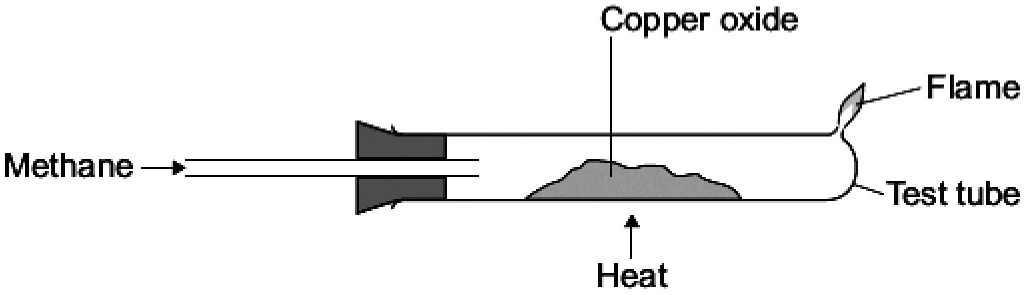
1 An experiment was done on the reaction of copper oxide (CuO) with methane (CH_4).



(a) The equation for this reaction is shown below.

$$4CuO(s) + CH_4(g) \rightarrow 4Cu(s) + 2H_2O(g) + CO_2(g)$$

The water and carbon dioxide produced escapes from the test tube.

Use information from the equation to explain why.

....

(1)

(b) (i) Calculate the relative formula mass (M_r) of copper oxide (CuO).

Relative atomic masses (A_r): O = 16; Cu = 64.

....

....

....

Relative formula mass (M_r) = ...

(2)

(ii) Calculate the percentage of copper in copper oxide.

....

....

....

Percentage of copper = ... %

(2)

(iii) Calculate the mass of copper that could be made from 4.0 g of copper oxide.

....

....

Mass of copper = ... g

(1)

(c) The experiment was done three times.
The mass of copper oxide used and the mass of copper made was measured each time.
The results are shown in the table.

	Experiment		
	1	**2**	**3**
Mass of copper oxide used in g	4.0	4.0	4.0
Mass of copper made in g	3.3	3.5	3.2

(i) Calculate the mean mass of copper made in these experiments.

....

....

Mean mass of copper made = ... g

(1)

(ii) Suggest how the results of these experiments could be made more precise.

....

....

(1)

(iii) The three experiments gave slightly different results for the mass of copper made.
This was caused by experimental error.

Suggest **two** causes of experimental error in these experiments.

1 ....

....

2 ....

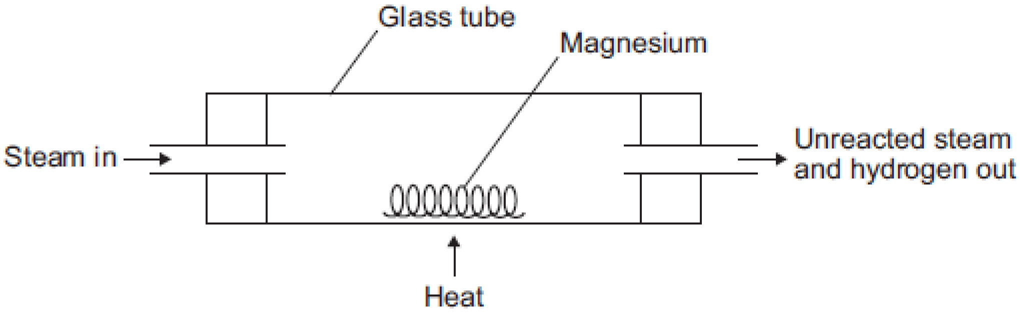
....

(2)

(Total 10 marks)

2 Magnesium reacts with steam to produce hydrogen gas and magnesium oxide.

A teacher demonstrated the reaction to a class. The figure below shows the apparatus the teacher used.



(a) (i) The hydrogen produced was collected.

Describe how to test the gas to show that it is hydrogen.

Test ....

....

Result ....

....

(2)

(ii) Explain why the magnesium has to be heated to start the reaction.

....

....

....

....

(2)

(b) The equation for the reaction is:

$$Mg(s) + H_2O(g) \longrightarrow MgO(s) + H_2(g)$$

(i) The teacher used 1.00 g of magnesium.

Use the equation to calculate the maximum mass of magnesium oxide produced.

Give your answer to three significant figures.

Relative atomic masses (A_r): O = 16; Mg = 24

....

....

....

....

Maximum mass = ... g

(3)

(ii) The teacher's demonstration produced 1.50 g of magnesium oxide.

Use your answer from part (b)(i) to calculate the percentage yield.

If you could not answer part (b)(i), use 1.82 g as the maximum mass of magnesium oxide. This is **not** the answer to part (b)(i).

....

Percentage yield = ... %

(2)

(iii) Give **one** reason why the percentage yield is less than 100%.

....

....

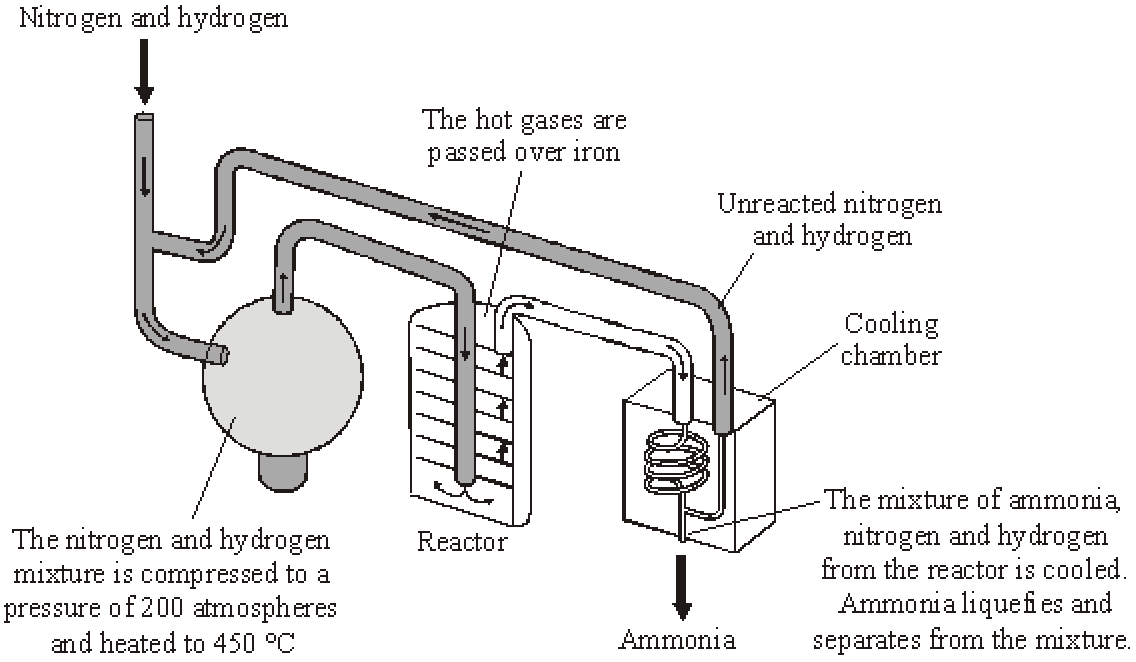
....

(1)

(Total 10 marks)

3 The Haber process is named after the German chemist, Fritz Haber.

The diagram shows the main stages in the Haber process.



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An exothermic reaction takes place when nitrogen reacts with hydrogen to make ammonia.

The reaction can be represented by this equation.

$$N_2\ (g) \quad + \quad 3H_2\ (g) \quad \rightleftharpoons \quad 2NH_3\ (g)$$

(a) Calculate the maximum mass of ammonia that could be made from 1000 g of nitrogen.

Relative atomic masses: H = 1; N = 14

....

....

....

....

Mass ....g

(3)

(b) At a temperature of 450 °C and 200 atmospheres the actual mass of ammonia produced when 1000 g of nitrogen is passed through the reactor is 304 g.

Calculate the percentage yield of ammonia produced in the reactor.

(If you did not answer part (a), then assume that the maximum mass of ammonia that can be made from 1000 g of nitrogen is 1100 g. This is **not** the correct answer to part (a).)

....

....

....

....

....

Percentage yield of ammonia = ... %

(2)

(c) State **and** explain:

(i) how a **decrease** in temperature would affect the yield of ammonia

....

....

....

....

(2)

(ii) how an **increase** in pressure would affect the yield of ammonia.

....

....

....

....

(2)

(d) Factories that make ammonia are often near to large towns.

Discuss the economic, safety and environmental factors to be considered when there is an ammonia factory near a town.

....

....

....

....

....

....

....

(3)

(Total 12 marks)

4 (a) The formula for ammonia is NH_3. What does the formula tell you about each molecule of ammonia?

....

....

....

....

(3)

(b) Ammonia is used to make nitric acid (HNO_3). Calculate the formula mass (Mr) for nitric acid. (Show your working).

....

....

....

....

....

(3)

(Total 6 marks)

5 The formula for the chemical compound magnesium sulphate is $MgSO_4$.

Calculate the relative formula mass (M_r) of this compound. (Show your working.)

....

....

....

....

(Total 2 marks)

6 Use these relative atomic masses: H = 1; O = 16; Ca = 40
to calculate the relative formula mass (M_r) of

quicklime CaO ....

slaked lime $Ca(OH)_2$ ....

(Total 2 marks)

7 Iron is the most commonly used metal. Iron is extracted in a blast furnace from iron oxide using carbon monoxide.

$$Fe_2O_3 \quad + \quad 3CO \quad \rightarrow \quad Fe \quad + \quad 3CO_2$$

(a) A sample of the ore haematite contains 70% iron oxide.

Calculate the amount of iron oxide in 2000 tonnes of haematite.

....

....

Amount of iron oxide = ... tonnes

(1)

(b) Calculate the amount of iron that can be extracted from 2000 tonnes of haematite.
(Relative atomic masses: O = 16; Fe = 56)

....

....

....

....

....

....

Amount of iron = ... tonnes

(4)

(Total 5 marks)

8 Calculate the percentage of iron in iron sulphate ($FeSO_4$).

(Relative atomic masses: Fe = 56, O = 16, S = 32)

....

....

....

....

Percentage of iron in iron sulphate = ...%

(Total 3 marks)

9 Calcium oxide (quicklime) is made by heating calcium carbonate (limestone).

calcium carbonate	→	calcium oxide	+	carbon dioxide
100 g		?		44 g

(a) 44 grams of carbon dioxide is produced when 100 grams of calcium carbonate is heated.

Calculate the mass of calcium oxide produced when 100 grams of calcium carbonate is heated.

....

mass .... g

(1)

(b) What mass of carbon dioxide could be made from 100 tonnes of calcium carbonate?

mass .... tonnes

(1)

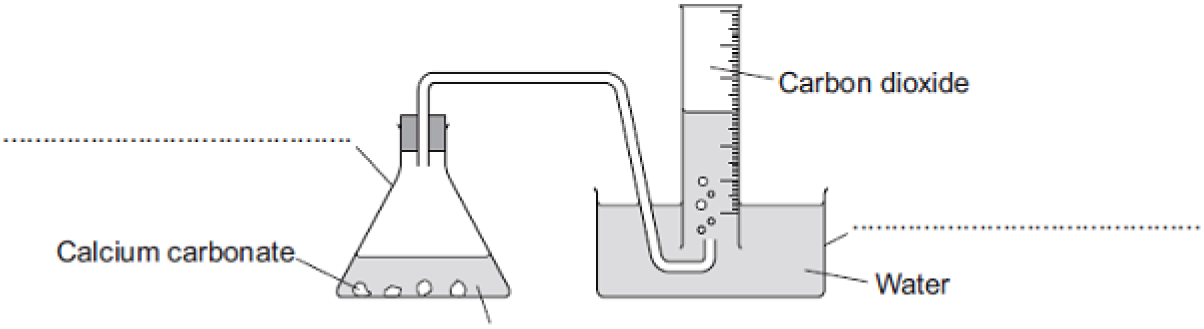
(Total 2 marks)

10 Some students were investigating the rate at which carbon dioxide gas is produced when metal carbonates react with an acid.

One student reacted 1.00 g of calcium carbonate with 50 cm^3, an excess, of dilute hydrochloric acid.

The apparatus used is shown in **Diagram 1**.

Diagram 1



Dilute hydrochloric acid

(a) Complete the **two** labels for the apparatus on the diagram.

(2)

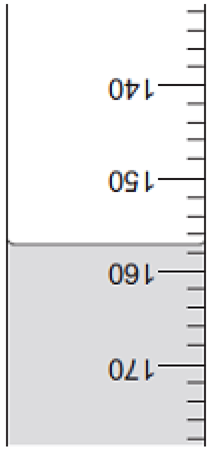
(b) The student measured the volume of gas collected every 30 seconds.

The table shows the student's results.

Time in seconds	**Volume of carbon dioxide collected in cm^3**
30	104
60	
90	198
120	221
150	232
180	238
210	240
240	240

(i) **Diagram 2** shows what the student saw at 60 seconds.

Diagram 2



What is the volume of gas collected?

Volume of gas = ... cm^3

(1)

(ii) Why did the volume of gas stop changing after 210 seconds?

....

....

(1)

(c) Another student placed a conical flask containing 1.00 g of a Group 1 carbonate (M_2CO_3) on a balance.

He then added 50 cm^3, an excess, of dilute hydrochloric acid to the flask and measured the mass of carbon dioxide given off.

The equation for the reaction is:

$$M_2CO_3 + 2HCl \longrightarrow 2MCl + H_2O + CO_2$$

The final mass of carbon dioxide given off was 0.32 g.

(i) Calculate the amount, in moles, of carbon dioxide in 0.32 g carbon dioxide.

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

....

....

....

Moles of carbon dioxide = ... moles

(2)

(ii) How many moles of the metal carbonate are needed to make this number of moles of carbon dioxide?

....

....

Moles of metal carbonate = ... moles

(1)

(iii) The mass of metal carbonate used was 1.00 g.

Use this information, and your answer to part **(c) (ii)**, to calculate the relative formula mass (M_r) of the metal carbonate.

If you could not answer part **(c) (ii)**, use 0.00943 as the number of moles of metal carbonate. This is **not** the answer to part **(c) (ii)**.

....

....

Relative formula mass (M_r) of metal carbonate = ...

(1)

(iv) Use your answer to part **(c) (iii)** to calculate the relative atomic mass (A_r) of the metal in the metal carbonate (M_2CO_3) and so identify the Group 1 metal in the metal carbonate.

If you could not answer part **(c) (iii)**, use 230 as the relative formula mass of the metal carbonate. This is **not** the answer to part **(c) (iii)**.

To gain full marks, you must show your working.

....

....

....

....

Relative atomic mass of metal is ....

Identity of metal ....

(3)

(d) Two other students repeated the experiment in part **(c)**.

(i) When the first student did the experiment some acid sprayed out of the flask as the metal carbonate reacted.

Explain the effect this mistake would have on the calculated relative atomic mass of the metal.

....

....

....

....

....

....

....

(3)

(ii) The second student used 100 cm^3 of dilute hydrochloric acid instead of 50 cm^3.

Explain the effect, if any, this mistake would have on the calculated relative atomic mass of the metal.

....

....

....

....

....

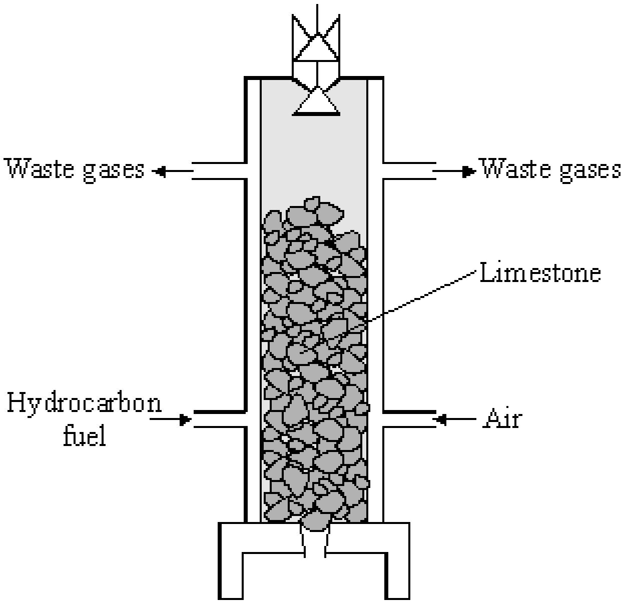
....

....

(3)

(Total 17 marks)

11 Limestone is a useful mineral. Every day, large amounts of limestone are heated in limekilns to produce lime. Lime is used in the manufacture of iron, cement and glass and for neutralising acidic soils.



$$CaCO_3 \rightleftharpoons CaO + CO_2$$

(i) The decomposition of limestone is a *reversible* reaction. Explain what this means.

....

....

....

....

(2)

(ii) Calculate the mass of lime, CaO, that would be produced from 250 tonnes of limestone, $CaCO_3$.

Relative atomic masses: C 12; O 16; Ca 40.

....

....

....

....

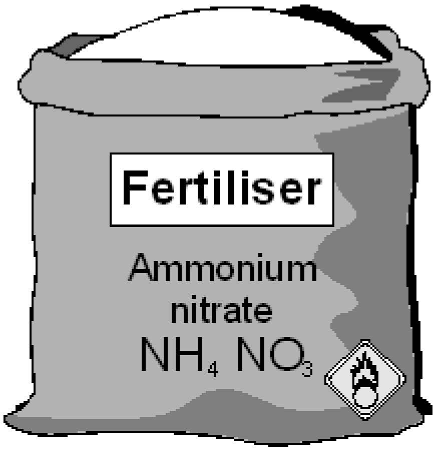
....

Mass of lime = ... tonnes

(3)

(Total 5 marks)

12 As the world population increases there is a greater demand for fertilisers.



(a) Explain what fertilisers are used for.

....

....

....

....

(2)

(b) The amount of nitrogen in a fertiliser is important.

(i) How many nitrogen atoms are there in the formula, NH_4NO_3?

....

(1)

(ii) Work out the relative formula mass of ammonium nitrate, NH_4NO_3.

Relative atomic masses: H 1; N 14; O 16.

....

....

Relative formula mass of ammonium nitrate = ...

(1)

(Total 4 marks)

13 Aspirin tablets have important medical uses.

A student carried out an experiment to make aspirin. The method is given below.

1. Weigh 2.00 g of salicylic acid.
2. Add 4 cm^3 of ethanoic anhydride (an excess).
3. Add 5 drops of concentrated sulfuric acid.
4. Warm the mixture for 15 minutes.
5. Add ice cold water to remove the excess ethanoic anhydride.
6. Cool the mixture until a precipitate of aspirin is formed.
7. Collect the precipitate and wash it with cold water.
8. The precipitate of aspirin is dried and weighed.

(a) The equation for this reaction is shown below.

$$\underset{\text{salicylic acid}}{C_7H_6O_3} + C_4H_6O_3 \rightarrow \underset{\text{aspirin}}{C_9H_8O_4} + CH_3COOH$$

Calculate the maximum mass of aspirin that could be made from 2.00 g of salicylic acid.

The relative formula mass (M_r) of salicylic acid, $C_7H_6O_3$, is 138

The relative formula mass (M_r) of aspirin, $C_9H_8O_4$, is 180

....

....

....

....

Maximum mass of aspirin = ... g

(2)

(b) The student made 1.10 g of aspirin from 2.00 g of salicylic acid.

Calculate the percentage yield of aspirin for this experiment.

(If you did not answer part (a), assume that the maximum mass of aspirin that can be made from 2.00 g of salicylic acid is 2.50 g. This is **not** the correct answer to part (a).)

....

....

....

....

Percentage yield of aspirin = ... %

(2)

(c) Suggest **one** possible reason why this method does **not** give the maximum amount of aspirin.

....

....

(1)

(d) Concentrated sulfuric acid is a catalyst in this reaction.

Suggest how the use of a catalyst might reduce costs in the industrial production of aspirin.

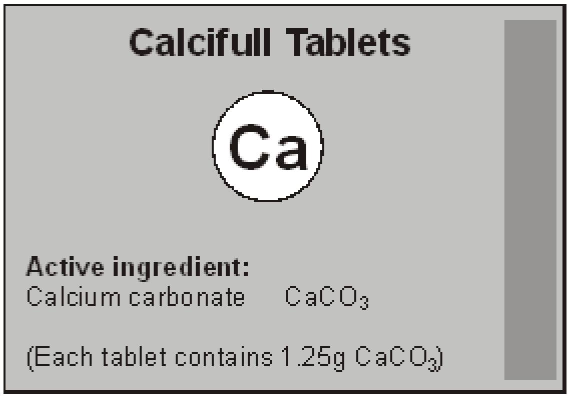
....

....

(1)

(Total 6 marks)

14 Calcium carbonate tablets are used to treat people with calcium deficiency.



Calcifull Tablets

Ca

Active ingredient:

Calcium carbonate $CaCO_3$

(Each tablet contains 1.25g $CaCO_3$)

(a) Calculate the relative formula mass (M_r) of calcium carbonate.

Relative atomic masses: C = 12; O = 16; Ca = 40.

....

....

Relative formula mass = ...

(2)

(b) Calculate the percentage of calcium in calcium carbonate, $CaCO_3$.

....

....

Percentage of calcium = ... %

(2)

(c) Calculate the mass of calcium in each tablet.

....

....

Mass of calcium = ... g

(2)

(d) An unwanted side effect of this medicine is that it can cause the patient to have 'wind' (too much gas in the intestine).

The equation below represents the reaction between calcium carbonate and hydrochloric acid (the acid present in the stomach).

$$CaCO_3 (s) + 2HCl (aq) \rightarrow CaCl_2 (aq) + H_2O (l) + CO_2 (g)$$

Suggest why the patient may suffer from 'wind'.

....

....

(1)

(Total 7 marks)

15

(a) A chemist was asked to identify a nitrogen compound. The chemist carried out an experiment to find the relative formula mass (***M_r***) of the compound.

The ***M_r*** of the compound was **44**.

Relative atomic masses: N = 14, O = 16

Draw a ring around the formula of the compound.

NO **NO_2** **N_2O_4** **N_2O**

(1)

(b) Potassium nitrate is another nitrogen compound. It is used in fertilisers. It has the formula **KNO_3**.

The **M_r** of potassium nitrate is **101**.

Calculate the percentage of **nitrogen** by mass in potassium nitrate.

Relative atomic mass: N = 14.

....

....

Percentage of nitrogen = ... %

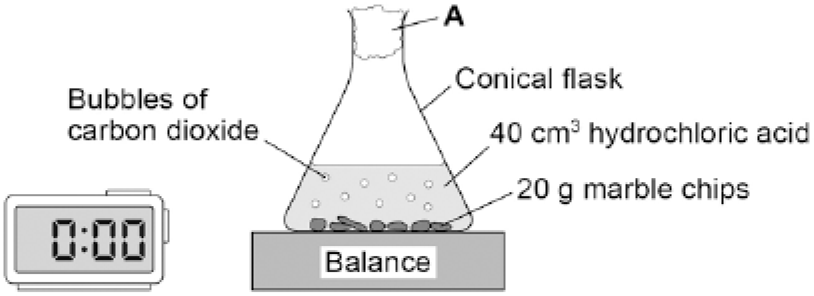
(2)

(Total 3 marks)

16 A student investigated the rate of reaction between marble chips and hydrochloric acid.

Figure 1 shows the apparatus the student used.

Figure 1



(a) What is **A**?

Tick **one** box.

cotton wool ☐

limestone ☐

poly(ethene) ☐

rubber bung ☐

(1)

(b) **Table 1** shows the student's results for one investigation.

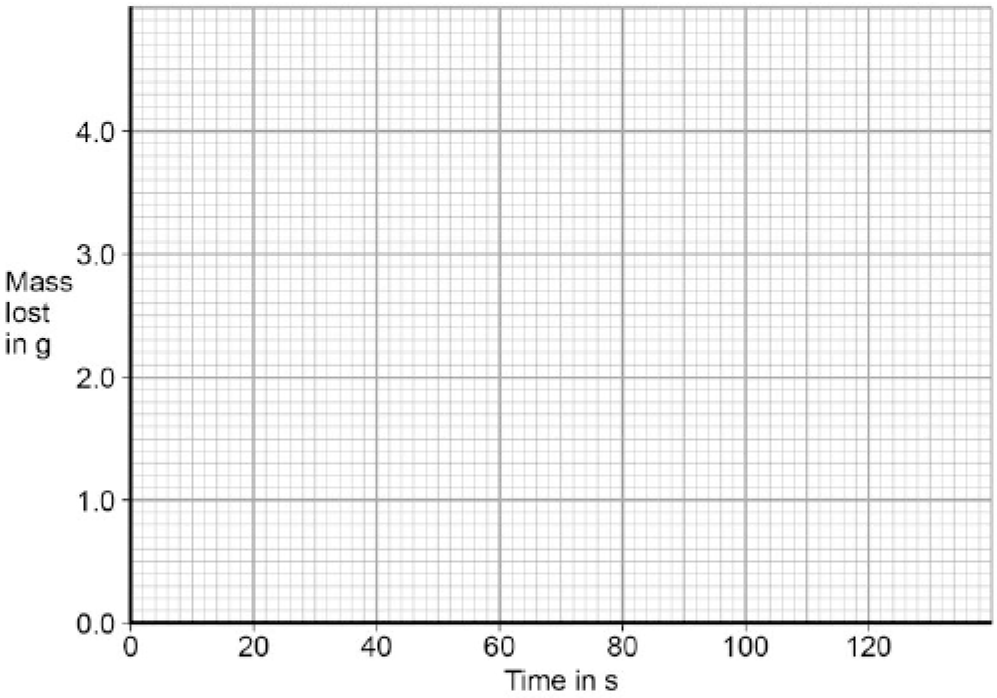
Table 1

Time in s	**Mass lost in g**
0	0.0
20	1.6
40	2.6
60	2.9
80	3.7
100	4.0
120	4.0

On **Figure 2**:

- Plot these results on the grid.
- Draw a line of best fit.

Figure 2



(3)

(c) Use **Figure 2** to complete **Table 2**.

Table 2

Mass lost after 0.5 minutes	.... g
Time taken to complete the reaction	.... s

(2)

(d) The equation for the reaction is:

$2HCl(aq) + CaCO_3(s) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$

Explain why there is a loss in mass in this investigation.

....

....

....

....

(2)

(e) Another student investigated the rate of a different reaction.

Table 3 shows the results from the different reaction.

Table 3

Mass lost when the reaction was complete	9.85 g
Time taken to complete the reaction	2 minutes 30 seconds

Calculate the mean rate of the reaction using **Table 3** and the equation:

$$\text{mean rate of reaction} = \frac{\text{mass lost in g}}{\text{time taken in s}}$$

Give your answer to two decimal places.

....

....

Mean rate of reaction = ... g / s

(2)

(f) The student measured the change in mass of the reactants.

Describe another method, other than measuring the change in mass of the reactions, that the student could have used to find the rate of the reaction between marble chips and hydrochloric acid.

....

....

....

....

(2)

(g) Another student planned to investigate the effect of temperature on the rate of reaction. The student predicted that the rate of reaction would increase as the temperature was increased.

Give **two** reasons why the student's prediction is correct.

Tick **two** boxes.

The particles are more concentrated. ☐

The particles have a greater mass. ☐

The particles have a larger surface area. ☐

The particles have more energy. ☐

The particles move faster. ☐

(2)

(Total 14 marks)

17 This question is about carbon and gases in the air.

(a) Carbon atoms have protons, neutrons and electrons.

Complete the table by writing the relative mass of a neutron and an electron.

Name of particle	**Relative mass**
proton	1
neutron	
electron	

(2)

(b) What is the total number of protons and neutrons in an atom called?

Tick (✓) **one** box.

The atomic number ☐

The mass number ☐

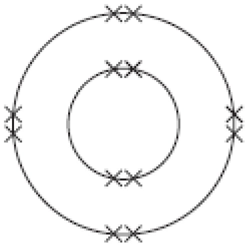
One mole of the atom ☐

(1)

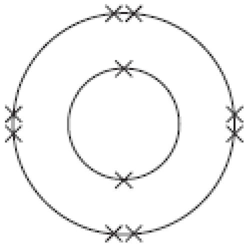
(c) An atom of carbon has six electrons.

Which structure, **A, B** or **C**, represents the electronic structure of the carbon atom?

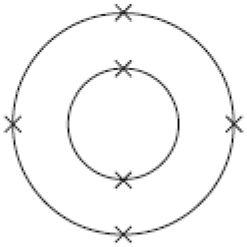
Structure A



Structure B



Structure C



The carbon atom is structure ☐

(1)

(d) Carbon reacts with oxygen to produce carbon dioxide (CO_2).

(i) How many different elements are in one molecule of carbon dioxide?

....

(1)

(ii) What is the total number of atoms in one molecule of carbon dioxide?

....

(1)

(e) Sometimes carbon reacts with oxygen to produce carbon monoxide (CO).

(i) Calculate the relative formula mass (M_r) of carbon monoxide.

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

....

....

M_r of carbon monoxide = ...

(1)

(ii) Calculate the percentage by mass of carbon in carbon monoxide.

....

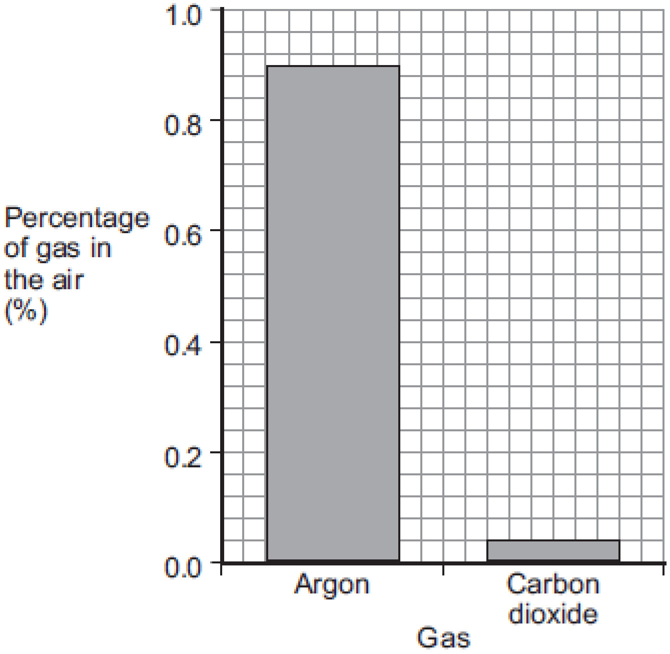
....

Percentage by mass of carbon in carbon monoxide = ...%

(1)

(f) Carbon dioxide is one of the gases in the air.

(i) The graph shows the percentage of argon and the percentage of carbon dioxide in the air.



What is the percentage of argon in the air?

Percentage of argon = ... %

(1)

(ii) An instrumental method is used to measure the amount of carbon dioxide in the air.

Give **one** reason for using an instrumental method.

....

....

(1)

(Total 10 marks)

18 Ammonium chloride, NH_4Cl, is made up of nitrogen, hydrogen and chlorine atoms.

(i) Complete the table to show the number of atoms of each element present in NH_4Cl.

Element	**Number of atoms in NH_4Cl**
nitrogen	1
hydrogen	
chlorine	

(1)

(ii) Calculate the relative formula mass of ammonium chloride, NH_4Cl.

(Relative atomic masses: H = 1, N = 14, Cl = 35.5)

....

....

....

....

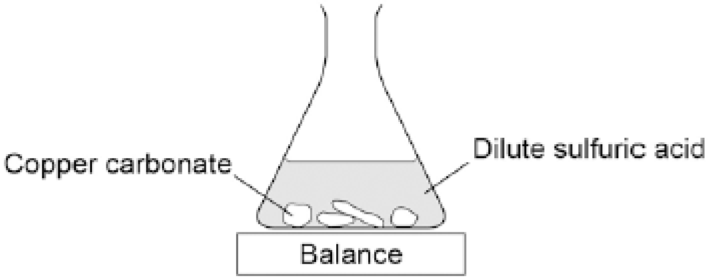
Relative formula mass = ...

(2)

(Total 3 marks)

19 A student investigated the reaction of copper carbonate with dilute sulfuric acid.

The student used the apparatus shown in the figure below.



(a) Complete the state symbols in the equation.

$$CuCO_3\ (.....) + H_2SO_4\ (aq) \rightarrow CuSO_4\ (aq) + H_2O\ (.....) + CO_2\ (g)$$

(2)

(b) Why did the balance reading decrease during the reaction?

Tick **one** box.

The copper carbonate broke down. ☐

A salt was produced in the reaction. ☐

A gas was lost from the flask. ☐

Water was produced in the reaction. ☐

(1)

(c) Describe a safe method for making pure crystals of copper sulfate from copper carbonate and dilute sulfuric acid. Use the information in the figure above to help you.

In your method you should name all of the apparatus you will use.

....

....

....

....

....

....

....

....

....

....

(6)

(d) The percentage atom economy for a reaction is calculated using:

$$\frac{\text{Relative formula mass of desired product from equation}}{\text{Sum of relative formula masses of all reactants from equation}} \times 100$$

The equation for the reaction of copper carbonate and sulfuric acid is:

$CuCO_3 + H_2SO_4 \rightarrow CuSO_4 + H_2O + CO_2$

Relative formula masses : $CuCO_3$ = 123.5; H_2SO_4 = 98.0; $CuSO_4$ = 159.5

Calculate the percentage atom economy for making copper sulfate from copper carbonate.

....

....

....

....

....

Atom economy = ... %

(3)

(e) Give **one** reason why is it important for the percentage atom economy of a reaction to be as high as possible.

....

....

(1)

(Total 13 marks)

20 Some students investigated magnesium oxide.

(a) Magnesium oxide has the formula MgO.

(i) Calculate the relative formula mass (M_r) of magnesium oxide.

Relative atomic masses: O = 16; Mg = 24.

....

....

Relative formula mass = ...

(2)

(ii) Calculate the percentage by mass of magnesium in magnesium oxide.

....

....

Percentage by mass of magnesium in magnesium oxide = ...%

(2)

(iii) Calculate the mass of magnesium needed to make 25 g of magnesium oxide.

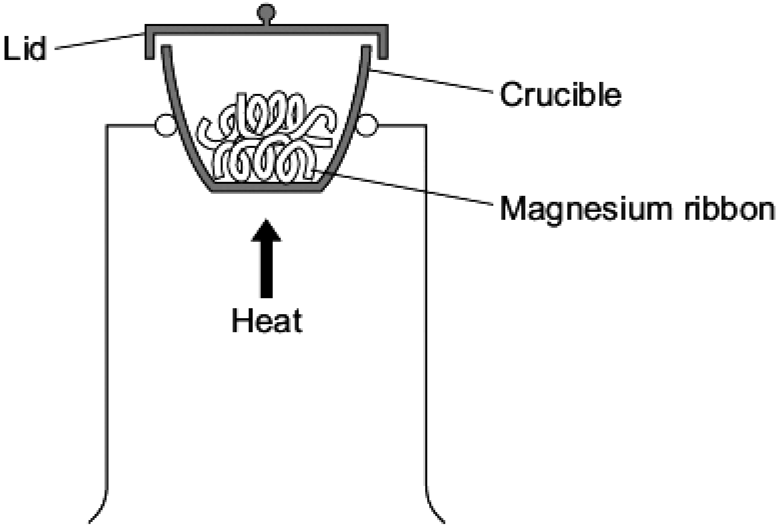
....

Mass of magnesium = ... g

(1)

(b) The students calculated that if they used 0.12 g of magnesium they should make 0.20 g of magnesium oxide.

They did this experiment to find out if this was correct.



- The students weighed 0.12 g of magnesium ribbon into a crucible.
- They heated the magnesium ribbon.
- They lifted the lid of the crucible slightly from time to time to allow air into the crucible.
- The students tried to avoid lifting the lid too much in case some of the magnesium oxide escaped.
- When all of the magnesium appeared to have reacted, the students weighed the magnesium oxide produced.

The results of the experiment are shown below.

Mass of magnesium used in grams	0.12
Mass of magnesium oxide produced in grams	0.18

(i) The mass of magnesium oxide produced was lower than the students had calculated. They thought that this was caused by experimental error.

Suggest **two** experimental errors that the students had made.

....

....

....

....

(2)

(ii) The students only did the experiment once.

Give **two** reasons why they should have repeated the experiment.

....

....

....

....

(2)
(Total 9 marks)

21 Calculate the formula mass (Mr), of the compound

calcium hydroxide, $Ca\ (OH)_2$.

(Show your working)

....

....

....

....

....

....

(Total 3 marks)

22 Toothpastes often contain fluoride ions to help protect teeth from attack by bacteria.

Some toothpastes contain tin(II) fluoride.

This compound has the formula SnF_2 .

(a) Calculate the relative formula mass (M_r) of SnF_2.

Relative atomic masses: F = 19; Sn = 119

....

....

....

....

Relative formula mass (M_r) = ...

(2)

(b) Calculate the percentage by mass of fluorine in SnF_2.

....

....

....

....

Percentage by mass of fluorine = ... %

(2)

(c) A tube of toothpaste contains 1.2 g of SnF_2.

Calculate the mass of fluorine in this tube of toothpaste.

....

....

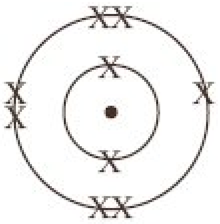
....

....

Mass of fluorine = ... g

(1)

(d) The diagram represents the electron arrangement of a fluorine atom.



Explain how a fluorine atom can change into a fluoride ion, F^-.

....

....

....

....

(2)

(Total 7 marks)

23 Iron is an essential part of the human diet. Iron(II) sulfate is sometimes added to white bread flour to provide some of the iron in a person's diet.

(a) The formula of iron(II) sulfate is $FeSO_4$

Calculate the relative formula mass (M_r) of $FeSO_4$

Relative atomic masses: O = 16; S = 32; Fe = 56.

....

....

The relative formula mass (M_r) = ...

(2)

(b) What is the mass of one mole of iron(II) sulfate? Remember to give the unit.

....

(1)

(c) What mass of iron(II) sulfate would be needed to provide 28 grams of iron?

Remember to give the unit.

....

(1)

(Total 4 marks)

24 Follow the steps to find the percentage of iron in iron oxide.

Relative atomic masses: O 16; Fe 56.

(i) Step 1

Calculate the relative formula mass of iron oxide, Fe_2O_3.

....

....

(1)

(ii) Step 2

Calculate the total relative mass of just the iron atoms in the formula, Fe_2O_3.

....

(1)

(iii) Step 3

Calculate the percentage (%) of iron in the iron oxide, Fe_2O_3.

....

....

Percentage of iron .... %

(1)

(Total 3 marks)

Mark schemes

1

(a) because they are gases

ignore vapours / evaporate / (g)

allow it is a gas

1

(b) (i) 80 / 79.5

correct answer with or without working = ***2*** *marks*

ignore units

if no answer ***or*** *incorrect answer then evidence of 64 / 63.5 + 16 gains* ***1*** *mark*

2

(ii) 80 / 79.87 / 79.9 / 79.375 / 79.38 / 79.4

correct answer with or without working = ***2*** *marks*

if no answer ***or*** *incorrect answer*

then

evidence of $\frac{64}{80}$ ***or*** $\frac{63.5}{79.5}$ *(x100) gains* ***1*** *mark*

accept (ecf)

$\frac{64 or 63.5}{answer(b)(i)}(\times100)$ *for* ***2*** *marks if correctly calculated*

if incorrectly calculated

evidence of $\frac{64 or 63.5}{answer(b)(i)}(\times100)$

gains ***1*** *mark*

2

(iii) 3.2

correct answer with or without working = ***1*** *mark*

allow (ecf)

4 x ((b)(ii)/100) for ***1*** *mark if correctly calculated*

1

(c) (i) 3.3

accept 3.33…….. o $3\frac{1}{3}$ *or 3.3 · or* 3.3^{r}

1

(ii) measure to more decimal places
or use a more sensitive balance / apparatus

allow use smaller scale (division)

or *use a smaller unit*

ignore accurate / repeat

1

(iii) any **two** from:

- ignore systematic / human / apparatus / zero / measurement / random / weighing / reading errors unless qualified
- different balances used **or** faulty balance
  ignore dirty apparatus
- reading / using the balance incorrectly **or** recording error
  accept incorrect weighing of copper / copper oxide
- spilling copper oxide / copper
  allow some copper left in tube
- copper oxide impure
  allow impure copper (produced)
- not all of the copper oxide was reduced / converted to copper **or** not enough / different amounts of methane used
  accept not all copper oxide (fully) reacted
- heated for different times
- heated at different temperatures
  accept Bunsen burner / flame at different temperatures
- some of the copper made is oxidised / forms copper oxide
- some of the copper oxide / copper blown out / escapes (from tube)
  ignore some copper oxide / copper lost
- some water still in the test tube

2

[10]

2 (a) (i) lit splint **or** ignite the gas

1

(squeaky) pop / explosion

1

(ii) because it provides energy (for the reaction)

1

to break bonds (in the reactants) **or** so the particles collide successfully

ignore reference to frequency or rate of collisions

*because it provides the activation energy gains **2** marks*

1

(b) (i) 1.67(g)

allow 1.66-1.68

*correct answer (to 3 significant figures) with or without working gains **3** marks*

*if answer incorrect allow up to **2** marks for the following steps:*

24 → 40

1.00 → 40 / 24

or

*moles magnesium = 1 / 24 **or** 0.04(17)*

multiply by 40

*allow ecf from incorrect ratio **or** incorrect number of moles*

3

(ii) **if correct answer from part (b)(i) used**

allow ecf from part (b)(i)

89.8 or 90

if 1.82 g used

82.4 or 82

*correct answer with or without working gains **2** marks*

*if answer incorrect, allow the following for **1** mark:*

1.50 / 1.67 (or their answer from part (b)(i))

if 1.82 g used: 1.50 / 1.82

2

(iii) any **one** from:

ignore measurement errors

- not all the magnesium reacted

  allow the reaction may be reversible
- some of the magnesium oxide / product may have been left in the tube **or** may have been lost

  ignore magnesium lost
- different / unexpected reaction
- magnesium not pure

1

[10]

3

(a) 1213.8 to 1214.3

*gains **3** marks without working*

correct answer not given then check working

1) moles of N_2 $= \frac{1000}{28} = 35.7$ mol

***1** mark for each correct step*

*do **not** penalise rounding errors in this part*

2) moles of NH_3 = 2 × (answer from (1)) = 71.4 mol

3) mass of NH_3 = (answer from 2) × 17 = 71.4 × 17 = 1214 g

3

or

- 28g of $N_2 \rightarrow$ 34g of NH_3

  ***1** mark for each correct step*

- 1g of $N_2 \rightarrow \frac{34}{28} = 1.214$g NH_3

  *do **not** penalise rounding errors in this part*

- 1000 g of $N_2 \rightarrow$ 1000 × 1.214
  = 1214g

  allow error carried forward eg

or

- $1000 \times \frac{34}{28}$

*gains **2** marks if correct answer not given*

*$1000 \times \frac{28}{34}$ gains **1** mark, **2** marks if correctly calculated*

*(823.5g) $1000 \times \frac{28}{17}$ gains **1** mark if calculated correctly (1647.05g)*

or

other correct methods

look for the key ideas in the methods above

(b) 25 **/** 25.035 **or** ecf from (a)

*gains **2** marks even when there is no working*

*incorrect answer then 304/(their answer from (a)) × 100 gains **1** mark*

or using figures from part (b)

27.6 / 28

*gains **2** marks even when there is no working*

*accept 27 for **1** mark*

*if answers incorrect then304/1100 × 100 gains **1** mark*

2

(c) (i) increase yield

1

reaction is exothermic

or

allow decreased yield because rate of reaction is slower / fewer collisions for **2** marks

***must** get both points for **2** marks*

1

(ii) increase yield

1

plus **one** from:

- more (gaseous) reactant molecules than (gaseous) product molecules (owtte)
  accept greater volume on the left than the right owtte
- increased rate of reaction / more collisions

1

(d) any **one** from:

economic

- large town provides workforce
- workers do not have to travel far to the factory. (owtte)
- transport infrastructure already in place for large town. (owtte)
- factory brings prosperity to town (owtte)
- factory provides employment
- reduced tourism
- reduction in local house prices
- any other sensible economic factor linked to town

1

any **one** from:

safety

- escape of dangerous / harmful chemicals / gases (owtte)
  *do **not** allow polluting gases unqualified*
- danger of increased traffic
- risk of explosion.(owtte) /danger of high pressure
- consequences of an accident could be severe if the town is close
- any other sensible safety idea

1

any **one** from:

environmental

- factory might be unsightly (owtte)
- screening of factory (owtte)
- loss of habitats (owtte)
- plant trees/ hedges etc on and around plant site
- pollution of water / air / soil could harm plants / animals **or** noise pollution
  must be explained
- CO_2 is produced by burning fuels / heating
- CO_2 causes global warming / any effect of global warming
- eye sore
- any other sensible environmental factor

1

[12]

-

4

(a) *reference to*
hydrogen (atoms))
nitrogen (atoms)) but **not** molecules
each for 1 mark

ratio of 1N to 3H **atoms**
for 1 further mark

or 1 nitrogen atom and 3 hydrogen atoms
(ignore any incorrect statements about nature of bonding)

3

(b) *evidence of*
H = 1
N = 14
O = 16

gains 1 mark

but
H = 1
N = 14
O = 16 × 3 or 48

gains 2 marks

but 63

gains 3 marks

3

[6]

5

Mg S O_4

24 + 32 + 16 (×4) or 64 / evidence of all A_r's correct [so 24 + 32 + 16 1 mark]

gains 1 mark

but (M_r) = 120 No ECF

gains 2 marks

[2]

6

56
74

each for 1 mark

[2]

7

(a) 1400

1

(b) 980

correct answer gains full credit

160 tonnes Fe_2O_3 produces 112 tonnes Fe

if incorrect allow one mark for relative formula mass iron oxide = 160
allow e.c.f.

1400 tonnes Fe_2O_3 will produce 1400 / 160 × 112 tonnes Fe

use of 2000 tonnes Fe_2O_3 – deduct one mark only if working out is correct

4

[5]

8 36.8 / 37

correct answer, no workings = 3 if incorrect, allow 1 mark for rfm $FeSO_4$ = 152
***or** if incorrect rfm, allow 1 mark for 56/Y × 100 where Y is incorrect formula mass*

allow 2 marks for $\frac{56}{152} \times 100$

[3]

9 (a) 56g

for 1 mark

1

(b) 44 tonnes

for 1 mark

1

[2]

10 (a) left hand: (conical) flask

*do **not** accept round bottomed*
flask or container which is not a flask

1

right hand: beaker / trough

accept plastic box

1

(b) (i) 157

1

(ii) all calcium carbonate used up **or** reaction stopped

*do **not** accept all acid used up*

1

(c) (i) 0.007(272727…)

*correct answer with or without working gains **2** marks*

*if answer incorrect, allow (0.32 / 44) for **1** mark*

2

(ii) 0.007(272727…)

*allow ecf from **(c)(i)***

1

(iii) (M_r = mass / moles = 1 / 0.00727…) = 137.5 or 138

*allow ecf from **(c)(ii)***

if use 0.00943 moles then = 106

if use 0.007 allow 143 (142.857)

1

(iv) (138) – 60 (= 78)

23 / 85

1

(78 / 2) = 39

1

potassium

sodium / rubidium

*identity of metal ecf on A_r, but **must** be Group 1*

*If no working max **1** mark*

1

(d) (i) (relative atomic mass) would decrease

1

because the mass lost greater

1

so moles carbon dioxide larger **or** moles metal carbonate greater

1

(ii) no change

1

because the acid (already) in excess

1

so the amount carbon dioxide lost is the same

1

[17]

11

(i) a reaction in which the products can be changed back to reactants

*accept a reaction that can go forwards **or** backwards*

1

under certain conditions

1

(ii) M_r $CaCO_3$ = 100

1

M_r CaO = 56

1

mass of CaO = 140 (tonnes)

1

mark consequentially

[5]

12

(a) put on soil **or** for plants

*accept land **or** field **or** garden **or** crops **or** plants*

accept alternative answer to provide more food for increased population

for growth

*accept to improve plant yield **or** help them grow*

*accept to replace **or** add nutrients (**not** nitrates) **or** minerals **or** to make plants grow better **or** for healthy plants*

*do **not** accept to make soil fertile **or** to feed plants*

2

(b) (i) 2

1

(ii) 80

1

[4]

13

(a) 2.61 / range 2.5 to 2.7

*correct answer with **or** without **or** with wrong working gains **2** marks*

(accept answers between 2.5 and 2.7)

if answer incorrect moles of salicylic acid = 2/138 = 0.0145 moles
*ie 2/138 **or** 0.0145 gains **1** mark*
or
*(180/138) × 2 gains **1** mark*
or
*1 g → 180/138 = (1.304 g) gains **1** mark*
*(**not** 1.304g alone)*

2

(b) 42.1 range 40.7 to 42.3

*accept correct answer with **or** without **or** with wrong working for **2** marks*

*ecf ie (1.1 / their answer from (a)) × 100 correctly calculated gains **2** marks*

*if answer incorrect percentage yield = 1.1 / 2.61 × 100 gains **1** mark*

if they do not have an answer to part (a)
or
they choose not to use their answer then:

- yield = (1.1 / 2.5) × 100 (1)
- = 44

  *accept 44 for **2** marks with no working*

2

(c) any **one** from:

- errors in weighing
- some (of the aspirin) lost

  *do **not** allow 'lost as a gas'*
- not all of the reactant may have been converted to product

  eg reaction didn't go to completion

  allow loss of some reactants
- the reaction is reversible

  accept other products / chemicals
- side reactions

  ignore waste products
- reactants impure
- not heated for long enough
- not hot enough for reaction to take place

1

(d) any **one** from:

- use lower temperature
- use less fuel / energy
  ignore references to use of catalyst
- produce product faster **or** speed up reaction
- more product produced in a given time (owtte)
- increased productivity
- lowers activation energy

1

[6]

14 (a) 100

ignore units

*40 + 12 + (3 × 16) for **1** mark*

1

(b) 40

*(**ecf** from part (a) can get **2** marks)*

$\frac{40}{\text{their (a)}} \times 100$ *for **1** mark*

1

(c) 0.5

*(**ecf** from part (b) can get **2** marks)*

$1.25 \times \left(\frac{\text{their (b)}}{100}\right)$ ***or** other correct working for **1** mark*

2

(d) gas produced **or** carbon dioxide / CO_2 produced

1

[7]

15 (a) N_2O

1

(b) 13.8 to 14

gains full marks without working

if answer incorrect
13 gains ***1*** *mark*
or
14/101 × 100 gains ***1*** *mark*

2

[3]

16 (a) cotton wool

1

(b) all points correct

± ½ small square

2

allow ***1*** *mark if 5 or 6 of the points are correct*

best fit line

must not deviate towards anomalous point

1

(c) (mass)
2.1 (g)

allow ecf from drawn best fit line

1

(time)
100 (s)

1

(d) a gas is produced

1

which escapes from the flask

1

(e) $\frac{9.85}{150} = 0.0656$

1

0.07 (g / s)

allow ecf answer correctly calculated to 2 decimal places

1

(f) collect the gas in a gas syringe

1

measured the volume of gas

allow carbon dioxide for gas

1

allow for ***1*** *mark*

collected gas

or

counted bubbles

(g) The particles have more energy

1

The particles move faster

1

[14]

17

(a) 1

must be in this order

1

very small

accept negligible, 1 / 2000

allow zero

1

(b) The mass number

1

(c) C

1

(d) (i) 2

1

(ii) 3

1

(e) (i) 28

1

(ii) 42.9

accept ecf from (e)(i)

accept 42 - 43

1

(f) (i) 0.9

1

(ii) any **one** from:

- accurate
- sensitive
- rapid
- small sample.

1

[10]

18 (i) 4 **and** 1

both answers must be correct

1

(ii) 53.5

if incorrect relative formula mass
allow 1 mark for correct working

accept e.c.f. from c(i) for 2 marks

2

[3]

19 (a) s

1

l

*Answers **must** be in the correct order.*

1

(b) A gas was lost from the flask

1

(c) **Level 3 (5–6 marks):**

A coherent method is described with relevant detail, and in correct sequence which demonstrates a broad understanding of the relevant scientific techniques and procedures. The steps in the method are logically ordered. The method would lead to the production of valid results.

Level 2 (3–4 marks):

The bulk of the method is described with mostly relevant detail, which demonstrates a reasonable understanding of the relevant scientific techniques and procedures. The method may not be in a completely logical sequence and may be missing some detail.

Level 1 (1–2 marks):

Simple statements are made which demonstrate some understanding of some of the relevant scientific techniques and procedures. The response may lack a logical structure and would not lead to the production of valid results.

0 marks:

No relevant content.

Indicative content

- sulfuric acid in beaker (or similar)
- add copper carbonate one spatula at a time
- until copper carbonate is in excess or until no more effervescence occurs *
- filter using filter paper and funnel
- filter excess copper carbonate
- pour solution into evaporating basin / dish
- heat using Bunsen burner
- leave to crystallise / leave for water to evaporate / boil off water
- decant solution
- pat dry (using filter paper)
- wear safety spectacles / goggles

*Students. may choose to use a named indicator until it turns a neutral colour, record the number of spatulas of copper carbonate added then repeat without the indicator.

6

(d) Total mass of reactants = 221.5

1

$$\frac{159.5}{221.5}$$

allow ecf from step 1

1

72.0 (%)

1

*allow 72.0 with no working shown for **3** marks*

(e) any **one** from:

- Important for sustainable development
- Economic reasons
- Waste products may be pollutants / greenhouse gases

1

[13]

20 (a) (i) 40

*correct answer with or without working **or** incorrect working*

*if the answer is incorrect then evidence of 24 + 16 gains **1** mark*

ignore units

2

(ii) 60

*correct answer with **or** without working or incorrect working*

*if the answer is incorrect then evidence of 24/40 **or** 24/(i) gains **1** mark*

ecf allowed from part(i)

ie 24/(i) ×100

ignore units

2

(iii) 15

ecf allowed from parts(i) and (ii)

24/(i) × 25 or (ii)/100 × 25

ignore units

1

(b) (i) any **two** from:

ignore gas is lost

- error in weighing magnesium / magnesium oxide

  allow some magnesium oxide left in crucible

- loss of magnesium oxide / magnesium

  allow they lifted the lid too much

  allow loss of reactants / products

- not all of the magnesium has reacted

  allow not heated enough

  allow not enough oxygen / air

2

(ii) any **two** from:

ignore fair test

- check that the result is not anomalous
- to calculate a mean / average

  allow improve the accuracy of the mean / average
- improve the reliability

  allow make it reliable
- reduce the effect of errors

2

[9]

21 Ca = 40

$(OH)_2$ = (16 + 1)2 **or** 34

gain 1 mark each

but

$M_r = 74$

gains 3 marks

[3]

22 (a) 157

*correct answer with **or** without working*

*(2 × 19 + 119) for **1** mark only*

*allow (119 + 19 =) 138 for **1** mark only*

ignore units

2

(b) 24.2

accept answers in the range 24 to 24.2038.....

ignore incorrect rounding after correct answer

*25 only without working gains **1** mark **or***

*38/157 × 100 gains **1** mark **or***

*(19/157 × 100 =) 12 to 12.1 gains **1** mark*

allow error carried forward from part(a)

*38/(a) × 100 gains **2** marks if calculated correctly*

*(19/138 × 100 =) 13.8 gains **1** mark*

2

(c) 0.29

accept answers in the range 0.28 to 0.3

allow error carried forward from part (b)

(b)/100 × 1.2 correctly calculated

ignore units

1

(d) an electron

allow electrons

*allow electron shared / lost for **1** mark*

apply list principle for additional particles

1

is gained owtte

must be linked to electron

accept can hold / take in if in correct context

*eg it can hold another electron (in its outer shell) = **2** marks*

*it can take an electron (from another atom) = **2** marks*

ignore reference to fluoride ions

*incorrect number of electrons gained does **not** gain the second mark*

1

[7]

23 (a) 152 correct answer with **or** without working = **2 marks**
56 + 32 + (4 ×16) gains **1** mark

ignore any units

2

(b) 152g(rams)

ecf from the answer to (a) and g

must have unit g / gram / gramme / grams etc

*accept g / mol **or** g per mole **or** g mole^{-1} **or** g/mol **or** g per mol **or** g mol^{-1}*

*do **not** accept g m*

*do **not** accept G*

1

(c) 76(g)

ecf from their answer to (a) or (b) divided by 2

ignore units

1

[4]

24 (i) 160

ignore units

1

(ii) 112

ignore units

1

(iii) 70

*do **not** carry forward errors*

1

[3]

1

(a) This question was not very well answered with the majority of the candidates being unable to pick out the idea of ‘gases from the equation. Most answers indicated that the water and carbon dioxide were used and burnt in the flame or that the water evaporated and the carbon dioxide was burnt. Vague references to waste products escaping were also prevalent.

(b) Parts (b)(i) and (b)(ii) were quite well answered. In general Foundation Tier candidates are getting better at calculating relative formula mass. Over half of the candidates gained both of the marks in part (b)(i) which is similar to the same type of question last year. A correct answer gained two marks but one mark could be gained if there was evidence of an intention to add the correct numbers. Common errors included multiplying the atomic masses ’64 × 16 = 1024’ and subtracting ’64 - 16 = 48’. Foundation Tier candidates have for many years found the calculation of the percentage of an element in a compound very difficult so it is pleasing to note about a third of candidates gained both marks. A number of candidates gained one mark by showing 64/80 or a suitable error carried forward from part (i). Here the most common error was not to have used 100 in their calculations. The most common answer gaining no marks was 51.2 % derived from 64 × 80/100.

(iii) A considerable number of candidates copied the information from the results table given for (c) instead of using their answer from (b)(ii) and wrote 3.3.Only a minority of candidates scored a mark for this question. Many answers were far in excess of 4 grams even though their answer to (b)(ii) was much less than 100 %. Many candidates did not use the 4 grams in their calculation and therefore guesses abounded.

(c) (i) A significant number of candidates did not have a calculator. Common answers were 10 as they forgot to divide by 3 and some included the 4.0 in the calculation.

(ii) The idea of smaller scale division eg measuring to more decimal places was not widely understood. The majority thought that comparing or repeating the test made it more precise. Many candidates were confused and suggested that rounding up to the nearest whole number improved precision.

(iii) This part was not answered well with only a small percentage of candidates scoring both marks. The main problem was that answers were too vague or not qualified. For example the responses ‘measuring error’ or ‘reading error’ were common as well as ‘measuring the amount of copper/copper oxide’. In the latter case it was required that candidates demonstrated that they knew that it was the mass of copper/copper oxide being measured or at least that the apparatus being used was a balance. The sloppy use of scientific terms was prevalent, such as interchanging copper and copper oxide in statements as if they were the same substance. The difference between the terms temperature and heat is not understood. Another common incorrect response was the issue of reliability and candidates responded in terms of not enough repeats as an experimental error. Students are also unaware of the consequences of systematic errors. The most common correct responses were those detailing that the copper/copper oxide had been weighed incorrectly, recording the results wrongly and the balance being faulty. Other creditworthy responses referred to the heat control between experiments and the regulation of the amount of methane passed during the experiments.

2

(a) (i) This question was generally well answered, with the majority of students gaining two marks. A common incorrect answer involved the use of glowing spills, while a small number of students used limewater.

(ii) The majority of students scored both marks here. Most answered the question in terms of increased energy and therefore increased number of successful collisions, instead of bond breaking. A good percentage of students mentioned activation energy, but did not always explain it clearly. Some students referred to heat as a type of catalyst.

(b) (i) Over half of the students gave the correct answer of 1.67 g. Many missed the instruction to use three significant figures or did not understand its meaning by giving an answer of 1.7 g or rounding down to 1.6 g. Another common error involved calculating the molar mass of magnesium oxide as 42, presumably considering a conservation of mass approach with Mg (24) and H_2O(18) and finishing with a mass of 1.75 g.

(ii) The majority of students scored full marks, via a number of different routes. Many trusted their value from part (b)(i) and gained full marks for a correct calculation. Some students, unable to answer (b)(i), correctly used the value provided in the question. However, some students gained an answer for (b)(i), but opted instead to use the value of 1.82g mentioned in the question.

(iii) The question had a wide range of responses, with just over half of students scoring the mark. The most common correct answer was the fact that not all the magnesium had reacted. Students should have been able to appreciate that the steam was in excess and that the amount of magnesium that reacted would dictate the yield. However, many students mentioned that not all the reactants reacted, while other vague statements such as ‘magnesium was lost’ or ‘some product was converted to heat’ gained no credit.

3

Part (a) was intended as a challenging calculation for the more able candidates and that proved to be the case. Some excellent answers were seen but many answers were simply a jumble of numbers which were difficult to give any credit. Very few candidates set out their working clearly. The problems for the markers were compounded by strange rounding of intermediate answers in the calculation so that a wide range of final answers was given. Candidates would be well advised to defer rounding until they reach their final answer. Some common errors included calculating the relative mass of 2NH3 as if it were N2H3 and getting the answer of 31 and using 14 as the relative molecular mass of N2.

Part (b) was better answered than part (a). Many candidates gained the marks either by error carried forward from their part (a) or by using the value of 1100 given in the question. A number of candidates used 1000g as their maximum yield rather than 1100g or their answer from (a).

In part (c)(i) few candidates linked an increased yield with the fact that the forward reaction is exothermic. Similarly in part (c)(ii) few realised that there would be an increased yield because in going from reactants to products there is a decrease in the number of gaseous molecules. Since we did not specify that the yield is an equilibrium yield the mark scheme was expanded to include sensible answers based on rates of reaction.

Part (d) asked the candidates to discuss the economic, safety and environmental factors. To gain all three marks the candidates were required to address all three issues. Many candidates only addressed one or two of them. Some common misconceptions were that nitrogen is a pollutant and that the ammonia produced would be sold in the local town. Many answers were long and vague often extending well beyond the available space. Candidates should be encouraged to be more concise and precise in their answers. A wide range of answers was accepted.

4

In (a) the commonest reason for loss of marks was referring to the nitrogen and hydrogen as 'molecules' or, less commonly, as 'ions'.

Part (b) was answered by a majority of candidates, many of whom answered correctly, simple arithmetical errors being the commonest reason for loss of marks.

7

(a) Only the weaker candidates failed to do this calculation correctly.

(b) The calculation involving relative formula masses caused problems for the majority of candidates. Weaker candidates did not realise that they had to calculate the relative formula masses of Fe_2O_3 and 2Fe. Many had forgotten that the haematite was not 100% iron oxide, even though they had performed a calculation based on this in part (a).

8

The calculation required showed that many candidates had an idea of how to calculate formula mass, even if often they answered 104. However, they did not know what to do next to calculate the percentage of iron in iron sulphate.

9

The question was designed to allow candidates to demonstrate their ability to apply simple mathematics to a chemical problem. Many found the mathematics was beyond them and some made no attempt. Part (a) was often better answered than (b). A number of candidates correctly wrote "100 – 44" and then failed to make the subtraction correctly in part (a).

11

Double Award only

Almost all candidates could explain the meaning of reversible but very few mentioned the effect of the conditions on the direction of the reversible reaction. The calculation was generally well answered, but when the answer was incorrect it was often difficult to follow the working, so no marks could be awarded.

12

Double Award only

Most candidates knew the basic idea that fertilisers aid plant growth or replace nutrients. However, many thought that fertilisers were ‘insecticides’ or ‘weedkillers’. In part (b) many candidates were not secure in their understanding of a chemical formula or how to work out the relative formula mass. The common incorrect answers were ‘7’ in part (i) and ‘31’ in part (ii).

13

Candidates have always found this type of calculation difficult and so it is pleasing to report that a good number of the candidates were able to complete part (a) successfully. The most common error was (138/180 × 2).

Part (b) was slightly better answered than part (a). A fair number of candidates used the data given in the brackets even when they answered part (a) correctly. A variety of incorrect responses were seen which usually involved selecting the wrong numbers such as (1.1 / 2 × 100 = 55%).

Part (c) was quite well answered. A wide variety of answers were accepted including simple ideas such as, ‘some of the aspirin was lost’ or ‘weighing errors’.

Many excellent responses were seen in part (d) such as, ‘using the catalyst allows the process to take place at a lower temperature which reduces energy costs’.

14

Foundation Tier

Answers here appeared to be centre dependent.

(a) This part was often correctly answered although some candidates simply added the three relative atomic masses and gave the answer 68.

(b) A number of candidates calculated the percentage of carbon in the compound rather than calcium.

(c) This was the least well-answered part with some candidates giving answers that were larger than 1.25g.

(d) Many candidates used the equation to identify that carbon dioxide gas is produced. Some answers indicated that the candidates did not understand the state symbols in the equation. Some simply ignored the equation and guessed answers such as hydrogen or oxygen.

Higher Tier

This question was very well answered and most candidates gained all seven marks. The question tended not to discriminate between the candidates.

(a) Most candidates calculated the relative formula mass correctly.

(b) Some candidates calculated a percentage based on an Ar = 12 rather than 40.

(c) Together with the aid of consequential marking, most candidates gained full credit.

(d) Most candidates realised that carbon dioxide caused the problem but some negated their mark by suggesting that the gas was oxygen or methane.

15

Foundation Tier

About half of the candidates were able to identify the formula as N2O in part (a). Some candidates showed their working and clearly understood what was required while others either made no attempt or were simply guessing.

In part (b) the percentage calculation proved to be difficult for many of the candidates. A number of candidates gave an incorrect answer with no working. Some candidates ignored the value of the *M*r given in the question and attempted to calculate a value for themselves, often incorrectly. Some calculated (14 ÷ 100) × 101 rather than (14 ÷ 101) × 100. Other candidates ignored the question and calculated percentage of potassium or oxygen. Candidates should be careful with rounding.

Higher Tier

Most of the candidates were able to identify the formula as N2O in part (a). Some candidates showed their working and clearly understood what was required.

In part (b) the percentage calculation was well answered by many of the candidates. A number of candidates gave an incorrect answer with no working. Some candidates ignored the value of the *M*r given in the question and attempted to calculate a value for themselves, often incorrectly. Some calculated (14 ÷ 100) × 101 rather than (14 ÷ 101) × 100. Other candidates ignored the question and calculated the percentage of potassium or oxygen. Candidates should be careful with rounding.

17 (a) Correct answers gave a combination of 1 for the neutron and 0 / very small / negligible or zero mass for the electron. The majority of responses were incorrect with students confusing the charge of the particles with their mass and giving 0 for the neutron and 1 / -1 for the electron. Some students wrote + / - next to their numbers. Guesses such as 12 and 6, 2 and 2 and 2 and 3 were seen.

(b) Were generally well answered.

(c) Were generally well answered.

(d) (i) Were generally well answered.

(ii) A common incorrect answer was 2.

(e) (i) Over half of responses were correct with an answer of 28. Incorrect responses gave the calculation of the M_r as 12 × 16 = 192.

(ii) Correct answers followed the correct M_r to display the correct mathematical logic to produce the answer within the range 42-43.
Partial credit was given for errors carried forward from 1(e)(i)
e.g. 12 / 192 × 100 = 6.25% and 12 / 44 × 100 = 27.3%.
A number of students gave the correct M_r in (i) and then proceeded to work out their answer without including it.

(f) (i) The majority were able to read the y axis and get 0.9%.

(ii) The most commonly seen correct answer was accurate with a few students giving rapid or sensitivity. Common errors were references to reliability or precision or vague references to the amounts of carbon dioxide in the air.

18 It was difficult to understand why so many candidates could correctly give the numbers of each atom in NH_4C1 but were then unable to calculate its relative formula mass.

20

(a) (i) This question was a good discriminator and well answered by many students. A large proportion of students gave the correct answer of 40. The most frequent errors included 24×16 = 384, 24 + (16+16) = 56 and 24 + 16/2 = 20. Some students used 8 and 12 as the atomic masses of the elements ignoring the information in the question stem.

(ii) Credit was allowed for error carried forward from part(i). Only the more able students scored credit. Many students simply subtracted the relative atomic masses or divided the sum of the relative atomic masses by 2. Evidence of 24/40 scored 1 mark but 16/24 and 16/40 were commonly seen.

(iii) A lack of thought was evident in this part of the question. Many answers resulted in the mass of magnesium needed to make 25g of magnesium oxide being greater than 25g! Many students did not attempt this part of the question.

(b) (i) A good discriminating question. Many answers were vague and students wrote at length without the required detail. Common examples were ‘experiment was done wrong’,‘equipment was faulty’ and‘incorrect measurement’. The majority of students scored credit for stating that the lid was lifted too long or that magnesium oxide escaped. The idea that the magnesium had not fully reacted/had not been heated long enough was realised by fewer students. Few students correctly gained a mark for specifically mentioning a weighing error for the magnesium or the magnesium oxide. Vague answers such as‘not enough magnesium used’ were common.

(ii) There were frequent references to human, random and systematic errors, which received no credit. A large number of students gained credit for improving the reliability although there was often confusion between reliability and accuracy. Many answers included the idea of checking if the first result was anomalous but the wording was often vague and credit was not awarded for the simple idea of checking for errors. A minority of students gained credit for calculating an average or mean.

21

This question was generally quite well done though some, mainly weaker, candidates applied the subscripted “2” only to the H or multiplied rather than added the relative atomic masses.

22

Foundation Tier

These were standard demand questions which aimed to differentiate between grades C and D. Perhaps not surprisingly, a significant number of candidates, between 10% and 20%, did not attempt some parts of these questions. All parts were, however, successfully completed by many candidates and the questions differentiated successfully between the higher grades on this paper.

A large number of the candidates gained both marks for this calculation in part (a). A number of candidates ignored the formula and simply added 19 + 119 and reached the answer 138. This was awarded one mark since they had shown some understanding of the method of calculation. Some candidates had little understanding of chemical formulae. Answers such as, $(19^2 + 119)$, $(19 + 119)^2$ and $(119^2 + 19)$, were all seen.

Part (b) was not well answered and was only completed by the more able candidates. A number of candidates struggled with long calculations due to lack of a calculator while others did not understand how to calculate a percentage. Candidates were allowed to use an incorrect answer from part (a) in calculating part (b) and could gain both marks if it was calculated correctly. Common errors were (19/157 × 100) or (19/138 × 100). Either of these calculations correctly evaluated was awarded one mark since the candidate understood the principle of the method.

F tier candidates found part (c) very difficult. Candidates should be encouraged to look carefully at an answer, once they have completed a calculation, to ensure that it is sensible. A number of candidates gave answers which were greater than 1.2 g! Candidates could gain this mark using an incorrect answer from part (b) provided that it was correctly calculated.

Part (d) was answered correctly by a good proportion of the candidates. One mark was for identifying that the formation of the ion was something to do with electrons and the second mark was for the idea that an electron is gained. A number of candidates lost the second mark because they thought that an electron is shared or lost. A few candidates thought that the ion is formed by losing a proton.

Higher Tier

The majority of the candidates gained both marks for this calculation in part (a). A number of candidates ignored the formula and simply added 19 + 119 and reached the answer 138. This was awarded one mark since they had shown some understanding of the method of calculation. Some candidates had little understanding of chemical formulae. Answers such as, $(19^2 + 119)$, $(19 + 119)^2$ and $(119^2 + 19)$, were all seen.

Part (b) was less well answered than part (a) and the number of correct responses seemed slightly lower than for similar questions on previous examinations. A number of candidates struggled with long calculations due to lack of a calculator while others did not understand how to calculate a percentage. Candidates were allowed to use an incorrect answer from part (a) in calculating part (b) and could gain both marks if it was calculated correctly. Common errors were (19/157 × 100) or (19/138 × 100). Either of these calculations correctly evaluated was awarded one mark since the candidate understood the principle of the method.

Candidates should be encouraged to look carefully at an answer, once they have completed a calculation, to ensure that it is sensible. A number of candidates gave answers which were greater than 1.2 g in part (c). Candidates could gain this mark using an incorrect answer from part (b) provided that it was correctly calculated.

Part (d) was answered correctly by most of the candidates. One mark was for identifying that the formation of the ion was something to do with electrons and the second mark was for the idea that an electron is gained. A number of candidates lost the second mark because they thought that an electron is shared or lost. A few candidates thought that the ion is formed by losing a proton.

23

Foundation Tier

Part (a) was well answered by many of the candidates. Some candidates did not understand the chemical formula and gave 56 + 32 + 16 = 104. A small number of candidates multiplied the relative atomic masses.

Part (b) was poorly answered with many of the candidates making no attempt. Candidates were allowed to carry forward an error from part (a). Examiners simply looked for the candidate’s answer to part (a) in grams.

In part (c) very few candidates were able to work out the calculation and many made no attempt. A number of them gave 152 multiplied by 28 and gained an answer of 4256.

Higher Tier

Part (a) gave an easy start to the paper for the majority of the candidates. Some candidates did not understand the chemical formula and gave 56 + 32 + 16 = 104. A small number of candidates multiplied the relative atomic masses.

Part (b) was less well answered with only about half of the candidates gaining the mark.

Candidates were allowed to carry forward an error from part (a). Examiners simply looked for the candidate’s answer to part (a) in grams.

Many of the candidates in part (c) were unable to work out this simple calculation. A number of them gave 152 multiplied by 28 and gained an answer of 4256.

24

Foundation Tier

Several candidates did not attempt the calculations. Many of those who achieved marks in steps 1 and 2 were often unable to calculate the percentage of iron in the iron oxide.

Higher Tier

The calculations were usually correct.