(2)

Q31.

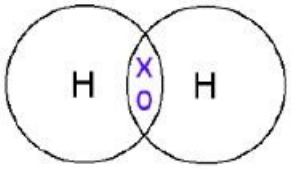
Question number	Answer	Additional guidance	Mark
(i)	aluminium chloride	reject 'aluminium chlorine'	(1)

Question number	Answer	Additional guidance	Mark
(ii)	neutralisation	allow acid + base allow 'acid-base' allow 'exothermic'	(1)

Q32.

Question number	Answer	Additional guidance	Mark
(i)	sodium + hydrochloric acid (1) → sodium chloride + hydrogen (1)	allow reactants either way round allow products either way round reject 'sodium chlorine' allow $Na + HCl \rightarrow NaCl + H_2$ (1) $2Na + 2HCl \rightarrow 2NaCl + H_2$ (2)	(2)

Question number	Answer	Mark
(ii)	**B** flammable **A** corrosive has a different hazard symbol **C** oxidising has a different hazard symbol **D** toxic has a different hazard symbol	(1)

Question number	Answer	Additional guidance	Mark
(iii)		allow dots or crosses or mixture allow other suitable symbols	(1)

Q33.

Question number	Answer	Additional guidance	Mark
(i)	neutralisation OR exothermic	allow exothermic	(1)

Question number	Answer	Mark
(ii)	**D** ammonium nitrate is the only correct answer **A** is incorrect because the cation is ammonium and the anion is nitrate **B** is incorrect because the cation is ammonium **C** is incorrect because anion is nitrate	(1)

Q34.

Question number	Answer	Additional guidance	Mark
	Any TWO from • no more bubbles / fizzing (1) • no further change in colour (1) • {solid / copper carbonate} remains at bottom of flask / no more {solid / copper carbonate} dissolves (1)	 ignore references to pH allow cloudy/opaque liquid ignore no more copper carbonate will react	(2)

Q35.

Question number	Answer	Additional guidance	Mark
(i)	the acid is in excess	allow exact quantity of acid used to react with the carbonate	(1) AO3

Question number	Answer	Mark
(ii)	D 1/10 000 is the only correct answer. A, B and C are factually incorrect	(1) AO1

Q36.

Question number	Answer	Additional guidance	Mark
(i)	pH meter	allow universal indicator / pH paper ignore datalogger alone ignore pH scale / pH strip ignore indicator alone	(1)

Question number	Answer	Additional guidance	Mark
(ii)	7 / seven	allow pH7 / PH7	(1)

Q37.

Question number	Answer	Additional guidance	Mark
(i)	(squeaky) pop / gas burns / water forms	allow explosion / bang / flame / fire / energy released ignore reaction occurs / ignites / set alight ignore references to splints (glowing or lit)	(1)
(ii)	A description to include • *volumes going up:* (oxygen/ hydrogen/ gas) increase (with time) / volume (directly) proportional to time (1) • *quantitative comparing hydrogen and oxygen:* (volume of) hydrogen double (volume of) oxygen / ORA / 2:1 ratio (1)	allow hydrogen goes up by 4 (cm^3) each time / by 2 cm^3 per minute / equivalent for oxygen for MP1 explicit reference needed to a ratio and **not** just quoting 2 figures allow amount in place of volume throughout twice as much hydrogen produced as oxygen (1) **rate** of hydrogen production double that of oxygen (2)	(2)

Q38.

Question Number	Answer	Additional guidance	Mark
	hydrochloric (acid)	allow HCl ignore HCL, hCl, HCL_2 etc	(1) AO 2 1

Q39.

Question number	Answer	Mark
	B	(1)

Q40.

Question number	Answer	Mark
	C methyl orange is the only correct answer A is incorrect as it tests for carbon dioxide/not an acid-alkali indicator. B is incorrect as no distinct/discrete change of colour D is incorrect as the colour change is not clear enough	**(3)** **AO2-2**

Q41.

Question number	Answer	Additional guidance	Mark
(i)	K_2SO_4	allow SO_4K_2 allow $(K^+)_2SO_4^{2-}$ (both charges needed & allow in reverse) reject incorrect subscript and superscripts (both charges needed & allow in reverse) reject incorrect subscript and superscripts	(1)
(ii)	5.22 with or without working scores 2 $\frac{5.22 + 5.24 + 5.21}{3}$ (= 5.2233) (1) = 5.22 (1)	 5.22 + 5.24 + 5.21 = 15.67 (MP1 does not score) allow 15.67 (1) (*ie* not divided by 3 but MP2 scores as answer to 2dp)	(2)