Mark schemes

(a) s

Answers must be in the correct order.

(b) A gas was lost from the flask

(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.

(d) Total mass of reactants = 221.5
allow ecf from step 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

(a) electrons transferred from potassium to sulfur

two potassium atoms each lose one electron

forming K\(^+\) / 1\(^+\) ions

sulfur atoms gain 2 electrons

forming S\(^2-\) / 2\(^-\) ions

(b) there are no gaps / sticks between the potassium ions and sulfide ions

(c) (two) shared pairs between H and S

rest correct - no additional hydrogen electrons and two non-bonding pairs on sulfur

second mark dependent on first

(d) 342
(e) Property Explanation of property

- Low melting point
  - Electrons are free to move
  - There are no charged particles free to move

- Does not conduct electricity when molten
  - Ions are free to move
  - Weak intermolecular forces of attraction
  - Bonds are weak
  - Bonds are strong

more than one line drawn from a variable negates the mark

(f) Property Explanation of property

- High boiling point
  - Electrons are free to move
  - There are no charged particles free to move

- Conduct electricity when molten
  - Ions are free to move
  - Weak intermolecular forces of attraction
  - Bonds are weak
  - Bonds are strong

more than one line drawn from a variable negates the mark

(a) add excess copper carbonate (to dilute hydrochloric acid)
   accept alternatives to excess, such as ‘until no more reacts’

filter (to remove excess copper carbonate)
   reject heat until dry

allow 1 mark for evidence of \((2 \times 27) + 3[32 + (16 \times 4)]\)
heat filtrate to evaporate some water or heat to point of crystallisation
accept leave to evaporate or leave in evaporating basin

leave to cool (so crystals form)
until crystals form
must be in correct order to gain 4 marks

(b) \[ M_r\ CuCl_2 = 134.5 \]
correct answer scores 4 marks

moles copper chloride = (mass / \( M_r = 11 / 134.5 \)) = 0.0817843866

\[ M_r\ CuCO_3 = 123.5 \]

Mass CuCO_3 (=moles \times M_2 = 0.08178 \times 123.5) = 10.1(00)
accept 10.1 with no working shown for 4 marks

(c) \[ \frac{79.1}{100} \times 11.0 \]

or

11.0 \times 0.791

8.70 (g)
accept 8.70(g) with no working shown for 2 marks

(d) Total mass of reactants = 152.5

134.5

152.5
allow ecf from step 1

88.20 (%)
allow 88.20 with no working shown for 3 marks

(e) atom economy using carbonate lower because an additional product is made or carbon
dioxide is made as well
allow ecf
(a) (delivery) tube sticks into the acid

the acid would go into the water or the acid would leave the flask or go up the delivery tube

*ignore no gas collected*

(b) any one from:

- bung not put in firmly / properly
- gas lost before bung put in
- leak from tube

(c) all of the acid has reacted

(d) take more readings in range 0.34 g to 0.54 g

*take more readings is insufficient*

*ignore repeat*

(e) \[ \frac{95}{24000} \]

0.00396

or

\[ 3.96 \times 10^{-3} \]

*accept 0.00396 or 3.96 \times 10^{-3} with no working shown for 2 marks*

(f) use a pipette / burette to measure the acid

because it is more accurate volume than a measuring cylinder

or

greater precision than a measuring cylinder

or

use a gas syringe to collect the gas

so it will not dissolve in water

or

use a flask with a divider

*accept description of tube suspended inside flask*

so no gas escapes when bung removed

(g) they should be collected because carbon dioxide is left in flask at end
and it has the same volume as the air collected / displaced

(a) (sulfuric acid is) completely / fully ionised

In aqueous solution or when dissolved in water

(b) \( H^+(aq) + OH^-(aq) \rightarrow H_2O(l) \)

\[ \text{allow multiples} \]
\[ 1 \text{ mark for equation} \]
\[ 1 \text{ mark for state symbols} \]

(c) adds indicator, eg phenolphthalein / methyl orange / litmus added to the sodium hydroxide (in the conical flask)

\[ \text{do not accept universal indicator} \]

(adds the acid from a) burette

with swirling or dropwise towards the end point or until the indicator just changes colour

until the indicator changes from pink to colourless (for phenolphthalein) or yellow to red (for methyl orange) or blue to red (for litmus)

(d) titrations 3, 4 and 5

\[ \text{or} \]
\[ \frac{27.05 + 27.15 + 27.15}{3} \]

27.12 cm\(^3\)

\[ \text{accept 27.12 with no working shown for 2 marks} \]

\[ \text{allow 27.1166 with no working shown for 2 marks} \]

(e) Moles \( H_2SO_4 \) = conc \times vol = 0.00271

\[ \text{allow ecf from 8.4} \]

Ratio \( H_2SO_4:NaOH \) is 1:2

\[ \text{or} \]
\[ \text{Moles NaOH} = \text{Moles} \ H_2SO_4 \times 2 = 0.00542 \]

Concentration NaOH = mol / vol = 0.00542 / 0.025 = 0.2168
0.217 (mol / dm$^3$)

accept 0.217 with no working for 4 marks

accept 0.2168 with no working for 3 marks

(f) \( \frac{20}{1000} \times 0.18 = \text{no of moles} \)

or

0.15 \times 40 \text{ g}

0.144 (g)

accept 0.144g with no working for 2 marks

\[ \text{(a) } N_2 + 3 H_2 \rightarrow 2 NH_3 \]

(b) catalyst

(c) as pressure increases percentage yield increases

(d) 32–23

both readings correct

= 9 (\%)
(d) a gas is produced

which escapes from the flask

(e) \[
\frac{9.85}{150} = 0.0656
\]

0.07 (g / s)

allow ecf answer correctly calculated to 2 decimal places

(f) collect the gas in a gas syringe

measured the volume of gas

allow carbon dioxide for gas

allow for 1 mark

collected gas

or

counted bubbles

(g) The particles have more energy

The particles move faster

(a) because it is a good conductor of electricity.

(b) (i) 2.1 (%)

(ii) correct bar for calcium at 3.6 %

allow error of +/- 0.05%

correct bar for iron at 5.0 %

allow error of +/- 0.05%

(c) (i) decomposition

(ii) carbon dioxide

(iii) carbon = 1

allow one
(iv) 44 (g)

allow forty four

(d) (i) to make alloys for specific uses.

(ii) any three from:
- to conserve resources of iron or iron ore
  allow steel instead of iron or iron ore
  allow limited resource or non-renewable
- to avoid the need for quarrying/mining
- to conserve energy resources or fossil fuels
- to limit the amount of carbon dioxide produced or to reduce global warming
- to reduce the amount of landfill

“it” = steel

ignore cost and reuse and time and waste

(a) (i) (thermal) decomposition

allow decomposes or endothermic

(ii) copper oxide

(b) (i) the (potassium) carbonate did not decompose/change/react (when heated)

allow temperature not high enough

do not allow potassium did not decompose

ignore references to reactivity

the mass did not change or the limewater did not go cloudy

because no carbon dioxide produced

(ii) the less reactive the metal the more (easily) its carbonate will decompose/react or vice versa

needs to be a relative comparison

allow max 1 mark where the distinction between a metal and its carbonate is not clear

allow 1 mark for carbonates of reactive metals do not decompose or vice versa
(c)  
(i) make it economical (to extract the metal/iron)  
   *allow make it worth extracting*  
   *allow so they can make money/profit*  
   1

(ii) Fe  
   balanced correctly (2,3,4,3)  
   *not ecf*  
   *allow correct balanced equation but with 2Fe₂ on right for one mark*  
   1

(iii) iron from the blast furnace is brittle  
   steel produced is strong / flexible  
   *allow steel has more/specific uses*  
   *allow steel is rust-resistant*  
   “it” = iron  
   1

(iv) (recycling) is used to conserve iron (ore) or energy or resources or minimise pollution or reduce the need to quarry  
   *allow reverse arguments.*  
   1

   (not reuse) because of damage, paint removal, rusting/corrosion, metal fatigue/weaker  
   1

   (not landfill) because sites have limited space or loss of habitats  
   *allow to reduce the use of landfill*  
   1

10

Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also apply a ‘best-fit’ approach to the marking.

**Level 3 (5 – 6 marks)**  
There is a description of titrations that would allow a comparison to be made between the two solutions of hydrochloric acid.

**Level 2 (3 – 4 marks)**  
There is a description of an experimental method including addition of acid to alkali which may include an indicator or colour change and may include a measurement of volume.

**Level 1 (1 – 2 marks)**  
There is a simple description of using some of the apparatus.

0 marks  
No relevant content.
examples of chemistry points made in the response could include:
- acid in burette or flask
- alkali/sodium hydroxide or acid in burette or flask
- volume of acid or alkali measured using the pipette
- indicator in flask
- white tile under the flask
- slow addition
- swirling/mixing
- colour change of indicator
- burette volume measured

(a) (i) natural gas
   allow fossil fuels / biogas generator

(ii) air contains oxygen

this would react with / oxidise the hydrogen
   allow this would react with / oxidise the iron
   ignore nitrogen

(iii) cooled

ammonia condenses / liquefies (so can be separated)

nitrogen and hydrogen (remain as gases and) are returned to the reactor
   allow recycled

(b) (i) 200 °C and 1000 atmospheres

(ii) the reaction is reversible
   allow stated as equilibrium or forward / backward reaction anywhere in answer

forward reaction is exothermic so increased temperature lowers the yield of ammonia
   allow converse

a lower temperature would decrease rate of reaction
   allow converse

a higher pressure would increase the yield of ammonia because the forward reaction produces the least number of (gaseous) molecules / moles
   allow converse
higher pressures would involve high cost / energy

ignore risk / explosion