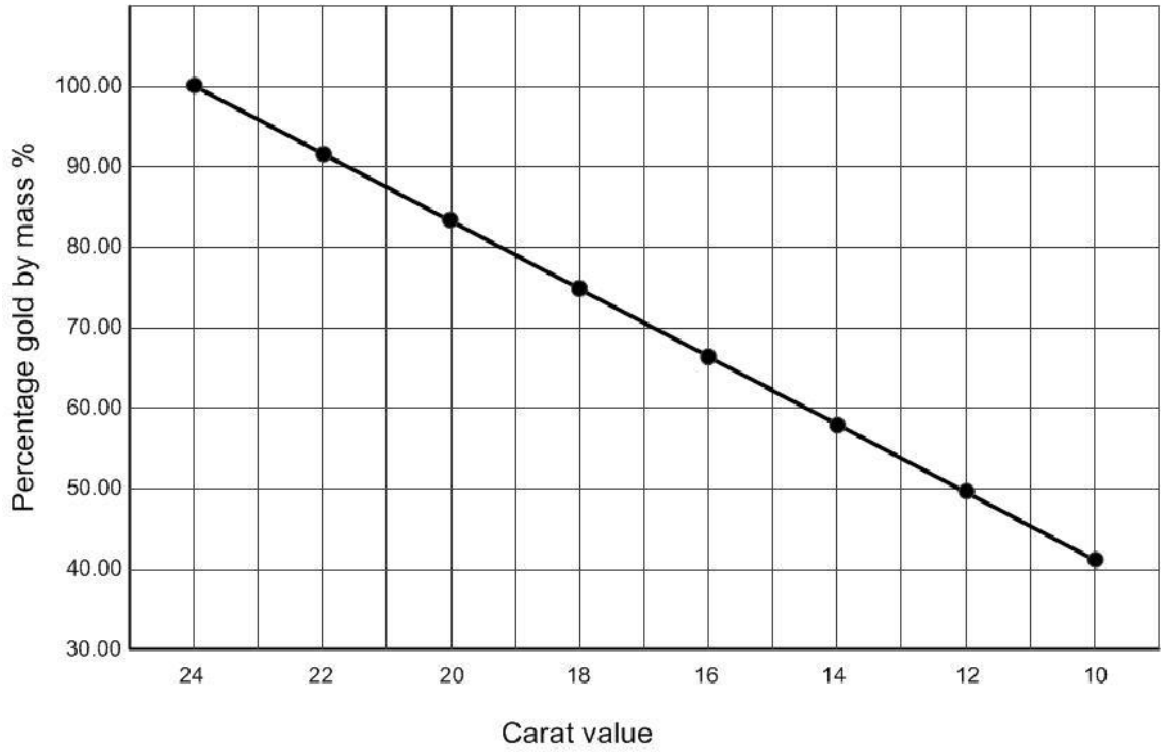
1(a). The purity of gold is measured in carats.

24 carat gold is almost pure gold.

Gold with lower carat values is an alloy which contains other metals such as silver and copper.

The graph shows how the percentage of gold by mass is related to its carat value.



What mass of other metals are in 20 g of 11 carat gold?

Show your working

_____ g **[2]**

(b). A chemist tests a 50 g sample of gold.

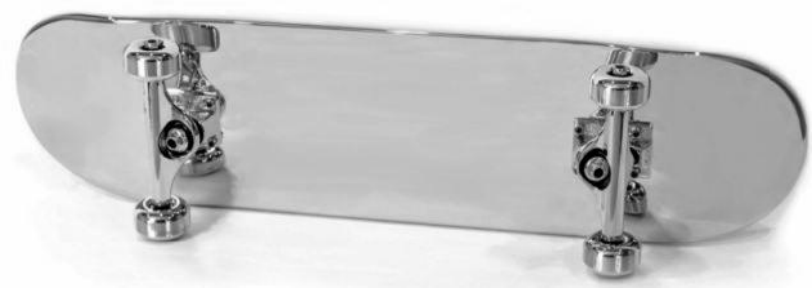
He finds that it contains 0.19 **moles** of gold.

What is the carat value of the sample?

Use the periodic table and the graph above to help you.

Carat value = _____ **[3]**

2. Sam works for a company that makes skateboards.



Customers complain that their skateboards lose performance once they have got wet.

Skateboards have bearings in **each** wheel to help the wheels rotate smoothly and freely.

Skateboard wheel bearing

The bearings in the wheels contain smaller steel ball bearings. These rust if they get wet.

The word equation for rusting is:

iron + water + oxygen ⟶ rust (hydrated iron(III) oxide)

(i) Sam tests the skateboard after it has been in wet conditions.

Each ball bearing has a mass of 5 g. There are seven ball bearings in each bearing. The steel is an alloy of iron and carbon. It contains 0.5% carbon. Half of the iron in each ball bearing rusts away.

Calculate the mass of rust (hydrated iron(III) oxide) produced per bearing.

Give your answer to the nearest gram (g).

mass of rust = _____ g **[5]**

(ii) The mass of the skateboard when new is 3 kg.

By what percentage has the rust caused the mass of the skateboard to increase?

Give your answer to two significant figures.

percentage mass increase _____ % **[3]**

3(a). Hydrogen is used on an industrial scale to make fertilisers.

One reaction pathway for making hydrogen is methane gas reacting with steam in a two stage process.

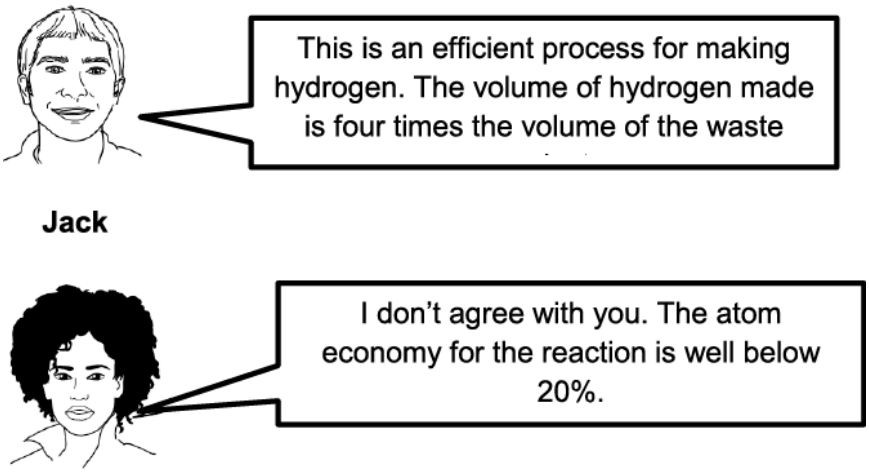
Stage 1: $CH_4 + H_2O \rightleftharpoons CO + 3H_2$

Stage 2: $CO + H_2O \rightleftharpoons CO_2 + H_2$

The overall equation for the reaction is ….

$$CH_4 + 2H_2O \rightleftharpoons 4H_2 + CO_2$$

Jack and Liz discuss the process.



(i) What is the waste product of this process?

---

[1]

(ii) Use a calculation to show that the volume of hydrogen made is four times the volume of the waste product.

(One mole of gas has a volume of 24 dm^3 at room temperature and pressure).

[2]

(iii) Use the overall equation for the reaction to calculate the atom economy.

atom economy _____ [3]

(iv) Explain why the atom economy for the process is low even though the volume of hydrogen made is high.

---

[2]

(b). Liz also says that she thinks that this method of making hydrogen is not sustainable in the long term.

Explain why Liz may think this.

---

[4]

4.

(i) Work out the relative formula mass (RFM) of ammonia, NH_3.

RFM of ammonia = _____ **[1]**

(ii) What is the mass of ammonia that would be made if 1.0 tonne of nitrogen reacted completely with hydrogen?

Show your working.

mass of ammonia = _____ tonne **[2]**

(iii) A factory converts 95 % of the nitrogen into ammonia.

What mass of ammonia does this factory make from each tonne of nitrogen?

mass of ammonia = _____ tonne **[1]**

5. Eve makes some magnesium sulfate by reacting magnesium with sulfuric acid.

She uses 2.4 g of magnesium.

She wants to work out the maximum mass of magnesium sulfate that she can make.

The equation for the reaction and part of Eve's calculation is shown below.

Complete the calculation.

$$Mg + H_2SO_4 \rightarrow MgSO_4 + H_2$$

Relative mass of Mg = 24 g

Mass of Mg used in experiment = 2.4 g

Mass of $MgSO_4$ made = _____ g **[2]**

6(a). Magnesium sulfate is used in some medicines.

Magnesium sulfate can be made by reacting magnesium oxide with sulfuric acid.

$$MgO + H_2SO_4 \rightarrow MgSO_4 + H_2O$$

The table shows the relative formula masses of some of the compounds involved in the reaction.

Compound	Relative formula mass
MgO	40
H_2SO_4	
$MgSO_4$	120
H_2O	18

Calculate the mass of sulfuric acid that reacts exactly with 5 g of magnesium oxide.

_____ g **[2]**

(b). Elly works out a formula for calculating the maximum mass of magnesium sulfate that can be made from different amounts of magnesium oxide.

Elly's formula is:

mass of magnesium sulfate in grams = 3 × mass of magnesium oxide in grams

Use the equation and information from the table to explain why Elly's formula works.

_____

_____

_____ **[2]**

7(a). James does a titration with an acid and an alkali.

He uses dilute sulfuric acid, sodium hydroxide solution and an indicator solution.

Describe and explain how James would carry out a set of titrations to get an accurate value for how much acid reacts with 25.0 cm^3 of the sodium hydroxide.

The quality of written communication will be assessed in your answer.

---

[6]

(b). The sodium hydroxide solution contains 40g/dm^3 of sodium hydroxide. How much sodium hydroxide is in 25.0 cm^3 of the solution?

answer _____ g **[2]**

(c). James gets these results.

titration number	1	2	3	4
volume of acid in cm^3	26.4	25.2	25.6	25.4

James decides that the best value for the volume of acid is 25.4 cm^3.

Show how he arrived at this value.

---

[2]

(d). The equation for this reaction is

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

(i) The relative formula mass of sodium hydroxide is 40.
Calculate the relative formula mass of sulfuric acid.
Relative atomic masses are given in the Periodic Table on the back page.

answer _____ [1]

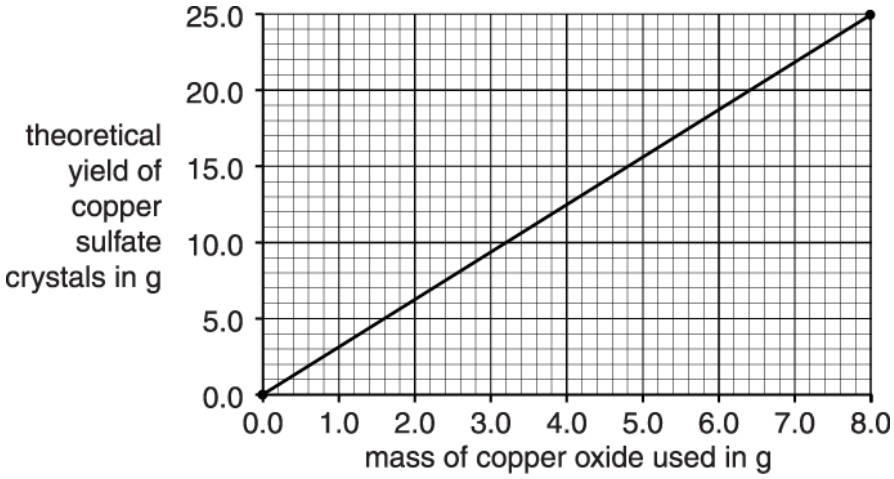
(ii) What mass of sulfuric acid reacts with 40g of sodium hydroxide?
Show your working.

answer _____ g [2]

8. Sam works for a company that makes chemicals to kill fungi on plants.

One of the chemicals the company makes is copper sulfate.

Sam draws a graph to show the theoretical yield of copper sulfate crystals that can be made from copper oxide.



(i) What mass of copper oxide would Sam need to make 10 g of copper sulfate crystals?

_____ [1]

(ii) The company makes the fungicide in large quantities.

Use your answer to **(i)** to work out how much copper oxide would be needed to make 5 kg of copper sulfate crystals.

_____ [2]

(iii) Complete the table to show the relative formula masses of copper oxide and copper sulfate.

Compound	Formula	Relative formula mass
Copper oxide	CuO	
Copper sulfate	$CuSO_4$	

[2]

(iv) Copper sulfate crystals do not only contain copper sulfate.
The crystals also contain water molecules in their structure.
The values on the graph take this into account.

Compare your answers to **(iii)** with the graph to show that the crystals do not **only** contain copper sulfate.

---

[2]

9(a). Fizzy water can be found naturally.

The water is fizzy because it contains dissolved carbon dioxide gas. The carbon dioxide comes from the decomposition of rocks that contain carbonate compounds.

One compound found in rocks is magnesium carbonate.

Ali investigates the decomposition of magnesium carbonate by heating a small amount in a test tube. This is the equation for the reaction.

$MgCO_3(s) \rightarrow MgO(s) + CO_2(g)$

Ali weighs the test tube before and after heating.

The mass of the test tube after heating is less.

Ali says that this means the **law of conservation of mass** is not correct.

Explain why Ali is **wrong**.

--- [2]

(b). In theory, 42.0 g of $MgCO_3$ loses 22.0 g of carbon dioxide when it completely decomposes.

Ali heats 4.2 g of $MgCO_3$.

(i) Calculate the mass of carbon dioxide lost when 4.2 g of $MgCO_3$ completely decomposes.

Mass = ---------- g **[1]**

(ii) In Ali's experiment, the mass of carbon dioxide lost is 1.8 g.

Calculate the percentage yield of carbon dioxide in Ali's experiment.

Percentage yield = ---------- % **[1]**

10.

A nanoparticle has a volume of 8×10^{-27} m.

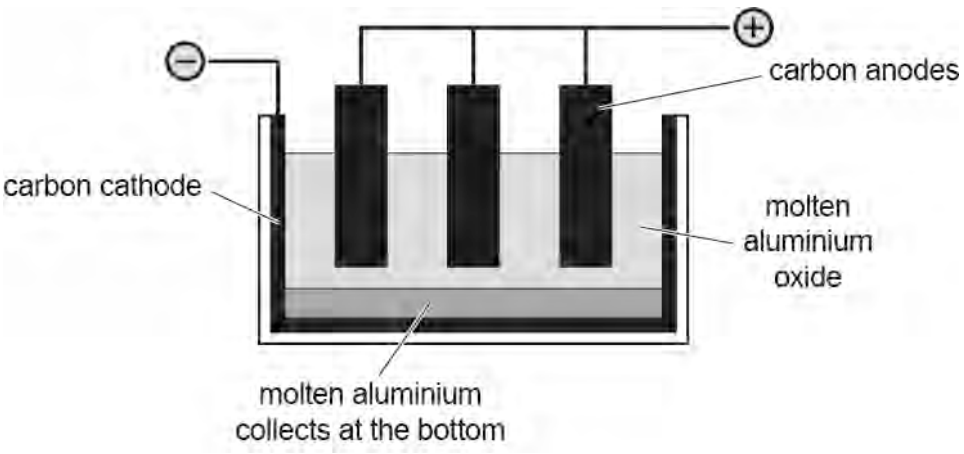
A molecule has a volume of 4×10^{-30} m.

Estimate how many **moles** of this molecule there are in the nanoparticle.

Number of moles = ---------- mol **[3]**

11.

Aluminium is made by the electrolysis of molten aluminium oxide.



This is an equation for the overall reaction in the electrolysis cell.

$2Al_2O_3 \rightarrow 4Al + 3O_2$

1.0 kg of aluminium is made in the cell.

Calculate the volume of oxygen (in dm^3 at room temperature and pressure) that is made.

Assume one mole of gas has a volume of 24 dm^3 at room temperature and pressure.

Volume = ---------- dm^3 **[4]**

12(a) Alex does some experiments to make some salts.

.

In his first experiment, he uses 0.2 moles of magnesium oxide. He works out the mass of magnesium oxide in 0.2 moles.

He uses this equation: number of moles = mass of substance (g) ÷ relative formula mass (g)

Use the equation and the Periodic Table to work out the mass of magnesium oxide in 0.2 moles.

Give your answer to **1** decimal place.

Mass = ---------- g **[3]**

(b). In another experiment, Alex reacts 4.0 g copper oxide with hydrochloric acid to make copper chloride. This is an equation for the reaction.

copper oxide	+	hydrochloric acid	→	copper chloride	+	water
CuO	+	2HC*l*	→	$CuCl_2$	+	H_2O

Alex works out the mass of copper chloride he can make in the experiment.

He uses these relative formula masses.

Name of compound	Formula	Relative formula mass
copper oxide	CuO	79.5
copper chloride	$CuCl_2$	134.5

What mass of copper chloride can be made from 4.0 g of copper oxide?

Use the relative formula masses and the equation to help you.

Give your answer to **2** decimal places.

Mass = ---------- g **[4]**

(c). Alex adds 4.0 g of solid copper oxide to 25.0 cm^3 dilute hydrochloric acid.

At the end of the experiment, Alex sees that there is a problem because he has some unreacted solid left.

(i) How will this problem affect his actual yield?

---

[1]

(ii) How could Alex change his experiment to solve this problem?

---

[1]

13. 0.10 g of calcium carbonate makes 24 cm^3 of carbon dioxide.

Jack uses 0.070 g of calcium carbonate.

What volume of carbon dioxide does he make?

Give your answer to **2** significant figures.

Volume = ---------- cm^3 **[3]**

END OF QUESTION PAPER

Question			Answer/Indicative content	Marks	Guidance
1	a		FIRST CHECK THE ANSWER ON THE ANSWER LINE f answer = 11 (g) award 2 marks percentage gold = 45% / reads 45% from graph other elements = 55 % ✓ $\frac{55}{100} \times 20 = 11(g)$ ✓	2	
	b		FIRST CHECK THE ANSWER ON THE ANSWER LINE f answer = 18 (carat) award 3 marks mass = number of moles x RAM or gives correct numbers = 197 x 0.19 ✓ % of gold = $\frac{37.43}{50} \times 100 = 74.86$ % = 18 carat ✓ = 37.43 ✓	3	
			Total	5	
2		i	FIRST CHECK THE ANSWER ON THE ANSWER LINE If answer = 33 (g) award 5 marks. 7 x 5 = 35 = mass of steel in ball bearings 35x 0.995 = 34.825g of Fe 34.825 ÷ 2 = 17.4125 amount of iron turned to rust ✓ RAM Fe = 55.8 RMM rust = 213.6 ✓ therefore number of moles of Fe = 17.4125 ÷ 55.8 ✓ ratio of Fe: Rust is 2:1 ✓ therefore number of grams of rust = $\frac{17.4125 \times 213.6}{55.8 \times 2}$ ✓ = 33.327 = 33 (g)✓	5	

Question			Answer/Indicative content	Marks	Guidance
		ii	FIRST CHECK THE ANSWER ON THE ANSWER LINE If answer = 2.1 (%) award 3 marks mass of rust = 4 x 33 = 132 g mass of iron converted to rust = 4 x 17.4125 = 69.65 increase in mass = 132 – 69.65 = 62.35g ✓ % increase = $\frac{62.35}{3000}$ x 100 = 2.078333… ✓ = 2.1(%) to 2 sig figs ✓	3	ALLOW ECF from (i)
			Total	8	

Question			Answer/Indicative content	Marks	Guidance
3	a	i	carbon dioxide ✓	1	
		ii	H_2: 4 × 24 = 96 dm^3 ✓ CO_2: 1 × 24 = 24 dm^3 ✓	2	ALLOW clear indication of 4 moles:1 mole ratio in calculation for (1) mark
		iii	FIRST CHECK THE ANSWER ON THE ANSWER LINE If answer = 15.38 award 3 marks 8 / 52 × 100 = 15.4 / 15.38 % uses 8 in calculation ✓ uses 52 in calculation ✓ substitutes and computes correctly ✓	3	ALLOW any number of (correct) sig figs correct answer scores (3)
		iv	hydrogen has a low (relative atomic)mass ✓ all gases have the same (molar) volume / mass of carbon dioxide is much greater than hydrogen ✓	2	
	b		methane is a fossil fuel / in finite supply ✓ waste product is carbon dioxide ✓ carbon dioxide causes climate change ✓ idea that process cannot continue without causing harm to the environment / cannot continue because raw materials will not be available ✓	4	
			Total	12	

Question			Answer/Indicative content	Marks	Guidance
4		i	17	1	**Examiner's Comments** All but the weakest candidates could correctly calculate the relative formula mass of ammonia to gain the mark in (i). (1 x 14) + (3 x 1) = 17 Some weaker candidate multiplied atomic masses rather than adding them.
		ii	1.0 x (2x17)/28 (1) = 1.2 (1)	2	**allow** 1.21 **ignore** additional figures beyond 3 sig fig if they would round down to 1.21 **allow** ecf from **(i)** **allow** both marks for correct answer without working **Examiner's Comments** In (ii) only the strongest candidates could complete the calculation correctly. 1.0 x (2x17)/28 = 1.2 tonne Many candidates with incorrect answers included working with a jumble of figures that contained little or no logic.
		iii	(1.2 × 95/100 =) 1.14	1	**allow** 1.1 **allow** ecf from **(ii)** (ie candidate's answer in **(ii)** x 0.95) **Examiner's Comments** Stronger candidates gained the mark in (iii) even if they did not have the correct answer for (ii), since they correctly calculated 95% of the answer that they gave in (ii). Most candidates could not successfully calculate 95% of their answer in (ii).
			Total	4	

Question			Answer/Indicative content	Marks	Guidance
5			Correct answer = 12 g (2) *If answer is not fully correct allow (1) mark for* relative formula mass(RFM)=120 OR incorrect RFM ÷ 10	2	Check equation for RFM written with $MgSO_4$ **Examiner's Comments** Candidates found this mathematical question difficult. A few gained a single mark for a correct calculation of the relative formula mass of magnesium sulfate, but over half of candidates scored no marks here.
			Total	2	

Question			Answer/Indicative content	Marks	Guidance
6	a		RFM = 98 (1) (98 / 40) × 5 = 12.25 g (1)	2	Check table for RFM allow ecf for wrong formula mass incorrect RFM ÷ 8 scores (1) accept correctly rounded answers to fewer sig figs i.e. 12 g / 12.3 g Examiner's Comments Over half of the candidates scored at least some credit in this calculation, usually for correct calculation of the Relative Formula Mass of sulfuric acid.
	b		Look for a comparison: 40 g and 120 g / RFM 40 and 120 (1) RFM in 1: 3 ratio idea / 40 × 3 idea (1)	2	ignore '3 x' alone' or '3 x mass of magnesium oxide' alone (in the question) 40 × 3 = 120 scores 2 marks Examiner's Comments In this question, poor expression sometimes cost marks. Answers such as 'because it is three times the mass of magnesium oxide' did not score, as this merely restates the information in the box. Better answers referred explicitly to the ratio of the Relative Formula Mass of the compounds being in the ratio of 1:3.
			Total	4	

Question			Answer/Indicative content	Marks	Guidance
7	a		[Level 3] Gives most of the essential stages in the method AND makes a statement about accuracy AND makes a statement about repeating. Quality of written communication does not impede communication of the science at this level. (5 – 6 marks) [Level 2] Gives most of the essential stages in the method AND makes a statement about accuracy OR makes a statement about repeating. Quality of written communication partly impedes communication of the science at this level. (3 – 4 marks) [Level 1] Makes points about the titration. Quality of written communication impedes communication of the science at this level. (1 – 2 marks) [Level 0] Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)	6	This question is targeted at grades up to B Indicative scientific points may include: Method - Essential stages [cued in stem] • alkali [solution] in flask / beaker • indicator into alkali • add acid / acid in burette • [sudden] indicator / colour change Method - Other points • read the burette • swirl • stop adding acid [at endpoint] Accuracy • [measure alkali using] pipette • Run acid through tap [to flush out air] • drop by drop / slowly • meniscus • look for similar results / concordant Repeating • repeat; • rough; A level 1 method may include any statements from the method lists. Incorrect statements limit the mark to the lower mark of the level at levels 2 & 3 e.g. “indicator goes clear” [rather than colourless] If they make up the alkali solution from solid, ignore the **whole** of that section, until the titration begins. Consider this to impede QWC at level 3. N.B. The alkali must then be transferred to a flask / beaker to gain credit for the first point in the essential stages. Use the L1, L2, L3 annotations in Scoris; do not use ticks. Examiner's Comments Most candidates were clearly familiar with the procedure for carrying out a titration,

Question			Answer/Indicative content	Marks	Guidance
					but there was also a significant minority who appeared to have little or no practical experience. There was a surprising number of descriptions of a burette as a “titration stick” or “titration tube”
	b		1g [2] Either 40x25.0 or divides by 1000 [1]	2	**Examiner's Comments** Able candidates had no difficulty calculating the mass of sodium hydroxide in the solution, though others found it more taxing. Few candidates showed their working, so were not even able to gain that mark. This part was not attempted by a minority of candidates.
	c		Any two from He calculated a mean; ignored 26.4; it is an outlier / rough result;	2	**Ignore** It is the middle of the other two values **Ignore** take the median 25.2 + 25.6 + 25.4 [=76.2] divided by 3 (2) **Examiner's Comments** Most candidates realised that the first result was an outlier and that the best value was the mean of the other three results. Some candidates showed confusion between mean and median. Also common was “after discarding the first reading, 25.4 is in the middle of the other three”.
	d	i	98	1	Enter text here.
		ii	49g [2] 98/2 [1]	2	ECF on di ie half the answer to di [2] Recognises that the reacting ratio is 1:2 eg 196g or di) x 2 [1] **Examiner's Comments** While calculating the relative formula mass was within the reach of most candidates, using the equation to decide what mass of acid reacts with 40g of sodium hydroxide was a lot more difficult and was not attempted by a significant minority.

Question			Answer/Indicative content	Marks	Guidance
			Total	13	
8		i	3.2(g); (1)	1	Accept 3.2 alone Examiner's Comments Most were able to correctly read the graph to work out the mass of copper oxide needed.
		ii	1600 g / 1.6 kg; (2) Uses 1000 in calculation / 1000 g = 1 kg/1.6 or 1600 with no units or incorrect units (1)	2	Answer with units (2) Allow ecf for incorrect answer to b (i) Examiner's Comments Some candidates gave a fully correct calculation, with units, to gain both marks. Candidates need to take care in calculation questions that they give units if they are not provided. Some did not convert kg into g correctly. Conversion factors of 10 or 100 were often seen.
		iii	79.5 g; 159.5 g	2	Examiner's Comments Most correctly calculated the relative formula mass for copper oxide. The relative formula mass of copper sulfate was more challenging.
		iv	*refers to table*:(relative formula) mass of $CuSO_4$ approximately twice (relative formula) mass of CuO / mass of CuO is half mass of $CuSO_4$ / gives 2:1 ratio idea / gives example masses e.g. 8.0g CuO should make 16.0g $CuSO_4$; *refers to graph:* yield of copper sulfate on graph is too high / line on graph too high / more than double / reads values from graph e.g. 25 g yield compared to 15.95g yield or 8.0 g gives 25 g / calculates ratio or gradient from graph to give approximately 3:1 ratio;	2	Allow ecf for incorrect formula masses in iii Examiner's Comments ??Some very good answers were seen in which some candidates calculated and compared ratios of mass in the table with those on the graph. A relatively high proportion of candidates omitted this question, implying that they found theoretical mass a challenging area.
			Total	7	

Question			Answer/Indicative content	Marks	Guidance
9	a		No overall loss (in mass) idea / No elements/mass/atoms/chemicals/particles/compounds lost / law states that matter is neither (created nor) destroyed in a chemical reaction / AW ✓ Carbon dioxide is a gas / Carbon dioxide leaves the test tube / a gas is given off / idea that all products are not in the test tube / AW ✓	(AO 3.1b × 2)	ALLOW It is an open system Examiner's Comments Almost all candidates knew that the mass change was due to the escape of carbon dioxide gas. The law of conservation of mass was not always fully explained. Better answers explained the idea that overall there is *no overall* total change in mass, leading to two marks.
	b	i	2.2 (g) ✓	1 (AO 2.2)	ALLOW 2 or more sf
		ii	82(%) ✓	1 (AO 2.2)	ALLOW 2 or more sf Examiner's Comments A very high proportion of candidates answered (i) correctly. In addition, very few candidates omitted a response, showing that all candidates are confident to use reacting ratios to calculate masses from an equation. Although fewer went on to correctly calculate percentage yield for (ii), most showed some understanding of the necessary method. Again, very few omitted this part question.
			Total	4	

Question			Answer/Indicative content	Marks	Guidance
10			FIRST CHECK ANSWER ON ANSWER LINE If answer = 3×10^{-21} (mol) award 3 marks	3	ALLOW full credit (3) marks for any answer which starts by cubing volumes
			Molecules in one nanoparticle = 8×10^{-27} / 4×10^{-30} / = 2000 ✓	(AO 2.2)	ALLOW correct working shown OR 2000 for (1)
			Recall Avogadro constant = $6(.0) \times 10^{23}$✓	(AO 1.2)	
			Moles = 2×10^{3} / 6×10^{23} = 3.3×10^{-21} (mol)✓	(AO 2.2)	ALLOW ECF Examiner's Comments Standard form is one of the mathematical requirements which may be less familiar to GCSE candidates. However, many correctly calculated that there are 2000 molecules in the nanoparticle. Fewer quoted the correct number of particles in a mole and only the higher ability candidates reached the final answer. This meant that this question discriminated well. We have adjusted the mark scheme to allow for a typo within this question. AfL In the new specification, candidates need to understand standard form and to recall Avogadro's number.
			Total	3	

Question			Answer/Indicative content	Marks	Guidance
11			FIRST CHECK ANSWER ON ANSWER LINE If answer = 667etc (dm^3) award 4 marks 4 × 27(g) (=108) ✓ =1000 ÷ 108 ECF (= 9.259) ✓ 3 × 24 (dm^3) (=72) ✓ = (× 72 ECF =) 667 (dm^3) ✓ OR No moles Al = 1000/27 (=37.04) ✓ Uses ratio 4:3 in calculation ✓ No moles O_2 = ANS × ¾ (=27.77……) ✓ (× 24=) 667 (dm^3) ✓	4 (AO 4 × 2.2)	9.259 = (2) for MP1 and MP2 0.667 = (3) for MP1 MP3 and MP4 222 = (3) for MP1 MP2 and MP4 0.222 = (2) for MP1 and MP4 ALLOW 666 (Rounding already assessed in earlier Q) ALLOW any number of sig figs 27.7 = (3) for MP1, MP2 and MP3 <u>Examiner's Comments</u> Some candidates gained three or four marks through this difficult, multi-stage calculation. Most candidates correctly calculated the formula mass of aluminium oxide. Some used this to calculate the number of moles of oxygen produced. Some recognised the reacting ratio of aluminium oxide to oxygen and used the molar gas volume to calculate the final volume. Although this was a very challenging question there was a very low omit rate. Almost all candidates were able to at least partially work towards the complete calculation.
			Total	4	

Question			Answer/Indicative content	Marks	Guidance
12	a		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 8.1 (g) award 3 marks	3	
			calculates mass of magnesium oxide = 40.3 g ✓	(AO 2.2)	
			40.3 (or ECF) × 0.2 = 8.06 (g) ✓	(AO 2.2)	
			= 8.1 (g) (answer correctly rounded to 1 decimal place) ✓	(AO 1.2)	If other mass is used in place 40.3 allow ECF if working is otherwise correct. DO NOT ALLOW ECF from an incorrect method. Examiner's Comments This question was well answered, with many candidates gaining all three marks. Candidates confidently rearranged the equation and solved for mass. Some made small errors in the calculation of relative atomic mass, but Error Carried Forward was allowed. Some forgot to round to one decimal place on the final answer line.

Question			Answer/Indicative content	Marks	Guidance
	b		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 6.77 / 6.73 (g) award 4 marks	4	
			Works out number of moles of copper oxide = 0.05 / shows 4.0 / 79.5 in working ✓	(AO 2.2)	If other mass is used in place of 79.5 or 134.5 allow ECF if working is otherwise correct. DO NOT ALLOW ECF from an incorrect method.
			Ml × 134.5 ✓	(AO 2.2)	
			= 6.767295597484277 (g) ✓	(AO 2.2)	M3 ALLOW 6.725 g (calculated by using 0.05)
			= 6.77 (g) (2 decimal places) ✓	(AO 1.2)	M4 ALLOW 6.73 g rounded from 6.725 Examiner's Comments Again, this question was well answered by many candidates, who used the equation and the masses to correctly calculate the mass and rounded it correctly to two decimal places. Despite the instruction to 'use the relative formula masses' given, some candidates attempted to calculate their own masses and made simple errors in doing so. This highlights the importance of studying the information given and the instructions in the question before starting to answer calculation type questions.  **AfL** In calculations, candidates need to watch out for instructions such as 'Give your answer to 1/2 decimal place(s)'. Some candidates who correctly completed their calculation forgot to round to the necessary number of decimal places on the answer line for both parts (a) and (b).

Question			Answer/Indicative content	Marks	Guidance
	c	i	actual yield low(er) ✓	1 (AO 2.2)	IGNORE less than 100%/less than theoretical yield Examiner's Comments Most candidates knew that Alex's yield would be lower. Some did not express this very well, however, by saying 'the actual yield will be lower than the theoretical yield'. As this statement is always true, whether or not there is unreacted solid, this answer did not gain any credit.
		ii	use more acid / higher volume of acid / more concentrated acid ✓	1 (AO 3.3b)	ALLOW use less copper oxide IGNORE 'dilute' Examiner's Comments Most made sensible suggestions, such as changing the concentration or volume of the acid. The most common answer which did not gain credit was to state that Alex should 'leave the experiment for longer'.
			Total	9	

Question			Answer/Indicative content	Marks	Guidance
13			FIRST CHECK ANSWER ON ANSWER LINE If answer = 17 (cm^3) award 3 marks 0.07 / 0.10 or 0.10/0.07 ✓ (uses 24)= 16.8 ✓ = 17 (cm^3) ✓	3 (AO 2.2 × 2) (AO 1.2)	IGNORE 17.0 ALLOW MP3 for (incorrect) answer with working rounded to 2sf <u>Examiner's Comments</u> Most candidates worked out the volume, usually by using a ratio method. Some forgot or missed the instruction to 'give your answer to 2 significant figures'. AfL The new specifications test the ability for candidates to round mathematical answers to a given number of significant figures or decimal places. Candidates need to 'watch out' for these instructions in calculations and make sure that they are followed.
			Total	3	