Questions

Q1.

Sucrose is a carbohydrate.

When a solution of sucrose is fermented using yeast, ethanol is formed.

sucrose + water → ethanol + carbon dioxide

In one experiment, 100.00 g of sucrose was dissolved in water.

Yeast was added and the mixture allowed to ferment until no more bubbles of carbon dioxide were seen to be formed.
The ethanol was obtained from the mixture and its mass determined.

The results are shown in Figure 3.

	mass in g
mass of sucrose	100.00
mass of ethanol obtained from the reaction	8.07
theoretical mass of ethanol formed	53.80

Figure 3

The percentage yield is calculated using

$$\text{percentage yield} = \frac{\text{actual yield}}{\text{theoretical yield}} \times 100$$

(i) State the meanings of the terms actual yield and theoretical yield.

(2)

actual yield

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....

theoretical yield

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(ii) Use the information in Figure 3 to calculate the percentage yield of ethanol in this experiment.

(2)

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percentage yield = ...

(iii) State two reasons why the actual yield of a reaction is usually less than the theoretical yield.

(2)

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2 ....

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(Total for question = 6 marks)

Q2.

Sucrose is a carbohydrate.

When a solution of sucrose is fermented using yeast, ethanol is formed.

sucrose + water → ethanol + carbon dioxide

The balanced equation for the fermentation of sucrose is

$$C_{12}H_{22}O_{11} + H_2O \rightarrow 4C_2H_5OH + 4CO_2$$

(i) Calculate the atom economy of this reaction to produce ethanol.

Give your answer to two significant figures.
(relative formula masses: $C_{12}H_{22}O_{11}$ = 342, H_2O = 18, C_2H_5OH = 46, CO_2 = 44)

(3)

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atom economy = ... %

(ii) Explain the effect on the atom economy of this reaction if the carbon dioxide produced was used to make fizzy drinks.

(2)

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(Total for question = 5 marks)

Q3.

When hydrogen is removed from an alkane, an alkene is formed.

This is an example of a dehydrogenation reaction.

900 dm3 of propane, measured at room temperature and pressure, were dehydrogenated to form propene.

$$\underset{\text{propane}}{C_3H_8(g)} \rightleftharpoons \underset{\text{propene}}{C_3H_6(g)} + H_2(g)$$

Calculate the maximum mass, in kg, of hydrogen formed in this reaction.

(relative atomic mass: H = 1.0;
1 mol of any gas at room temperature and pressure occupies 24 dm3)

(4)

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mass of hydrogen = ... kg

(Total for question = 4 marks)

Q4.

When hydrogen is removed from an alkane, an alkene is formed.

This is an example of a dehydrogenation reaction.

$$\underset{\text{propane}}{C_3H_8(g)} \rightleftharpoons \underset{\text{propene}}{C_3H_6(g)} + H_2(g)$$

State the maximum volume of propene, in dm3, formed by the dehydrogenation of 300 dm3 of propane.
(assume all volumes of gases are measured under the same conditions of temperature and pressure)

(1)

maximum volume of propene = ... dm3

(Total for question = 1 mark)

Q5.

Sucrose is a carbohydrate.

When a solution of sucrose is fermented using yeast, ethanol is formed.

sucrose + water → ethanol + carbon dioxide

In one experiment, 100.00 g of sucrose was dissolved in water.

Yeast was added and the mixture allowed to ferment until no more bubbles of carbon dioxide were seen to be formed.
The ethanol was obtained from the mixture and its mass determined.

The results are shown in Figure 16.

	mass in g
mass of sucrose	100.00
mass of ethanol obtained from the reaction	8.07
theoretical mass of ethanol formed	53.80

Figure 16

The percentage yield is calculated using

$$\text{percentage yield} = \frac{\text{actual yield}}{\text{theoretical yield}} \times 100$$

(i) State the meanings of the terms actual yield and theoretical yield.

(2)

actual yield

....

....

theoretical yield

....

....

(ii) Use the information in Figure 16 to calculate the percentage yield of ethanol in this experiment.

(2)

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....

....

percentage yield = ...

(iii) State two reasons why the actual yield of a reaction is usually less than the theoretical yield.

(2)

1 ....

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2 ....

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(Total for question = 6 marks)

Q6.

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.

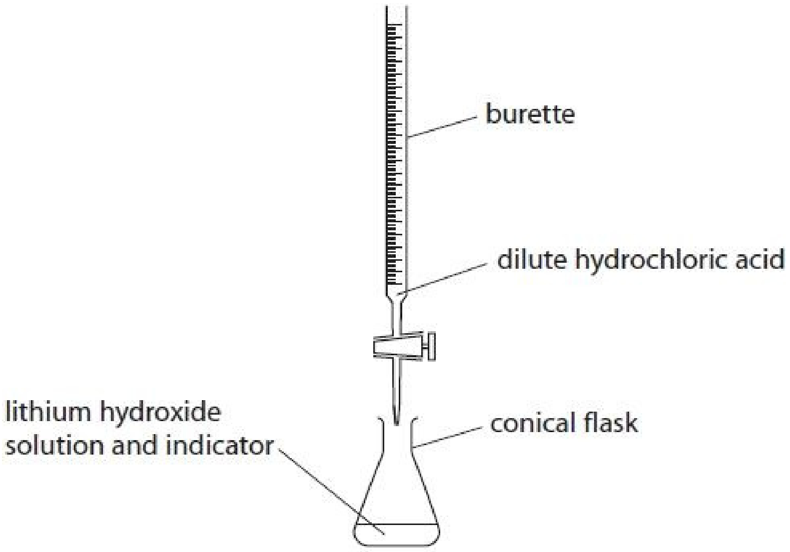

Figure 7

Figure 8 shows the results of the rough titration.

final reading on burette in cm^3	30.10
initial reading on burette in cm^3	2.50

Figure 8

What was the volume of acid added in the rough titration?

(1)

- ☐ A 2.50 cm3
- ☐ B 27.60 cm3
- ☐ C 30.10 cm3
- ☐ D 32.60 cm3

(Total for question = 1 mark)

Q7.

The concentration of dilute sulfuric acid can be determined by titration with sodium hydroxide solution of known concentration.

25.00 cm3 of dilute sulfuric acid was measured out using a pipette and transferred to a conical flask.

A few drops of methyl orange indicator were added to the acid in the conical flask. Sodium hydroxide solution was added to the acid from a burette until the indicator changed colour.

The titration was repeated until two concordant results were obtained.

The accurate result was the average of the two concordant results.

A brief report of the practical method has been given above.

Further detail can be added to this method to ensure that anyone following the method will obtain an accurate result.

Explain two details that could be added to this practical method to ensure an accurate result is obtained.

(4)

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2 ....

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(Total for question = 4 marks)

Q8.

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)

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(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, H2SO4, with sodium hydroxide.

(2)

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(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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(Total for question = 7 marks)

Q9.

Lead can be obtained by heating its oxide with carbon.
The balanced equation for the reaction is

$$2PbO + C \rightarrow 2Pb + CO2$$

Calculate the atom economy for the production of lead in this reaction.
(relative atomic masses: C = 12, O = 16, Pb = 207
relative formula masses: PbO = 223, CO2 = 44)

Give your answer to two significant figures.

(4)

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atom economy = ... %

(Total for question = 4 marks)

Q10.

Lead nitrate solution mixed with sodium sulfate solution forms lead sulfate as a precipitate.

$$Pb(NO_3)_2 + Na_2SO_4 \rightarrow PbSO_4 + 2NaNO_3$$

The theoretical yield of lead sulfate for this reaction was 2.85 g.
The actual yield of lead sulfate obtained was 2.53 g.
Calculate the percentage yield of lead sulfate in this experiment.

Give your answer to two significant figures.

(3)

percentage yield = ... %

(Total for question = 3 marks)

Q11.

(a) Lead nitrate solution mixed with sodium sulfate solution forms lead sulfate as a precipitate.

$$Pb(NO_3)_2 + Na_2SO_4 \rightarrow PbSO_4 + 2NaNO_3$$

In an experiment, the theoretical yield of lead sulfate for this reaction was 2.85 g. In the experiment only 2.53 g of lead sulfate is obtained.

Calculate the percentage yield of lead sulfate in this experiment.

Give your answer to two significant figures.

(3)

percentage yield = ...%

(b) The method used to make the lead sulfate is:

- pour 100 cm^3 lead nitrate solution into a beaker
- add drops of sodium sulfate solution until a precipitate is seen
- allow the precipitate to settle to the bottom of the beaker
- pour off the liquid
- use a spatula to transfer the solid lead sulfate onto a filter paper.

Explain two ways of improving this experimental method in order to increase the amount and quality of lead sulfate that could be obtained from 100 cm^3 of lead nitrate solution.

(4)

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(Total for question = 7 marks)

Q12.

Another student carried out the titration accurately.

12.15 cm3 of dilute sulfuric acid with a concentration of 0.140 mol dm–3 reacted completely with 25.00 cm3 of potassium hydroxide solution.

$$H_2SO_4 + 2KOH \rightarrow K_2SO_4 + 2H_2O$$

Calculate the concentration of this potassium hydroxide solution.

(4)

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concentration of potassium hydroxide solution = ... mol dm–3

(Total for question = 4 marks)

Q13.

In an experiment, ammonia gas is made by heating a mixture of ammonium chloride and calcium hydroxide.

$$2NH_4Cl(s) + Ca(OH)_2(s) \rightarrow CaCl_2(s) + 2NH_3(g) + 2H_2O(l)$$

10.0 g of ammonium chloride is added to an excess of calcium hydroxide.

Calculate the maximum volume of ammonia gas that could be formed.

(relative atomic mass H = 1.00, N = 14.0, O = 16.0 and Ca = 40.0; one mole of any gas occupies 24 dm^3 at room temperature and pressure)

(2)

volume = ... dm^3

(Total for question = 2 marks)

Q14.

A different solution of potassium hydroxide had a concentration of 0.175 mol dm–3.

This potassium hydroxide solution was made by dissolving 2.56 g of impure potassium hydroxide to form 250 cm3 of solution.
Calculate the percentage by mass of potassium hydroxide in the impure potassium hydroxide.
(relative formula mass: KOH = 56.0)

(3)

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percentage by mass of potassium hydroxide = ...

(Total for question = 3 marks)

Q15.

In one stage of the production of nitric acid, nitrogen oxide, NO, is reacted with oxygen to make nitrogen dioxide, NO_2.

$2NO + O_2 \rightarrow 2NO_2$

Calculate the minimum volume of air, measured at room temperature and pressure, required to react with 1000 g nitrogen oxide to form nitrogen dioxide.
Assume that the air contains 20% oxygen by volume.

(relative atomic masses: N = 14, O = 16
1 mol of gas occupies 24 dm^3 at room temperature and pressure)

(4)

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volume of air = ... dm^3

(Total for question = 4 marks)

Q16.

Calcium carbonate decomposes on heating to form calcium oxide and carbon dioxide.

$$CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$$

A second sample of calcium carbonate is strongly heated in a crucible until there is no further loss in mass.
The mass of calcium oxide remaining in the crucible is 5.450 g.

(i) The theoretical yield of calcium oxide in this experiment is 5.600 g.

Calculate the percentage yield of calcium oxide.

(2)

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percentage yield = ...

(ii) The mass of solid left in the crucible is less than the theoretical mass of calcium oxide that should be obtained.

A possible reason for this is that

(1)

- ☐ A some solid was lost from the crucible
- ☐ B the solid remaining absorbed some water from the air
- ☐ C some carbon dioxide remained in the crucible
- ☐ D the decomposition was incomplete

(Total for question = 3 marks)

Q17.

The theoretical maximum yield of zinc oxide was 1.86 g.

The actual yield was 1.63 g.

Calculate the percentage yield of zinc oxide.

(2)

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percentage yield = ...

(Total for question = 2 marks)

Q18.

Calcium carbonate decomposes on heating to form calcium oxide and carbon dioxide.

$$CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$$

(i) Calculate the relative formula mass of calcium carbonate, $CaCO_3$.
(relative atomic masses: C = 12, O = 16, Ca = 40)

(2)

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relative formula mass = ...

(ii) Calculate the atom economy for the formation of calcium oxide in this reaction.

$$CaCO_3 \rightarrow CaO + CO_2$$

You must show your working.
(relative atomic masses: C = 12, O = 16, Ca = 40;
relative formula mass: calcium oxide = 56)

(2)

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atom economy = ... %

(Total for question = 4 marks)

Q19.

Calculate the volume of 48 g of oxygen at room temperature and pressure.

(relative atomic mass: O = 16,
1 mol of gas occupies 24 dm3 at room temperature and pressure)

(2)

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volume of oxygen = ... dm3

(Total for question = 2 marks)

Q20.

The concentration of dilute sulfuric acid can be determined by titration with sodium hydroxide solution of known concentration.
25.00 cm3 of dilute sulfuric acid was measured out using a pipette and transferred to a conical flask.
A few drops of methyl orange indicator were added to the acid in the conical flask. Sodium hydroxide solution was added to the acid from a burette until the indicator changed colour.
The titration was repeated until two concordant results were obtained.

The accurate result was the average of the two concordant results.

In the titration, 25.00 cm3 of dilute sulfuric acid reacted with
24.25 cm3 of 0.200 mol dm−3 sodium hydroxide solution, NaOH.

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

Calculate the concentration of the dilute sulfuric acid, H2SO4, in mol dm−3.

(4)

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concentration of sulfuric acid = ... mol dm−3

(Total for question = 4 marks)

Q21.

The concentration of dilute sulfuric acid can be determined by titration with sodium hydroxide solution of known concentration.

25.00 cm^3 of dilute sulfuric acid was measured out using a pipette and transferred to a conical flask.

A few drops of methyl orange indicator were added to the acid in the conical flask. Sodium hydroxide solution was added to the acid from a burette until the indicator changed colour.

The titration was repeated until two concordant results were obtained.

The accurate result was the average of the two concordant results.

The concentration of some dilute sulfuric acid, H_2SO_4, is 0.250 mol dm^{-3}.

Calculate the concentration of sulfuric acid in this solution in g dm^{-3}.
(relative formula mass: H_2SO_4 = 98)

(2)

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concentration of sulfuric acid = ... g dm^{-3}

(Total for question = 2 marks)

Q22.

The industrial production of sulfuric acid involves several steps.

One of these steps is the reaction of sulfur dioxide, SO2, with oxygen to form sulfur trioxide, SO3.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

Calculate the mass, in kilograms, of 750 dm3 of sulfur dioxide, measured at room temperature and pressure.
(relative formula mass: SO2 = 64;

1 mol of any gas at room temperature and pressure occupies 24 dm3)

(3)

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mass of sulfur dioxide = ... kg

(Total for question = 3 marks)

Q23.

The industrial production of sulfuric acid involves several steps.

One of these steps is the reaction of sulfur dioxide, SO2, with oxygen to form sulfur trioxide, SO3.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

Calculate the volume of oxygen needed to react completely with 750 dm3 of sulfur dioxide.

(all volumes of gases are measured under the same conditions of temperature and pressure)

(1)

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volume of oxygen = ... dm3

(Total for question = 1 mark)

Q24.

Figure 3 shows some titration results obtained from an experiment in which an alkali is titrated with an acid.

	titration		
	rough	**1**	**2**
final burette reading in cm^3	25.75	49.35	23.70
initial burette reading in cm^3	0.00	25.75	0.00
volume of acid used in cm^3	25.75	23.60	23.70

Figure 3

Calculate the accurate volume of acid reacting with the alkali.

(2)

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accurate volume of acid reacting cm3

(Total for question = 2 marks)

Q25.

Hydrogen burns in air at a temperature well above 100 °C to form water.

(i) The boiling points of hydrogen and water are shown in Figure 15.

	boiling point in °C
hydrogen	−253
water	100

Figure 15

Use this information to add the missing state symbols to the equation for the reaction taking place as the hydrogen burns.

(2)

$$2H_2(.........) + O_2(g) \rightarrow 2H_2O(.........)$$

(ii) The atom economy for the reaction in (i) is 100%.

State how the equation shows that the atom economy is 100%.

(1)

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(Total for question = 3 marks)

Q26.

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.

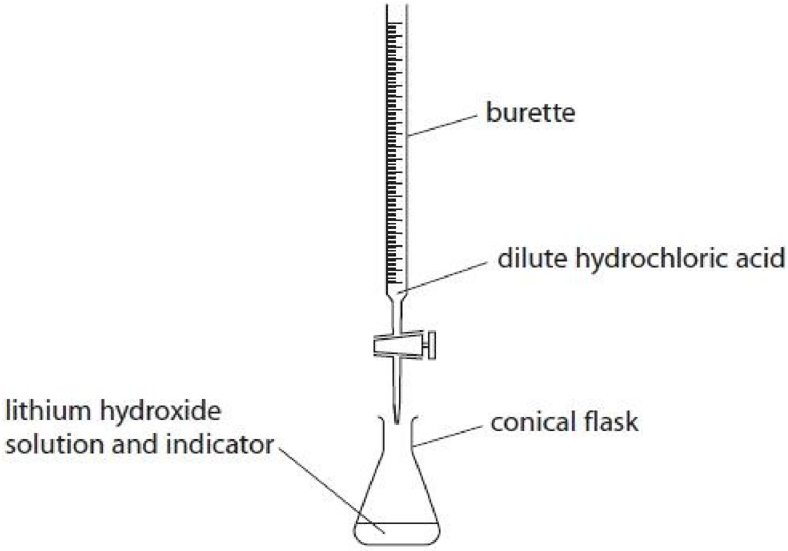

Figure 7

Describe how the rough titration should be carried out once the dilute hydrochloric acid, lithium hydroxide solution and indicator are placed in the apparatus in Figure 7.

(4)

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(Total for question = 4 marks)

Q27.

Ammonia solution and dilute sulfuric acid are used to prepare pure, dry ammonium sulfate crystals.

In an experiment a titration is carried out to determine the volumes of ammonia solution and dilute sulfuric acid that react together.

Then an ammonium sulfate solution is prepared from which the pure, dry crystals are obtained.

Describe in detail, using suitable apparatus, how this experiment should be carried out.

(Total for question = 6 marks)

Q28.

* Describe the experimental procedure to carry out a titration to find the exact volume of sulfuric acid needed to neutralise 25.0 cm3 of sodium hydroxide solution and obtain pure, dry crystals of sodium sulfate.

(6)

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(Total for question = 6 marks)

Q29.

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 titration was repeated to obtain a mean volume of dilute sulfuric acid required to neutralise the 25.0 cm3 of ammonia solution.
The volumes of the two solutions were measured accurately.

Explain two other practical steps that should be used in the titration to ensure that an accurate titre volume is obtained.

(4)

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(Total for question = 4 marks)

Q30.

Sodium hydroxide solution reacts with hydrochloric acid.

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

(i) 25.0 cm^3 of 0.100 mol dm^{-3} sodium hydroxide, NaOH, solution is added to 35.0 cm^3 of 0.0750 mol dm^{-3} dilute hydrochloric acid, HCl.

Use the information to determine which reagent is in excess.

(3)

(ii) To find the exact amount of dilute hydrochloric acid that reacts with 25.0 cm^3 of the sodium hydroxide solution, a titration is carried out. Figure 14 shows the results for the titrations.

	1st titration	2nd titration	3rd titration	4th titration
final burette reading / cm^3	37.60	36.20	39.15	38.40
initial burette reading / cm^3	1.80	0.00	3.95	2.10
volume of acid used / cm^3	35.80	36.20	35.20	36.30

Figure 14

In this titration, the accurate volumes of acid used that are within 0.20 cm^3 of each other are considered concordant volumes.

Use the concordant results to calculate the mean volume of hydrochloric acid required.

(1)

mean volume = ... cm^3

(iii) During the titration, the indicator used changed colour at the end point.

Which of the following shows an indicator with the colour change that would be seen in this titration?

(1)

		indicator	colour in alkali	colour at end point
☐	**A**	phenolphthalein	colourless	pink
☐	**B**	phenolphthalein	pink	yellow
☐	**C**	methyl orange	red	yellow
☐	**D**	methyl orange	yellow	orange

(Total for question = 5 marks)

Q31.

Methane reacts with steam to form hydrogen and carbon dioxide.

The reaction takes place in two stages.

stage 1: $CH_4(g) + H_2O(g) \rightleftharpoons 3H_2(g) + CO(g)$

stage 2: $CO(g) + H_2O(g) \rightleftharpoons H_2(g) + CO_2(g)$

(i) Stage 1 takes in heat energy, it is endothermic.

Explain the effect of increasing the temperature on the yield of the products of stage 1.

(2)

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(ii) The overall equation for the process is

$$CH_4(g) + 2H_2O(g) \rightarrow 4H_2(g) + CO_2(g)$$

0.40 g of methane were fully reacted with steam to form carbon dioxide and hydrogen.

Calculate the maximum volume of hydrogen in dm3, measured at room temperature and pressure, that could be made in this reaction.
(relative formula mass: CH4 = 16, 1 mol of any gas at room temperature and pressure occupies 24 dm3)

(3)

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maximum volume of hydrogen = ... dm3

(Total for question = 5 marks)

Q32.

Sulfur trioxide is produced by reacting sulfur dioxide with oxygen.

$$2SO_2 + O_2 \rightleftharpoons 2SO_3$$

(i) This reaction takes place in industry at 1–2 atm pressure and can reach a dynamic equilibrium.

Explain the effect on the rate of attainment of equilibrium, if the process is carried out at a pressure higher than 1–2 atm.

(3)

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(ii) What volume of oxygen, in cm3, would react completely with 500 cm3 sulfur dioxide?

(1)

☐ A 500 ÷ 2

☐ B 500

☐ C 500 × 2

☐ D 500 × 32

(Total for question = 4 marks)

Q33.

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)

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(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)

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....

percentage yield = ...

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

(1)

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

$KOH + HCl \rightarrow KCl + H2O$

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, H2O = 18.0)
Give your answer to one decimal place.

(4)

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atom economy = ... %

(Total for question = 9 marks)

Q34.

The method used to make lead sulfate is:

- pour 100 cm3 lead nitrate solution into a beaker
- add drops of sodium sulfate solution until a precipitate is seen
- allow the precipitate to settle to the bottom of the beaker
- pour off the liquid
- use a spatula to transfer the solid lead sulfate onto a filter paper

Explain two ways of improving this experimental method to increase the amount and quality of lead sulfate obtained from the same volume of lead nitrate solution.

(4)

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(Total for question = 4 marks)

Q35.

(i) In an experiment to produce lead, 7.67 g of lead are obtained.
The theoretical yield of lead for the experiment is 11.80 g.
Calculate the percentage yield of lead in this experiment.

(2)

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percentage yield = ...

(ii) In most reactions, the percentage yield of any product is less than 100%.

Give two reasons why the percentage yield is less than 100%.

(2)

reason 1

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reason 2

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(Total for question = 4 marks)

Q36.

A titration of sodium hydroxide solution with hydrochloric acid can be carried out as follows

1. a pipette is used to measure 25.00 cm3 of sodium hydroxide solution into a conical flask
2. a few drops of indicator are added to the sodium hydroxide solution
3. the burette is filled with hydrochloric acid
4. the hydrochloric acid is added to the sodium hydroxide solution until the indicator changes colour.

(i) Describe how the pipette should be used to measure exactly 25.00 cm3 of sodium hydroxide solution into the conical flask.

(2)

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(ii) The burette is first washed with water.

It is then rinsed with some of the acid before it is filled with the acid to begin the titration. Explain why the burette is rinsed with the acid.

(2)

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(Total for question = 4 marks)

Q37.

The industrial production of sulfuric acid involves several steps.

One of these steps is the reaction of sulfur dioxide, SO2, with oxygen to form sulfur trioxide, SO3.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

What volume of sulfur trioxide, in dm3, is produced by the complete reaction of 750 dm3 of sulfur dioxide?

(all volumes of gases are measured under the same conditions of temperature and pressure)

(1)

- ☐ A 375.5
- ☐ B 750
- ☐ C 1125.5
- ☐ D 1500

(Total for question = 1 mark)

Q38.

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

(i) Write the steps in the correct order.

Some of the steps have been completed for you.

(1)

first step				last step
K				M

(ii) Suggest an alternative piece of apparatus that could be used in step L to obtain exactly 25.0 cm3 of potassium hydroxide solution.

(1)

....

(Total for question = 2 marks)

Mark Scheme

Q1.

Question number	Answer	Additional guidance	Mark
(i)	Actual yield – {mass/amount/yield} (of product) formed in the {reaction / experiment} (1) Theoretical yield – calculated {mass/amount/yield} of product formed (using the balanced equation) / {mass/amount/yield} of product formed if all reactant used to form product only with no losses (1)	allow how much (product) formed ignore 'actual' allow maximum {mass / amount/yield} of product that could be formed (with no losses) ignore estimated / predicted / expected mass formed ignore what would form theoretically	(2) AO1-1

Question number	Answer	Additional guidance	Mark
(ii)	$\frac{8.07}{53.80}$ (1) (= 0.15) 0.15 x 100 (1) (= 15)	award correct answer of 15(%) with or without working (2) allow $\frac{53.80}{8.07}$ x100 / 666.7/667/666.6 for 1 mark	(2) AO3-1a

Question number	Answer	Additional guidance	Mark
(iii)	Any two from: • Some reactant remained unreacted (1) • Some product is lost during {the reaction /processes/extraction/purification} (1) • Side reactions occur (1)	allow reaction not left long enough allow above 15% ethanol, enzymes in yeast denature allow oxidation of ethanol ignore reactants are lost in experiment ignore yield is lost / loss of yield do not allow self-deprecating answers allow impurities in the reactants ignore reversible reaction	(2) AO1-1

Q2.

Question number	Answer	Additional guidance	Mark
(i)	342 + 18 = 360 / 4x46 + 4x44 = 360 **and** 4 x 46 (1) (=184) $\frac{(4 \times 46)}{360} \times 100$ (1) (=51.111...) 51(%) (to 2 sig figs) (1)	award full marks for 51 with or without working 0.5111 scores 1 mark 12.8 or 12.78 or 12.778 scores 1 mark 13 scores 2 51.1 / 51.11 (or more sig figs) scores 2 marks 25.555 scores 1 26 scores 2 marks sig fig mark can still be awarded if answer from an incorrect calculation has been given to 2 sig figs if using numbers from question	**(3)** AO2-1

Question number	Answer	Additional guidance	Mark
(ii)	An explanation linking • carbon dioxide becomes {useful/a desired product /no longer a waste product} (1) • so atom economy increases (to 100%) (1)	ignore any increased atom economy less than 51%	**(2)** AO2-1

Q3.

Question number	Answer	Additional guidance	Mark
	1 mol C_3H_8 produces 1 mol H_2 (1) no moles propane = $\frac{900}{24}$ (1) (= 37.5) = no moles H_2 mass of H_2 = 37.5 x 2 g (1) (= 75.0 (g)) = 7.50×10^{-2} (kg) (1) (= 0.075)	Answer of 0.075 with or without working scores full marks Allow ECF throughout allow 37.5 (moles) for 2 marks Allow 75.0×10^{-3} (kg) as a correct final answer 0.0375 scores 3 75(.0) scores 3	**(4)** AO2-1

Q4.

Question number	Answer	Mark
	300 (dm^3)	**(1)** AO2-1

Q5.

Question number	Answer	Additional guidance	Mark
(i)	Actual yield – {mass/amount/yield} (of product) formed in the {reaction / experiment} (1) Theoretical yield – calculated {mass/amount/yield} of product formed (using the balanced equation) / {mass/amount/yield} of product formed if all reactant used to form product only with no losses (1)	allow how much (product) formed ignore 'actual' allow maximum {mass / amount/yield} of product that could be formed (with no losses) ignore estimated / predicted / expected mass formed ignore what would form theoretically	**(2)** **AO1-1**

Question number	Answer	Additional guidance	Mark
(ii)	$\frac{8.07}{53.80}$ (1) (= 0.15) 0.15 x 100 (1) (= 15)	award correct answer of 15(%) with or without working (2) allow $\frac{53.80}{8.07}$ x100 / 666.7/667/666.6 for 1 mark	**(2)** **AO3-1a**

Question number	Answer	Additional guidance	Mark
(iii)	Any two from: • Some reactant remained unreacted (1) • Some product is lost during {the reaction /processes/extraction/ purification} (1) • Side reactions occur (1)	allow reaction not left long enough allow above 15% ethanol, enzymes in yeast denature allow oxidation of ethanol ignore reactants are lost in experiment ignore yield is lost / loss of yield do not allow self-deprecating answers allow impurities in the reactants ignore reversible reaction	**(2)** **AO1-1**

Q6.

Question number	Answer	Mark
	B 27.60 is the only correct answer **A** is incorrect as this is the initial reading on the burette **C** is incorrect as this is the final reading on the burette **D** is incorrect as the values have been added rather than subtracted	**(1)** **AO2-1**

Q7.

Question Number	Answer	Mark
	Any two linked explanations Any two suitable precautions to make use of pipette or burette as accurate as possible or to carry out the titration as accurate as possible (1) linked explanation (1) e.g. read bottom of the meniscus on the burette/pipette scale / read burette/pipette at eye-level (1) to obtain accurate volume of sodium hydroxide solution / sulfuric acid added (1) add {solution from burette / alkali} one drop at a time near end point (1) to identify exactly when colour change of indicator takes place (1) use a white tile (1) to make it easier to see exactly when colour change of indicator takes place (1) make sure no air bubbles in burette or pipette when measuring volumes (1) so exact volumes are recorded (1) continually swirl flask (1) to ensure complete mixing of acid with alkali (1) wash inside of conical flask with a little deionised/distilled water (1) to wash reactants into reaction mixture (1) wash burette / pipette with appropriate solution before titration (1) to ensure burette / pipette is not contaminated (1) do not award marks for concordancy / reliability / changes of indicator	**(4)** AO 1 2

Q8.

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)**

Q9.

Question Number	Answer	Additional guidance	Mark
	final answer of 90 with or without working (4) OR total mass : 2x223 + 12 / (2 x 207) + 44 (= 458) (1) mass of useful products : 2 x 207 = 414 $\frac{414}{458}$ (1) x 100 (1) (= 90.39) = 90 (1)	allow ECF throughout 458 seen (1) 90.39 / 90.4 for 3 marks 110.628... / 111 (2) 110 (3) correct rounding of an answer with working to 2 sig fig (1)	**(4)** AO 2 1

Q10.

Question number	Answer	Additional guidance	Mark
	• mass values in correct places (1) • multiplication by 100 (1) • correct final answer to two significant figures (1)	$\frac{2.53}{2.85} \times 100 = 88.8\%$ 89% (to 2 s.f.) Award full marks for correct numerical answer without working.	(3)

Q11.

Question number	Answer	Additional guidance	Mark
(b)	• mass values in correct places (1) • multiplication by 100 (1) • correct final answer to two significant figures (1)	$\frac{2.53}{2.85} \times 100 = 88.8\%$ 89% (to 2 s.f.) award full marks for correct numerical answer without working	(3)

Question number	Answer	Mark
(c)	An explanation that combines identification – improvement of the experimental procedure (maximum 2 marks) and justification/reasoning, which must be linked to the improvement (maximum 2 marks): • add excess sodium sulfate solution rather than a few drops (1) • so more reaction occurs to form more lead sulfate (1) • filter the reaction mixture rather than pour off the liquid (1) • so none of the lead sulfate is lost on separation (1) • wash the lead sulfate (1) • so the impurities are removed (1) • place the lead sulfate in an oven/warm place (1) • so the lead sulfate is dry (1)	(4)

Q12.

Question number	Answer	Additional guidance	Mark
	moles of sulfuric acid = $0.140 \times \frac{12.15}{1000}$ (1) (= 0.001701 mol) ratio 2 : 1 KOH to H_2SO_4 (1) moles of KOH = 2 x 0.001701 (1) (= 0.003402 mol) concentration of KOH = $0.003402 \times \frac{1000}{25.00}$ (1) (= 0.136 mol dm^{-3})	award full marks for correct final answer without working allow ecf from moles of sulfuric acid allow ecf from moles of KOH	(4) AO2

Q13.

Question number	Answer	Additional guidance	Mark
	Formula mass ammonium chloride = 14.0 + 4.00 + 35.5 = 53.5 moles of ammonium chloride $= \frac{10.0}{53.5} = 0.187$ (1) volume ammonia = 0.187 × 24 = 4.49 dm^3 (1) or • 2 × 53.5 = 107 g ammonium chloride produces 2 × 24 = 48 dm^3 ammonia (1) • 10.0 g ammonium chloride produces $\frac{10.0}{2 \times 53.5} \times 2 \times 24 = 4.49$ dm^3 ammonia (1)	Award full marks for correct numerical answer without working.	(2)

Q14.

Question number	Answer	Additional guidance	Mark
	$0.175 \times 56.0 = 9.80$ g dm^{-3} (1) mass in 250 cm^3 sample = $0.25 \times 9.80 = 2.45$ g (1) % pure KOH = 2.45 /2.56 x 100 = 95.7 (%) (1)	award full marks for correct final answer without working	(3) AO2

Q15.

Question number	Answer	Additional guidance	Mark
	2000 dm^3 with or without working scores 4 moles NO = 1000/30 (1) (= 33.3...) moles O_2 = moles NO /2 (1) (= 16.666...) volume O_2 = moles x 24 = 16.666... x 24 (1) (=400 dm^3) volume air = volume O_2 x 100/20 (1) (=2000 dm^3) OR 2 mol NO = 60 g (1) 60 g NO : 24 dm^3 oxygen (1) 1000 g NO reacts with 24 x 1000/60 (1) (=400 dm^3) volume air = volume O_2 x 100/20 (1) (=2000 dm^3)	ecf on all stages **3 marks** all working up to 400 x 20/100 = 80	**(4)**

Q16.

Question number	Answer	Additional guidance	Mark
(i)	97.3(%) with or without working scores 2 $\frac{5.450}{5.600}$ (1) x 100 = 97.3214.... = 97.3(%) (1)	if fraction inverted then x 100 = 102.75... (3 or more sig fig) allow (1) for 0.973 allow (1) MP2 only for correctly x 100 some figure derived from the data given allow any sig fig except 1	(2)

Question number	Answer	Mark
(ii)	**A** some solid was lost from the crucible is the only correct answer **B** is incorrect because this would increase mass **C** is incorrect because this would not alter mass **D** is incorrect because this would increase mass	(1)

Q17.

Question number	Answer	Additional guidance	Mark
	$\frac{1.63}{1.86}$ (1) (= 0.876) 0.876 x 100 (1) (= 87.6 (%))	award full marks for correct final answer without working allow 2 or more sig figs MP2 depends on MP1	(2) AO2

Q18.

Question number	Answer	Additional guidance	Mark
(i)	100 with or without working scores 2 40 + 12 + 3 x 16 (1) =100 (1)	ignore any units ecf for MP2 if using 12,16 and 40, using addition and multiplication only	(2)
(ii)	56% without working scores 0 $\frac{56}{100}$ (1) (x 100) = 56 (%) (1)	56/answer to 4(d)(i) (1) x 100 (1) MP2 only for correctly x 100 some figure derived from the data given 100% scores 0	(2)

Q19.

Question number	Answer	Additional guidance	Mark
	moles of oxygen = 48/32 (1) (= 1.5 mol) volume of oxygen = 1.5 x 24.0 dm^3 (= 36 dm^3) (1)	award full marks for correct final answer without working allow ecf on incorrect number of moles	**(2)** **AO2**

Q20.

Question Number	Answer	Mark
	0.097 (mol dm^{-3}) with or without working (4) OR moles of NaOH = $\frac{24.25 \times 0.200}{1000}$ (1) (= 4.85×10^{-3}) from reaction equation moles acid = ½ x moles alkali = ½ x 4.85×10^{-3} (1) (= 2.425×10^{-3}) concentration of H_2SO_4 = $\frac{2.425 \times 10^{-3} \times 1000}{25.00}$ (1) = 0.097 (1) (mol dm^{-3}) OR ½ (1) x 24.25 x 0.200 = 25.00 x conc H_2SO_4 (1) conc H_2SO_4 = ½ x $\frac{24.25 \times 0.200}{25.00}$ (1) = 0.097(1) (mol dm^{-3}) on answer line 0.388 / 0.39 (3) [x2 instead of x½] 0.194 / 0.19 (3) [not x½] Ignore sig figs except for 1	**(4)** AO 3 2a AO 3 2b

Q21.

Question Number	Answer	Additional guidance	Mark
	24.5 (g dm^{-3}) with or without working (2) OR concentration = 98 x 0.25 (1) = 24.5 (1) (g dm^{-3})	allow 2.45 / 24500 (1)	**(2)** AO 2 1

Q22.

Question Number	Answer	Additional guidance	Mark
	final answer of 2 (kg) with or without working (3) OR moles of SO_2 = $\frac{750}{24}$ (1) (= 31.25) mass of SO_2 = $\frac{750}{24}$ x 64 (1) (= 2000) mass of SO_2 = $\frac{2000}{1000}$ (1) (= 2 (kg))	allow ECF throughout 31.25 x 64 (2) allow ECF allow any calculated mass / 1000 (1) final answer 2000 (kg) (2)	**(3)** AO 2 1

Q23.

Question Number	Answer	Additional guidance	Mark
	½ x 750 (1) = 375 (dm^3)	375 alone (1)	**(1)** AO 2 1

Q24.

Question Number	Answer	Additional guidance	Mark
	23.65 with or without working scores 2 OR $\frac{23.60+23.70}{2}$ (1) = 23.65 (1)	allow 1 mark for all 3 averaged (24.35)	**(2)** AO 3 2a AO 3 2b

Q25.

Question Number	Answer	Mark
(i)	$2H_2$ (g) + O_2 (g) → $2H_2O$ (g)	**(2)** AO 3 1a AO 3 1b

Question Number	Answer	Additional guidance	Mark
(ii)	all atoms in the reactants are present in the product / only one product is formed	allow no atoms are wasted (in the reaction) / no waste products / nothing is wasted allow total mass of reactants = mass of useful products allow complete calculation to show that atom economy is 100% ignore equation is balanced / same number of atoms on both sides	**(1)** AO 1 1

Q26.

Question number	Answer	Additional guidance	Mark
	a description including any four from:		**(4)** **AO1-1**
	• read the (initial) volume on the burette (1)	allow initial burette reading	
	• open the tap / add acid to {alkali/flask} (1)	allow add HCl to LiOH allow open tap ignore dropwise / drop by drop	
	• swirl the mixture (1)		
	• until end point / until indicator changes colour (1)	allow any change of colour given	
	• (close tap then) read (final) volume of acid in burette (1)	allow final burette reading	

Q27.

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 which is indicated as relevant. Additional content included in the response must be scientific and relevant. **AO1 (3 marks) AO2 (3 marks)** • pipette to measure out the ammonia solution (25 cm^3) • into a suitable container, e.g. conical flask • add few drops of methyl orange indicator • put flask on a white tile • fill burette with sulfuric acid solution • read level of liquid in burette • add acid from the burette • swirl flask gently / mix • add drop-wise near end-point • until {indicator just changes colour} • read level on burette • repeat experiment until concordant results owtte • mix the same volumes of sulfuric acid and ammonia solution (determined from the titration experiment) • but leaving out the indicator/methyl orange • pour solution into an evaporating dish • heat the solution to point of crystallisation • leave to cool • filter off crystals • leave to dry	EXP (6)

Level	Mark	Descriptor
	0	• No awardable content
Level 1	1-2	• Demonstrates elements of chemical understanding, some of which is inaccurate. Understanding of scientific ideas lacks detail. (AO1) • The explanation attempts to link and apply knowledge and understanding of scientific ideas, flawed or simplistic connections made between elements in the context of the question. (AO2)
Level 2	3-4	• Demonstrates chemical understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas is not fully detailed and/or developed. (AO1) • The explanation is mostly supported through linkage and application of knowledge and understanding of scientific ideas, some logical connections made between elements in the context of the question. (AO2)
Level 3	5-6	• Demonstrates accurate and relevant chemical understanding throughout. Understanding of the scientific ideas is detailed and fully developed. (AO1) • The explanation is supported throughout by linkage and application of knowledge and understanding of scientific ideas, logical connections made between elements in the context of the question. (AO2)

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 Describes at least two steps of any of the three stages in the preparation of the ammonium sulfate crystals	Possible candidate responses • add sulfuric acid using a burette to ammonium solution • use a pipette to measure out the ammonia solution and fill a burette with sulfuric acid • mix correct volumes of sulfuric acid and ammonia solution together without indicator • heat the ammonium solution until crystals start to form
Level 2	3–4	Additional guidance Describes at least two of the three stages in some detail, at least three steps, OR all three stages but lacking detail	Possible candidate responses • use a pipette to measure out the ammonia solution into a conical flask add few drops of indicator, add acid from a burette to ammonia solution. Crystallise the ammonium sulfate solution. • use a pipette to measure out the ammonia solution. Add sulfuric acid using a burette to ammonia solution. Mix correct volumes of sulfuric acid and ammonia solution together without indicator to produce ammonium sulfate solution. • carry out a titration adding acid to ammonia to find amounts of acid and ammonia solution needed. Mix correct amounts of sulfuric acid and ammonia solution together without indicator. Crystallise the ammonium sulfate solution.
Level 3	5–6	Additional guidance Describes all three stages in the preparation of the ammonium sulfate crystals in some detail to include without use of indicator (6 marks) OR two stages in detail to include repeating without indicator (5 marks)	Possible candidate responses • use a pipette to measure out the ammonia solution into a conical flask. Add a few drops of indicator. Add acid from a burette to ammonia solution, swirling flask, until indicator just changes colour. Mix correct volumes of sulfuric acid and ammonia solution together without indicator to produce ammonium sulfate solution. Heat the ammonium sulfate solution until crystals start to form. Leave to cool and filter off crystals. • use a pipette to measure out the ammonia solution into a conical flask. Add a few drops of indicator. Place flask on white tile. Fill a burette with sulfuric acid and read level on burette. Add acid to ammonia solution, swirling flask, until indicator just changes colour. Read level on burette. Use the results of titration, mixing the correct volumes of sulfuric acid and ammonia leaving out indicator.

Q28.

Question number	Indicative content
	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 (6 marks)** • rinse pipette with alkali and burette with acid • measure alkali using a pipette into suitable container e.g. flask/beaker and place flask on a white tile • add a few drops of indicator/suitable named indicator (eg methyl orange/phenolphthalein) • fill burette with acid and read volume of acid in burette • add acid from burette to the flask slowly swirling the flask until {indicator just changes colour/correct colour change for named indicator (eg methyl orange yellow to peach/orange, phenolphthalein pink to colourless)/solution is neutral} • read volume of acid in burette at end of titration • repeat experiment until concordant results • mix the same volume of alkali with the volume of acid determined from the titration but do not add indicator • pour solution into an evaporating basin then {heat solution/leave the water to evaporate} until pure salt crystals are left • dry crystals using absorbent paper

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) • Presents a description which is not logically ordered and with significant gaps. (AO1)
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) • Presents a description of the procedure that has a structure which is mostly clear, coherent and logical with minor steps missing. (AO1)
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) • Presents a description that has a well-developed structure which is clear, coherent and logical. (AO1)

Q29.

Question number	Answer	Additional Guidance	Mark
	An explanation linking two practical steps with reasons • use of white tile (1) • easier to see precisely when indicator changes colour (1) • (near to end point) {add (acid) slowly / in small quantities each time} (1) • easier to stop excess acid being added (when indicator changes colour) (1) • swirl flask when adding acid (1) • ensures complete mixing of both reactants (1) • touch tip of burette on inside wall of flask and/or rinse walls of flask (1) • ensures all acid takes part in reaction (1) • rinse burette (with acid)/ pipette (with ammonia)/flask (with water) beforehand (1) • no impurities to affect result (1) • remove funnel from burette (1) • to stop any extra drop of acid falling into burette (1)	ignore any improvements to measuring volumes of solution. only allow drop by drop if near end point ignore stir allow wash final drop from end of burette.	**(4)** AO1-2

Q30.

Question number	Answer	Additional guidance	Mark
(i)	25 ÷ 1000 × 0.1 = 0.0025 (1) 35 ÷ 1000 × 0.075 = 0.002 625 (1) The acid is in excess (1)	Third mark only awarded as conclusion from calculated data.	**(3)**

Question number	Answer	Mark
(ii)	$\frac{36.20 + 36.30}{2}$ = 36.25 (1)	**(1)**

Question number	Answer	Mark
(iii)	D	**(1)**

Q31.

Question number	Answer	Additional guidance	Mark
(i)	an explanation linking • shift equilibrium to right / in forward direction (1) • increase yield of {product / hydrogen / carbon monoxide} (1)	allow favours forward/endothermic reaction ignore references to decreasing amounts of reactants. marks are independent	(2)

Question number	Answer	Additional guidance	Mark
(ii)	final answer of 2.4 with or without working (3) OR $\frac{0.4}{16} = 0.025$ (1) 0.025 x 4 = 0.1 (1) 0.1 x 24 = 2.4 (1)		(3)

Q32.

Question number	Answer	Mark
(i)	An explanation that combines identification – understanding (1 mark) and reasoning/justification – understanding (2 marks): • rate increased/time to reach equilibrium reduced (1) • because gas molecules closer/more concentrated (1) • so increased collision rate/more frequent collisions(1)	(3)

Question number	Answer	Mark
(ii)	A	(1)

Q33.

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)

Q34.

Question number	Answer	Mark
	An explanation that combines identification – improvement of the experimental procedure (maximum 2 marks) and justification/reasoning, which must be linked to the improvement (maximum 2 marks): • add excess sodium sulfate solution rather than a few drops (1) • so more reaction occurs to form more lead sulfate (1) • filter the reaction mixture rather than pour off the liquid(1) • so none of the lead sulfate is lost on separation(1) • wash the lead sulfate (1) • so the impurities are removed (1) • place the lead sulfate in an oven/warm place (1) • so the lead sulfate is dry (1)	(4)

Q35.

Question Number	Answer	Additional guidance	Mark
(i)	final answer of 65(%) with or without working (2) OR $\frac{7.67}{11.80}$ (= 0.65) (1) $\frac{7.67}{11.80}$ x 100 (=65(%)) (1)	allow any fraction x 100 (1) 153.84.... scores 1	**(2)** AO 2 1

Question Number	Answer	Additional guidance	Mark
(ii)	any two from • incomplete / reversible reactions • competing/unwanted/side reactions • practical losses during the experiment / loss on transfer from one piece of equipment to another	ignore gases formed / impure substances / losses through incompetence / products not used up	**(2)** AO 1 1

Q36.

Question Number	Answer	Additional guidance	Mark
(i)	A description including any two from : • use a pipette filler (1) • wash pipette with sodium hydroxide solution (1) • draw the liquid up so (the bottom of the meniscus) touches the line (1)		**(2)** AO 1 2

Question Number	Answer	Additional guidance	Mark
(ii)	An explanation linking any two from : • to remove water from the burette (1) • because this would dilute the original acid (1) • this will give an inaccurate result / ORA (1)	ignore to avoid contamination ignore to kill bacteria	**(2)** AO 1 2

Q37.

Question Number	Answer	Mark
	B 750 **The only correct answer is B** ***A*** *is not correct because 375.5 dm³ is half the actual volume formed* ***C*** *is not correct because 1125.5 dm³ is one and a half times the actual volume formed* ***D*** *is not correct because 1500 dm³ is double the actual volume formed*	**(1)** AO 2 1

Q38.

Question number	Answer	Additional guidance	Mark
(i)	K, L, J, N, M		**(1)**

Question number	Answer	Additional guidance	Mark
(ii)	(volumetric) pipette	allow burette reject dropping pipette ignore balance	**(1)**