



## Mark schemes

<b>1</b>	(a) Air	2
	Steel	1
	(b)	
	Allow <b>1</b> mark for the correct meanings linked to context but incorrect way around	1
	(c) Damp litmus paper turns white	1
	(d) Iron(III)	1
		<b>[6]</b>
<b>2</b>	(a) 50	1
	(b) 5%	1
	(c) any <b>two</b> from:	
	<ul style="list-style-type: none"> <li>• cost (9 carat is cheaper)</li> <li>• pure gold is soft</li> <li><b>or</b></li> <li>24 carat gold is soft</li> <li><b>or</b></li> <li>9 carat gold is harder</li> <li><i>allow 9 carat gold is stronger</i></li> <li><i>allow gold is an alloy in 9 carat gold</i></li> <li>• can change the colour</li> </ul>	2
		<b>[4]</b>
<b>3</b>	(a) $\text{N}_2 + 3 \text{H}_2 \rightarrow 2 \text{NH}_3$	1

- (b) catalyst 1
- (c) as pressure increases percentage yield increases 1
- (d) 32–23  
*both readings correct* 1
- = 9 (%) 1

[5]

4

- (a) filtration  
**or**  
 by passing through filter beds to remove solids 1
- sterilisation to kill microbes  
*allow chlorine / ozone allow ultraviolet light* 1
- (b) water needs more / different processes 1
- because it contains any **two** from:  
 • more organic matter  
 • more microbes  
 • toxic chemicals or detergents 2
- (c) *(as part of glassware attached to bung)*  
 salt solution in (conical) flask  
*allow suitable alternative equipment, eg boiling tube* 1
- (at end of delivery tube)*  
 pure water in test tube which must not be sealed  
*allow suitable alternative equipment, eg, beaker, condenser* 1
- heat source (to heat container holding salt solution) 1
- if no other mark obtained allow for 1 mark suitable equipment drawn as part of glassware attached to bung **and** at end of delivery tube*
- (d) determine boiling point 1
- should be at a fixed temperature 100°C  
*allow should be 100°C*  
*allow if impure will boil at a temperature over 100°C* 1

(e) high energy requirement

1  
[11]

5

(a)  $1 \times 10^{-2}$  g

1

(b)  $\frac{0.46}{8.45} \times 100$

1

(test tube 1) 5.44 %

**and**

(test tube 2) 0.854 %

1

4.586

1

4.59

1

*allow ecf answer correctly calculated to 3 significant figures*

*allow 4.59 with no working for 4 marks*

*allow 4.586 with no working for 3 marks*

(c) **Level 3 (5–6 marks):**

Detailed and coherent conclusions based on the evidence together with an evaluation are given in a response that is coherent and well-structured. A range of relevant points is made demonstrating a broad understanding of the key scientific ideas.

**Level 2 (3–4 marks):**

An attempt to relate relevant points and draw conclusions or to make an evaluation. The logic may be inconsistent at times but builds towards a coherent argument.

**Level 1 (1–2 marks):**

Simple descriptive statements are made. The logic may be unclear and any conclusions, if present, may not be consistent with the reasoning.

**0 marks:**

No relevant content.

**Indicative content**

Simple statements

- nail rusted in test tubes 1 and 5
- test tubes 1 and 4 contained air / oxygen and water
- nail did not rust in test tubes 2, 3 and 4
- test tube 2 no water present
- test tube 3 no air / oxygen present
- test tube 4 paint stopped rusting
- test tube 6 scratched galvanised iron did not rust
- test tube 6 galvanising stopped rusting

Conclusions

- both water and oxygen are required for rusting
- coatings that prevent water and oxygen reaching the metal prevent rusting
- when paint is scratched, iron comes into contact with water and oxygen and the iron rusts
- in test tube 5 less iron exposed so less rusting than in test tube 1
- galvanising is better at resisting rusting than paint when scratched
- zinc is more reactive than iron, so when galvanised metal is scratched, zinc reacts with water and oxygen first / sacrificially

Evaluation

- oil and paint are effective at preventing rusting when the coating is intact
- galvanising is the most effective coating because it prevents rusting even when scratched.

- (d) iron + oxygen + water  
*all three needed for 2 marks*  
*2 correct = 1 mark*  
*ignore air*

2  
**[13]**

- 6** (a) all points correct  
*±1 small square*  
*allow 1 mark for 6 or 7 plots*

2

Year	Percentage (%) of bottles made from other materials
1975	5
1980	10
1985	22
1990	42
1995	70
2000	72
2005	90
2010	95

1

**(b) Level 3 (5–6 marks):**

A detailed and coherent argument is provided which considers a range of issues and comes to a conclusion consistent with the reasoning.

**Level 2 (3–4 marks):**

An attempt to describe the advantages and disadvantages of the production and uses is made, which comes to a conclusion. The logic may be inconsistent at times but builds towards a coherent argument.

**Level 1 (1–2 marks):**

Simple statements made. The logic may be unclear and the conclusion, if present, may not be consistent with the reasoning.

**0 marks:**

No relevant content.

**Indicative content**

- glass – 2 stages in production of soda-lime glass
- glass – second stage, heating sand, limestone and sodium carbonate
- HDPE – 3 stages in production
- HDPE – second stage, cracking of naphtha to obtain ethene
- HDPE – third stage, polymerisation of ethene
- fewer stages in glass production, may be quicker
- higher temperature in glass manufacture, therefore maybe higher energy requirement
- glass bottle can be reused
- consideration of collection / cleaning costs to reuse glass bottles
- other glass products can be made from recycled glass
- plastic has greater range of sizes
- both produced from limited raw materials
- higher percentage recycled materials in glass conserves raw materials

This indicative content is not exhaustive, other creditworthy responses should be awarded marks as appropriate.

6

[9]

7

(a) ammonia **and** nitric acid

*allow NH<sub>4</sub>OH*

*allow NH<sub>3</sub>(aq)*

1

(b) shows fertilisers are formulations

*allow gives percentage / proportion of nitrogen, phosphorus and potassium in the fertiliser*

1

(so) farmers can choose fertiliser with required properties

1

(c) as world population increases, ammonia production increases

1

ammonia is used to produce fertilisers

1

so increasing need for fertilisers as more food required for increased population

*allow as more food produced less mortality*

1

[6]

8

(a) (i) Filtration

1

(ii) Chlorine

1

(b) (i) nanoparticles are small / smaller / much smaller / tiny

*allow any in range 1–100 nm or  $1 \times 10^{-9} \text{ m} - 1 \times 10^{-7} \text{ m}$  **or** a few hundred atoms in size*

*ignore numbers if stated smaller*

1

(ii) they have a high surface area to volume ratio

*reference to surface area without volume ratio is insufficient*

*allow nanoparticles are very reactive **or** nanoparticles are more reactive than normal particles.*

1

(c) (sodium hydroxide) produces a white precipitate

*accept solid / suspension or ppt or ppte for precipitate.*

*ignore cloudy / milky*

1

which (then) dissolves / disappears (in excess sodium hydroxide)

*M2 cannot be awarded unless a solid of some sort has been made*

*ignore names or formulae of compounds*

1

[6]

9

(a) because sulfur dioxide causes acid rain

1

which kills fish / aquatic life **or** dissolves / damages statues / stonework **or** kills / stunts growth of trees

*if no other mark awarded then award 1 mark for sulfur dioxide is toxic or causes breathing difficulties.*

1



(b) (i) electrons are lost

1

(ii)  $\text{Cu}^{2+} + 2\text{e}^{-} \rightarrow \text{Cu}$

*allow  $\text{Cu}^{2+} \rightarrow \text{Cu} - 2\text{e}^{-}$*

*ignore state symbols*

1

(iii) copper sulfate

*allow any ionic copper compound*

1

(c) (lattice of) positive ions

1

delocalised electrons

*accept sea of electrons*

1

(electrostatic) attraction between the positive ions and the electrons

1

electrons can move through the metal / structure **or** can flow

*allow electrons can carry charge through the metal / structure*

*if wrong bonding named or described or attraction between*

*oppositely charged ions then do not award M1 or M3 – MAX 2*

1

(d) (copper compounds are absorbed / taken up by) plants

*allow crops*

1

which are burned

1

the ash contains the copper compounds

*do not award M3 if the ash contains copper (metal)*

1

(e)

/ $A_r$	55.6 / 63.5	16.4 / 56	28.0 / 32
moles	0.876	0.293	0.875
ratio	3	1	3
formula	$\text{Cu}_3\text{FeS}_3$		

award **4** marks for  $\text{Cu}_3\text{FeS}_3$  with some correct working

award **3** marks for  $\text{Cu}_3\text{FeS}_3$  with **no** working

if the answer is not  $\text{Cu}_3\text{FeS}_3$  award up to **3** marks for correct steps from the table apply ecf

if the student has inverted the fractions award **3** marks for an answer of  $\text{CuFe}_3\text{S}$

4  
[16]

10

(a) gold

1

(b) atom (s)

1

(c) (i) protons

*any order*

*allow proton*

1

neutrons

*allow neutron*

1

(ii) 3 / three

1

(d) (i) Al

*ignore any numbers / charges*

1

(ii) any **two** from:

- limited resource
- expensive in terms of energy / mining
- effects on the environment, such as, landfill, atmospheric pollution, quarrying

*allow uses a lot of energy to extract.*

2

(e) resistant to corrosion

1

does not react (with water or food)

*allow **one** mark for low density with a suitable reason given*

1

[10]

11

(a) (i) central block

1

(ii) conducts electricity

1

- (b) any **two** from:
- visual pollution
  - noise pollution
  - dust pollution
  - habitat destruction.
- 2
- (c) (i) to concentrate the ore / copper carbonate  
**or**  
to remove / separate the rock
- 1
- (ii) 12 (tonnes)
- If answer is incorrect allow one mark for  $(127 + 132) - 247$  or  $259 - 247$*
- 2
- (iii) any **one** from:
- so no reactant is wasted / left unreacted
  - so they know how much product they will make
  - need to record / compensate for the carbon dioxide produced
- allow so they can work out their carbon footprint.*
- 1

**[8]****12**

- (a) The ore is not pure or contains impurities or the ore does not contain 100% of the metal compound
- allow to concentrate the metal or metal compound*
- 1
- rock / other compounds need to be removed / separated
- 1
- (b) (i) (cast iron is) brittle
- allow not strong*
- ignore weak*
- 1
- (ii) the oxygen reacts with carbon
- allow carbon burns in oxygen or is oxidised*
- 1
- reducing the percentage of carbon in the mixture  
**or** producing carbon dioxide
- 1
- (c) (i) aluminium has a low density
- 1
- (ii) (because copper) is in the central / middle (block of the periodic table)
- 1
- whereas aluminium is in Group 3 (of the periodic table)
- 1

(iii) iron is more reactive (than copper)

*ignore cost*

1

so copper is displaced / reduced

1

[10]

13

(a) sodium loses (electron)

*sharing / covalent / metallic = max 2*

1

chlorine gains (electron)

1

1 **or** an (electron)

1

(b) (i) Have no overall electric charge

1

(ii) Should iodine be added to salt?

1

reason

any **one** from:

- cannot be done by experiment  
*accept difficult to get / not enough evidence*
- based on opinion / view  
*allow must be done by survey*
- ethical **or** economic issue.

1

(c) (i) nitric (acid)

1

(ii) an alkali

1

(iii) indicator

*accept any named acid base indicator*

1

(d) (i) Crystallisation

1

(ii) fertiliser

*allow to help crops grow*

1

(iii) any **one** from:

- pressure  
*allow concentration*
- temperature  
*ignore heat*
- catalyst.

1

**[12]****14**

(a) giant structure / lattice / layers / close packed

*first 3 marks can be obtained from a suitably labelled diagram*

*incorrect structure or bonding or particle = max 3*

1

made up of atoms / positive ions

1

with delocalized / free electrons

1

so electrons can move / flow through the metal

*accept so electrons can carry charge through the metal*

*accept so electrons can form a current*

1

(b) an alloy (is a metal which) has different types / sizes of atoms

*accept converse for pure metal throughout*

*both marks can be obtained from suitable diagrams*

*allow made of different metals*

*allow mixture of metals / atoms / elements*

*ignore particles*

*ignore properties*

*do **not** accept compound*

1

alloy has distorted layers

*allow layers are unable to slide*

1

- (c) (i) can return to its original shape  
*accept shape memory alloy*  
*accept smart alloy*  
*ignore other properties* 1
- (ii) (pure copper is too) soft  
*accept converse*  
*accept malleable or bends*  
*accept copper is running out*  
*ignore references to strength and weakness* 1
- (iii) aluminium oxide  
*accept alumina*  
*accept  $Al_2O_3$*   
*ignore bauxite / aluminium ore* 1
- (iv) any **one** from:  
  - different conditions
  - different catalyst
  - different pressure*allow different concentration*  
  - different temperature.*do **not** accept different monomers* 1
- (d) any **two** from:  
  - accurate
  - sensitive
  - rapid
  - small sample.*both needed for 1 mark* 1
- 15** (a) (i) Solids 1
- (ii) Chlorine 1
- (iii) kill microbes / bacteria  
*allow to make the water safe to drink*  
*ignore disinfect*  
*ignore remove / get rid of microbes* 1
- [11]**

(b) energy

*allow heat*

1

(c) improve dental health

*allow reduce tooth decay*

*allow (local) government requirement*

*allow help teeth*

1

[5]

16

(a) natural gas

*allow correct answer shown in box if answer line blank*

1

(b) (i) 450

*allow correct answer shown in box if answer line blank*

1

(ii) iron

*allow correct answer shown in box if answer line blank*

1

(iii) The catalyst lowers the activation energy.

1

(c) (the gases are) cooled

1

ammonia condenses

*allow ammonia liquefies*

1

nitrogen and hydrogen are recycled

*if no other mark awarded allow ammonia is separated for 1 mark*

1

[7]

17

(a) (i) nothing can enter **and** nothing can leave the reaction

*allow sealed reaction vessel*

1

(ii) forward and backward reactions have same rate

1

so there is no (overall) change in quantities of reactants and products

*allow concentrations of reactants and products*

1

(b) (i) natural gas

*allow methane / CH<sub>4</sub>*

*allow fossil fuels / hydrocarbons*

*allow water*

1

- (ii) provides an alternative reaction pathway  
which has a lower activation energy  
*ignore references to collisions* 1
- (iii) the amount (of ammonia) increases  
*allow yield increases* 1
- the equilibrium moves to the side (of the equation) with fewer (gaseous) molecules / moles  
*allow it favours the forward reaction* 1
- (c) (i) vertical arrow from reactants to maximum 1
- (ii) (energy of) products higher than (energy of) reactants  
*allow converse* 1
- (iii) amount of hydrogen iodide decreases 1
- equilibrium moves in the direction of the endothermic reaction  
*allow it favours the forward reaction* 1

[12]

18

- (a) (i) Solids 1
- (ii) Chlorine 1
- (iii) improves dental health **or** reduces tooth decay 1
- (b) put a sample of the filtered water in an evaporating basin **or** leave to evaporate  
*accept any description of evaporation (using a Bunsen or leaving on the windowsill)* 1
- there will be crystals of salt left 1
- (c) sodium and / or chloride ions are bigger than water (molecules) **or** ions are charged  
**or** molecules are not charged  
*do **not** accept sodium chloride molecules as ions is given in the question* 1

[6]



19

- (a) (i) brown 1
- (ii) oxygen + iron + water  $\longrightarrow$  hydrated iron oxide / rust  
*allow correct symbol equation*  
*ignore oxidation numbers for product* 1
- (b) (i) 32.3 1
- (ii) 7.6  
*ecf from (b)(i)* 1
- (iii) do not know start volume of air 1
- because the burette not graduated to the end  
*allow iron wool takes up some of the space*  
*if no other marks awarded accept all iron may have rusted (1) or*  
*still some oxygen left / not all used up (1)* 1
- (c) (i) gains oxygen and water **or** oxygen and water are added  
*allow reacts with or gains oxygen*  
*allow reacts with or gains water*  
*allow reacts with or gains elements which add to mass*  
*ignore iron oxide forms* 1
- (ii) as temperature increases (from 10 °C to 42 °C or to 50 °C) the increase in mass of nail increases  
*accept positive correlation*  
*accept mass increases* 1
- rate of increase gets faster as temperature goes up  
*accept exponential*  
*ignore non linear* 1
- no further increase at temperatures over 42 °C  
*accept no further increase at high temperatures*  
*exponential increase scores 2 marks* 1
- (iii) use a (bigger) flask **or** let air into the tube **or** leave for less time **or**  
*ignore more water* 1

to make sure sufficient oxygen / air **or** not all oxygen used up

*accept converse*

*if no other marks awarded allow change in surface area for rusting*

**or** change in number of nails for **1** mark

1

**[12]****20**

(a) pure copper is twice as good a conductor as 99% pure copper

*accept reverse argument*

*accept answers quoting 2 correct values from the graph scores 2*

*qualitative answer (e.g. pure copper is a better conductor than impure copper) scores 1*

**or**

*answers quoting a conductivity value from the graph scores 1*

2

- (b) Marks awarded for this answer will be determined by the Quality of Communication (QC) as well as the standard of the scientific response.

**0 marks**

No relevant content

**Level 1 (1–2 marks)**

Simple list of a limited number of points given, with no linking between ideas

**Level 2 (3–4 marks)**

A broader set of points made. There will probably not be links between ideas

**Level 3 (5–6 marks)**

Answer includes linking between ideas, showing the consequence of either not recycling or the advantage of recycling. Answers such as less fossil fuel needed so less carbon dioxide produced **or** less carbon dioxide produced so less global warming

**examples of the points made in the response**

**resources**

**(recycling)** conserves supplies of ores  
copper available for longer

as (at present rate of use) copper ores will run out in about 35 years

**(recycling)** conserves supplies of fossil fuels **or** energy  
less fuel used at a lower cost

**land pollution**

mining scars landscape **or** produces noise pollution  
mining destroys wildlife habitats

**(recycling)** less need to mine ores / fossil fuels  
*so less habitat destroyed or less scarring of landscape*

**(recycling)** less need to use landfill for waste

**atmospheric pollution**

burning fossil fuels produces carbon dioxide / greenhouse gas  
which (may) cause global warming **or** climate change

extraction produces sulfur dioxide  
which causes acid rain  
which can kill trees / fish

6

- (c) grow plants

*accept plants absorb copper (through roots)*

1

then plants are burned

1

ash (from burning) contains copper compounds

1

[11]

- (a) (i) economical

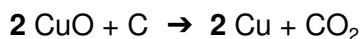
1

- (ii) phytomining 1
- (iii) carbon dioxide 1
- (b) (i) copper / Cu 1
- iron sulfate /  $\text{FeSO}_4$  1
- (ii) copper / ions have a positive charge  
*it = copper ions*  
*allow copper ions have a different charge*  
*accept copper / ions are free to move*  
*accept to gain electrons*  
*accept copper / ions are attracted to the negative electrode **or***  
*opposite charges attract* 1
- (c) any **two** from:  
*ignore not biodegradable or does not decay*
- copper ores are limited / running out  
*allow copper is running out*
  - copper can be recycled
  - copper can be reused
  - copper is expensive
  - landfill sites are filling up
  - copper compounds are toxic  
*allow copper is toxic*

2

**[8]****22**

- (a) (i) phytomining 1
- (ii) *(the land contains) very little copper*  
*allow low grade ore **or** large amounts of waste*  
*ignore quarrying / benefits of using plants* 1
- uneconomical  
*accept (smelting) uses a lot of energy / fossil fuels*  
*allow expensive* 1
- (iii) Cu 1



*allow 2 CuO + C → Cu<sub>2</sub> + CO<sub>2</sub> for 1 mark*

1

- (b) (i) iron is more reactive (than copper)

1

iron is cheap(er than copper)

*allow cheaper **or** uses less energy than electrolysis*

1

- (ii) any **two** from:

- copper / ions move **or** are attracted to the negative electrode / *cathode*
- where they are reduced **or** gain (two) electrons
- *where they form copper (metal / atoms)*

2

**[9]****23**

- (a) alloy

1

- (b) in mixture:

*different sized / bigger atoms*

1

*so there are no layers / rows / lines (to slide)*

*accept converse*

1

- (c) any **two** from:

*ignore references to bend and mould*

- cost
- toxicity
- strength
- *appearance of brace*
- *unreactive **or** resistant to corrosion / saliva*

*allow rusting as alternative to corrosion*

2

- (d) crosslinks

*allow lines / bonds between the rows / chains*

1

**[6]**

24

(a) filter

1

to remove solids **or** *insoluble particles***OR***add coagulant (1)*

flocculation / settling / remove solids (1)

1

(add) chlorine

*accept ozone / UV*

1

to reduce the number of microbes

*accept to kill microbes / bacteria / germs**accept sterilise**allow disinfect**ignore remove microbes*

1

(b) (i) ion exchange resin

*allow ion exchange column**allow sodium ions / Na<sup>+</sup>**allow hydrogen ions / H<sup>+</sup>*

1

(ii) prevent growth of microbes

*accept sterilise**accept to kill microbes / bacteria / germs**accept to reduce the number of microbes**ignore remove microbes*

1

(c) high cost of energy / *heating**allow uses a lot of energy*

1

(d) any **one** from:

- helps to develop / maintain bones

*allow any suitable positive effect on bones*

- helps to develop / maintain teeth

*allow any suitable positive effect on teeth*

- reduces heart disease

1

**[8]**

- 25** (a)  $2\text{NH}_3$   
*allow NH<sub>3</sub> with incorrect or missing balancing for 1 mark*  
*allow multiples* 2
- (b) (i) 200 1
- (ii) rate of reaction (too) slow  
*allow converse*  
*ignore references to yield / cost* 1
- (iii) 400 1
- (iv) lower yield  
*allow converse*  
*accept shifts equilibrium to left*  
*allow favours the backward reaction*  
*allow favours side with more (gaseous) molecules*  
*allow lower rate* 1
- (c) (gases) cooled  
*it = ammonia* 1
- ammonia liquefied*  
*accept ammonia condensed*  
*accept ammonia cooled below boiling point for 2 marks* 1
- [8]**
- 26** (a) (i) an alloy 1
- (ii) harder 1
- (b) (i) 162.5  
*correct answer with or without working gains 2 marks*  
*if no answer or incorrect answer then evidence of correct working*  
*[56 + (3x35.5)] gains 1 mark* 2

(ii) 34.46

*accept rounding from 34 - 34.5**correct answer with or without working gains 2 marks**accept ecf from (b)(i) correctly calculated for 2 marks**if no answer or incorrect answer then evidence of 56 / 162.5 or 56 / answer to (b)(i) gains**1 mark*

2

**[6]****27**

(a) (Chromium =) 20

*in correct order*

1

(Nickel =) 8

*accept Chromium = 8 and Nickel = 20 for 1 mark*

1

(b) (i) (because iron is made up of only) one type of atom

1

(ii) not strong

*allow too soft or too flexible**accept it rusts / corrodes or that it could wear away**accept could change shape / bend**accept layers / atoms could slide (over each other)*

1

(iii) structure is different / distorted / disrupted

*accept not in layers or not regular*

1

so it is difficult for layers / atoms / particles to slip / slide (over each other)

*accept layers cannot slip / slide*

1

**[6]****28**

(a) (i) many ethene / molecules / monomers

*accept double bonds open / break**accept addition polymerisation*

1

join to form a long hydrocarbon / chain / large molecule

*ignore references to ethane**correct equation gains 2 marks*

1

(ii) (can be deformed but) return to their original shape (when heated or cooled)

*ignore 'it remembers its shape'*

1



(iii) cross links / extra bonds in PEX

*it = PEX throughout*

*accept inter-molecular bonds*

*ignore inter-molecular forces*

1

molecules / chains in PEX are held in position

*accept rigid structure*

1

molecules / chains in PEX unable to slide past each other / move

1

(b) any **four** from:

*ignore costs / sustainability / non-renewable*

- less (hydrocarbon) fuels used

*allow less energy*

- less / no electrical energy used

*allow no electrolysis*

- reduce carbon / carbon dioxide emissions

*allow less global warming*

- reduce / no pollution by sulfur dioxide / acid rain

*allow less / no transportation*

- continuous process

- conserve copper which is running out or only low-grade ores available

*allow less waste*

- reduce the amount of solid waste rock that needs to be disposed

*allow less mining*

- reduce the need to dig large holes (to extract copper ores)

4

**[10]****29**

(a) fertilisers

1

(b) air

1

(c) speeds up the reaction

*accept lowers the activation energy*

*ignore makes the reaction work*

1

(d) reversible reaction

1

(e) (i) 10

1

(ii) water

*accept H<sub>2</sub>O / hydrogen oxide*

1

[6]

30

(a) any **two** from:

- heat water / make steam / boil water **or** heat / steam used in stage 1 or from stage 3
- carbon dioxide from stage 3 used in stage 7 /to make urea
- nitrogen and / or hydrogen recycled
- ammonia and / or carbon dioxide recycled

*allow unreacted material / gas recycled from stage 5 (to 4)**allow unreacted material / gas recycled from stage 8 (to 7)**NB: if neither of the last two points are awarded unreacted material recycled = 1 mark*

2

(b) (i) increase yield

because (forward) reaction is exothermic*ignore references to rate*

1

*allow because (forward) reaction gives out heat*

1

(ii) increase yield

*ignore references to rate*

1

because more (gaseous) reactant molecules than (gaseous) product molecules*accept because greater volume on the left than the right*

1

(c) 76.9 - 77

correct answer gains 2 marks with or without working  
allow 77 **or** 76.923...

allow 76 **or** 0.77 **or** 0.76923 for 1 mark

if answer incorrect allow 1 mark for **either**

$$\frac{60}{\text{attempt at total } M_r \text{ of all reactants}} \times 100$$

**or**

$$\frac{\text{attempt at total } M_r \text{ of area}}{78} \times 100$$

2

[10]

31

(a) any **one** from:

- disposal / lack of space / does not decompose in landfill sites  
*ignore non-biodegradable alone*
- other specified problems with waste (e.g. litter **or** eyesore **or** harm to animals **or** destroys habitats)

*ignore pollution unqualified*

1

(b) (i) (from) orange

*allow red / brick red / brown / yellow*

1

(to) colourless

*allow decolourised*

*do **not** allow discoloured*

*ignore clear*

1

(ii) one carbon-carbon bond and four carbon-hydrogen bonds correctly drawn

*do **not** accept h*

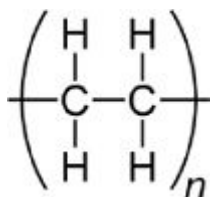
1

two trailing / connecting bonds extending beyond brackets

1

structure in bracket and n at the bottom right corner only

*do **not** accept N*



*would score 3 marks*

1

- (c) there are (covalent) bonds / links between chains **or** crosslinks  
*any mention of ionic bonds or strong intermolecular forces scores a maximum of 2 marks*  
*allow intermolecular bonds*

1

which are strong

1

so the bonds between chains cannot be (easily) overcome / broken (by heating)  
*allow bonds between chains require a lot of energy to be broken*  
*allow so molecules cannot move past each other / separate*  
*ignore converse for thermosoftening*

1

[9]

32

- (a) three bonding pairs  
*do **not** allow non-bonding electrons in hydrogen*  
*ignore any inner shells on nitrogen*

1

two non-bonding electrons

*allow either dots and crosses or combination of both*

1

- (b) (i) nitric

1

- (ii) fertilisers / explosives  
*ignore other uses*

1

- (iii) 80

*correct answer with or without working gains 2 marks*  
*if answer incorrect, allow  $14 + (1 \times 4) + 14 + (16 \times 3)$  for 1 mark*

2

- (iv) 35

*allow ecf from (b)(iii)*  
*allow ecf for 1 mark for correct working but incorrect answer.*  
*if answer incorrect, allow  $28 / 80 \times 100$  for 1 mark*  
*if answer is 17.5 % allow 1 mark*

2

- (c) Marks awarded for this answer will be determined by the Quality of Communication (QoC) as well as the standard of the scientific response. Examiners should also refer to the information on page 5, and apply a 'best-fit' approach to the marking.

**0 marks**

No relevant content

**Level 1 (1 – 2 marks)**

There are statements about the conditions used. There is no correct explanation of the link between rate or yield and the conditions.

**Level 2 (3 – 4 marks)**

There is a correct explanation of the conditions used that links the conditions to rate or yield

**Level 3 (5 – 6 marks)**

There is an explanation covering at least temperature and pressure, which shows understanding of the compromise between rate **and** yield

**examples of chemistry points made in the response:**

**200 atmospheres pressure**

- high pressure gives a high yield of ammonia
- too high a pressure causes risk of explosion
- high pressure costly to maintain
- a high pressure will cause the rate to be higher
- 4 moles of gas become 2 (or fewer moles of gas in products)

**450 °C**

- high temperature increases the rate of reaction
- optimum temperature
- (forward reaction is exothermic so) a high yield of ammonia requires a low temperature
- but too low a temperature causes the rate of reaction to be too slow

**iron catalyst**

- a catalyst speeds up the reaction
- an iron catalyst allows a lower temperature to be used (saving energy and causing a higher yield)
- iron catalyst increases the rate of reaction equally in both reactions

**others**

- compromise conditions
- unreacted nitrogen and hydrogen is recycled

6

[14]

33

- (a) (i) distillation

1

- (ii) 100 / one hundred

1

- (b) (i) measuring cylinder **or** pipette **or** burette  
*allow phonetic spelling*  
*do **not** accept teat pipette*  
*ignore any additional words or volumes* 1
- (ii) (re)heat the evaporating basin  
*accept heat to constant mass for **2** marks* 1
- weigh (again) **or** mass will not change  
*if no other mark awarded allow **1** mark for a chemical test for water* 1
- (iii) 33.2 (g)  
*correct answer with or without working scores **2** marks*  
*allow mass of residue = (24.04 g – 23.21 g) = 0.83 for **1** mark*  
*allow ecf (mass of residue × 40) for **1** mark* 2
- (c) to kill microbes / bacteria **or** to sterilise / disinfect water  
*allow to prevent disease*  
*ignore 'to make it safe to drink'* 1

- (d) Marks awarded for this answer will be determined by the Quality of Communication (QoC) as well as the standard of the scientific response. Examiners should also refer to the information on page 4, and apply a 'best-fit' approach to the marking.

**0 marks**

No relevant content

**Level 1 (1 – 2 marks)**

A simple relevant comment has been made on the data from at least one of the graphs.

**Level 2 (3 – 4 marks)**

At least two of the graphs have been considered with a relevant comment made.

**Level 3 (5 – 6 marks)**

All the graphs have been considered and relevant comments made about each. A justified conclusion may be given.

**examples of chemistry points made in the response:**

*extra information*

- (graph 1 shows) fluoride ions reduce the amount of tooth decay
- (graph 1 shows) the effect in reducing tooth decay is greatest for 55–64 year olds  
*accept any in range 55 – 64*
- (graph 2 shows) the fluoride ions reduce percentage with decayed teeth
- (graph 2 shows) effect is greatest at 2.5 to 3 mg per 1000 g of water then decay increases if more than 2.5 to 3 mg of fluoride ions per 1000 g water  
*accept any in range 2.5 – 3*
- (graph 2 shows percentage) decay decreases from 0 to 2.5 / 3 mg per 1000 g
- (graph 3 shows) more marked / brittle teeth as fluoride level increases
- above points linked together to draw a justified conclusion

6

[14]

34

- (a) any **two** from:

- copper / ores are running out / harder to find
- there are no / very small amounts of high-grade copper ores left
- copper metal is in demand
- copper is expensive
- now economical to extract copper from low-grade ores  
*it = copper*  
*allow new methods of extraction e.g. bioleaching and phytomining*  
*allow high-grade ores are running out for 2 marks*

2

- (b) (i) large amounts / 98% of rock to dispose of as waste  
*accept contains toxic (metal) compounds / bioleacher*

**or**

waste rock takes up a lot of space

1

- (ii) (copper sulfide reacts with oxygen to) produce sulfur dioxide /  $\text{SO}_2$   
*allow (sulfur reacts with oxygen to) produce sulfur dioxide /  $\text{SO}_2$*

1

that causes acid rain

*allow description of effects of acid rain **or** sulfur dioxide*

*if no other mark awarded allow  $\text{CO}_2$  produced which causes global warming **or**  $\text{CO}_2$  produced by burning fuel or heating the furnace for 1 mark*

1

- (iii) any **one** from:

- large amounts of fuels / energy used (for the furnace and electrolysis)  
*allow large amounts of electricity needed*  
*ignore high temperature / electrolysis unqualified*
- (the extraction has) many steps / stages / processes  
*allow (extraction) is a long process / takes a lot of time*
- large amounts of ore / material have to be mined  
*allow ores contain a low percentage of copper*

1

- (iv) (copper ions move towards) the negative electrode / *cathode*

1

because copper ions /  $\text{Cu}^{2+}$  are positively charged **or** are oppositely charged **or** copper ions need to gain electrons

*allow because metal ions are positive **or** opposites attract*

1

- (v) (growing) plants

1

[9]

35

- (a) (alloy) atoms / ions / particles not in layers  
*accept layers are distorted*  
*accept different (size) particles / atoms*

1

so, (alloy) layers / atoms / ions / particles can't slide

*if no other mark awarded allow (an alloy) is a mixture of metals for 1 mark*

1



- (b) diamonds have a giant covalent structure 1
- diamonds have strong bonds between carbon atoms 1
- (c) (i) a compound 1
- (ii) CH<sub>4</sub> 1
- (iii) covalent 1
- (d) methane has a low boiling point  
or boiling point less than 20°C molecules 1
- because it has small molecules  
*accept it has forces between molecules*  
*accept weak forces between molecules for 2 marks* 1

[9]

36

- (a) because atoms / ions / particles in alloy are different (sizes)  
*do not allow reference to molecules*  
*ignore reference to compounds* 1
- so layers distorted
- (and layers / atoms / ions / particles) don't slide **or** slide less easily  
*accept all marking points in a suitably labelled or annotated diagram* 1
- if no other mark awarded accept an alloy is a mixture **or** contains  
different metals / elements for 1 mark* 1
- (b) giant structure **or** lattice **or** macromolecule  
*max 3 marks if incorrect bonding* 1
- strong bonds (between carbon / atoms) 1
- covalent (bonds) 1
- each carbon / atom forms 4 bonds  
*accept tetrahedral*  
*if no other marks awarded, allow carbon (atoms) for 1 mark* 1

- (c) *reference to incorrect bonding = max 3*  
*reference to 'weak covalent bonds' = max 2*  
*allow correctly drawn diagram for first two marking points eg.*  
*(tangled) lines with no cross-links*

chains **or** large molecules  
*ignore layers*

1

with intermolecular forces **or** forces between chains  
*allow bonds for forces accept no cross-links*

1

that are weak  
*must relate to 2<sup>nd</sup> marking point*

1

and are easily overcome/ broken (when heated)  
*accept molecules / chains can flow / move*

1

**[11]****37**

(a) reversible

1

(b) catalyst

1

(c) recycled

*allow re-used*

1

(d) (Q) S R P

*allow 1 mark if one letter in correct place.*

2

**[5]****38**

(a) (i) gas

1

(ii) Increases

1

(b) (i) -1

*allow Cl<sup>-</sup>*

*allow -*

*allow negative*

1

(ii) sodium + chlorine → sodium chloride

*allow correct symbol equation*

1

- (c) reduce microbes  
*accept sterilise*  
*accept prevent diseases*  
*allow disinfect*  
*allow kill bacteria / germs / microbes / micro-organisms*  
*allow to make it safe to drink*  
*ignore get rid of bacteria*

1

- (d) any **one** from:

- no freedom of choice  
*allow unethical*
- fluoride in toothpaste
- too much can cause fluorosis  
*allow too much can cause damage to teeth*

1

[6]

39

- (a) air

1

- (b) recycle  
*allow re-use*

1

(unreacted) nitrogen and hydrogen

*allow N<sub>2</sub> and H<sub>2</sub>*

1

- (c)  $N_2 + 3H_2 \rightarrow 2NH_3$   
*allow correct multiples*

1

- (d) *allow converse arguments*  
*ignore references to compromise*

because a higher temperature would reduce (equilibrium) yield

*allow higher temperature favours backward reaction*

1

because a lower temperature would reduce rate

1

- (e) (i) (energy of) reactants greater than (energy of) products  
*allow converse*  
*allow (overall) energy decreases*  
*allow energy required to break bonds is less than the energy released making bonds*

1

(ii) line starting and finishing at same levels but with lower peak

1

[8]

40

(a) +1/+

*do not accept 1 without the +*

1

electron

*allow phonetic spelling*

1

(b) (i) elements

1

(ii) non-metal

1

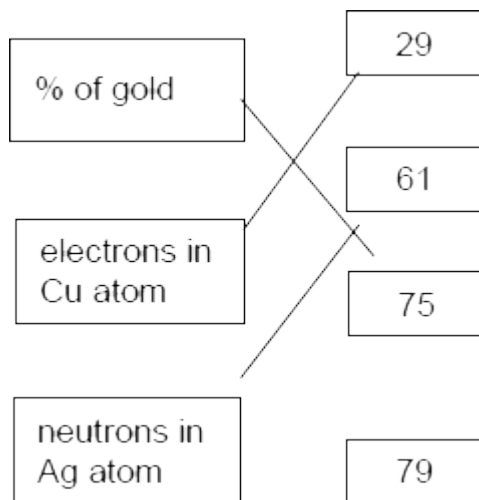
(c) soft

1

an alloy

1

(d)



**one** mark for each correct link  
*extra lines lose the mark*

3

[9]

41

(a) 2,4

*allow electrons in any position on correct shells*

1

(b) (electron) 79

1

neutron

*allow phonetic spelling*

1

118

1

(c) (i) 16 and 9

*in this order*

1

(ii) any **two** from:*ignore reasons about colour / lustre / corrosion / rarity*

- (100% / pure) gold is soft

*allow layers can slide in pure gold*

- (alloyed) to make the metal hard(er)

*ignore just 'the ring is an alloy'**allow (alloyed) to stop the layers sliding**allow (alloyed) to make the metal strong*

- gold is expensive **or** alloy is less expensive

2

[7]

42

(a) (i) reduction

*accept redox / smelting*

1

(ii) 3 4 3

1

(b) (i) 55

*ignore other units*

(ii) Water

*accept sodium hydroxide**accept correct formulae H<sub>2</sub>O or NaOH*

1

(iii) any **one** from:

- save energy / fuel for transporting the ore

*accept less (cost of) transport allow transported quickly*

- (old) quarries nearby for waste/red mud

1

(c) **Environmental**any **one** from:

- less mining / quarrying (of bauxite)  
*allow loss of habitat / less qualified noise pollution*
- less landfill space needed / used  
*allow less red mud / waste*
- less use of fossil fuels / energy
- less carbon dioxide produced

1

**Ethical or social**any **one** from:

- saves resources  
*allow using resources more than once*
- creates (local) employment  
*if answers reversed and both correct award 1 mark*
- more people aware of the need for recycling  
*allow less qualified noise pollution if not given in environmental*

1

**[7]****43**

(a) (i) 2.5(kg)

*ignore units*

1

(ii) 40% (cement) **and** Test 3*ignore units*

1

because it is anomalous or because it is much lower than the other two readings

*accept value not used to calculate mean**ignore outlier*

1

(iii) as the percentage of cement increases the mass needed to break the sleeper increases

*allow 'strength' for 'mass needed'**allow correct relationship using percentage of sand*

1

- (iv) volume/percentage / amount of water  
*accept temperature*

1

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

- availability (of the raw materials)
- cost of the raw materials
- purity (of the raw materials)

2

**[7]****44**

- (a) 2.5

*correct answer with or without working gains 2 marks*

*if answer incorrect*

*2.6 / 2.625 / 2.62 / 2.63*

*or recognise 3.0 as anomalous gains 1 mark*

*accept answer in table*

*ignore units*

2

- (b) as the percentage of cement increases the mass needed to break the sleeper increases

*allow 50% cement is the strongest or 30% sand is the strongest or the highest amount of cement is the strongest*

**or**

as the percentage of sand increases the mass needed to break the sleeper decreases

1

- (c) (i) any **two** from:

- availability of materials
- cost (of materials)
- time needed (for the concrete mixture) to set/harden
- compression strength (of the concrete)  
*accept weight of the train*
- testing full size (concrete railway sleepers)  
*accept any test on full size sleepers*  
*accept 'how well it would last / weather'*

2

- (ii) any **four** from:  
*maximum of 3 marks if no comparison made*  
*ignore yes or no*

negative concrete:

*allow converse statements for wood*

- more fossil fuel / energy / heat (needed to produce cement / concrete)
- cement / concrete resources / limestone not renewable whereas wood is renewable
- quarrying limestone destroys landscapes / habitats whereas growing wood improves landscapes / habitats

*allow quarrying causes noise pollution / dust / etc.*

- making cement / concrete releases carbon dioxide / greenhouse gases whereas growing wood absorbs carbon dioxide / greenhouse gases / is carbon neutral

*allow making cement / concrete*

*causes global warming / climate*

*change whereas growing wood*

*reduces global warming / climate change*

*ignore loss of trees / deforestation (and resultant effects such as an increase in CO<sub>2</sub>)*

positive concrete:

- (less resources are needed because) cement / concrete sleepers last longer **or** wood rots / needs replacing

*ignore strength / ease of breaking*

*ignore weathering / effects of acid rain*

4

[9]

45

- |     |      |                              |   |
|-----|------|------------------------------|---|
| (a) | (i)  | 10                           | 1 |
|     | (ii) | OH <sup>-</sup>              | 1 |
| (b) | (i)  | air                          | 1 |
|     | (ii) | particles move faster        | 1 |
|     |      | particles collide more often | 1 |



(iii) catalyst(s)

1

(c) liquid

1

[7]

46

(a) 79

1

79

1

(b) hundred

1

(c) (i) electron(s)

1

(ii) three

1

(d) changes rate of reaction

*accept lowers activation energy***or**

speeds up / slows down reaction

*accept reduces costs*

1

(e) (i) melt

1

(ii) crosslinking

*allow answers on diagram***or**

(covalent) bonds between polymers / chains

*allow bonds between layers**do **not** allow intermolecular*

1

[8]

47

(a) (i) cryolite

1

(ii) lower the melting point of the aluminium oxide

1

(b) (i) opposite charges **or** oxide ions are negative

1

attract

1

(ii) carbon

1

(iii) reacts with oxygen **or** forms carbon dioxide

*accept burns*

1

(c) **Structure mark:**

**either** Al (atoms) in layers / rows

*accept Al (atoms) all the same size*

*allow Al (atoms) in lines*

**or** alloy (atoms) not in layers / rows

*accept different sizes of atoms in alloy*

*allow alloy (atoms) not in lines*

1

**Sliding mark:**

**either** so (Al layers) can slide

**or** so (alloy) layers cannot slide

1

**[8]**

48

(a) 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.

### 0 marks

No relevant content.

### Level 1 (1-2 marks)

There is a simple description of a laboratory procedure for obtaining potassium chloride.

### Level 2 (3-4 marks)

There is a clear description of a laboratory procedure for obtaining potassium chloride from potassium hydroxide solution and hydrochloric acid that does not necessarily allow the procedure to be completed successfully by another person. The answer must include the use of an indicator or a method of obtaining crystals.

### Level 3 (5-6 marks)

There is a detailed description of a laboratory procedure for obtaining potassium chloride from potassium hydroxide solution and hydrochloric acid that can be followed by another person. The answer must include the use of an indicator and a method of obtaining crystals.

### examples of the chemistry/social points made in the response:

- One reagent in beaker (or similar)
- Add (any named) indicator
- Add other reagent
- Swirl or mix
- Add dropwise near end point
- Stop addition at change of indicator colour
- Note volume of reagent added
- Repeat without indicator, adding same volume of reagent **or** remove indicator using charcoal
- Pour solution into basin / dish
- Heat (using Bunsen burner)
- Leave to crystallise / leave for water to evaporate / boil off water

**Accept** any answers based on titration

- (b) nitric (acid)  
*allow HNO<sub>3</sub>*  
*ignore incorrect formula* 1
- (c) (i) because it is a fertiliser / helps plants grow  
*allow plant food*  
*do **not** accept pesticide / herbicide / neutralising soil* 1
- (ii) tick by: 'Should farmers stop using ammonium nitrate on their land?' 1
- any **two** from:
- cannot be done by experiment  
*accept difficult to get / not enough evidence*
  - based on opinion / view  
*allow must be done by survey*
  - ethical **or** economic issue  
*if top box ticked allow 1 mark for drinking water varies from place to place*
- 2 [11]

49

- (a) causes dust pollution 1
- increases traffic 1
- (b) (i) it is soft  
*accept the layers of atoms can slide over each other*  
*ignore other properties* 1
- (ii) contains chromium / nickel  
*allow contains other metals* 1
- (c) (i) an element 1
- (ii) hard 1

(iii) is resistant to corrosion

1

**[7]****50**

(a) (i) contains enough metal to make it economical to extract

1

(ii) Fe (+) CO<sub>2</sub>

*formula of both products must be correct*

1

(Fe<sub>2</sub>O<sub>3</sub>) (+) .....3.....(CO)

→

.....2.....(Fe) (+) .....3...(CO<sub>2</sub>)

*balancing correct*

*allow correct balancing using Fe<sub>2</sub>*

1

(iii) reduction

*accept redox*

1

(b) (i) oxygen reacts with the carbon to produce carbon dioxide

*allow carbon monoxide for carbon dioxide*

1

**OR**

carbon dioxide is produced (1)

which escapes as a gas (1)

1

(ii) to give steels with different / particular properties or for different / particular uses

*ignore to make different alloys*

1

(c) copper is very expensive

*accept the metal (iron / steel) costs less than copper*

*ignore energy*

1

because copper ores are 'low grade' / running out

*allow copper is rare*

*ignore nickel*

1

[9]

51

(a)

*allow answers referring*

*specifically to the naphtha fraction*

crude oil is evaporated/vaporised (by heating)

1

the vapours are condensed (by cooling)

1

(fractions condense) / boil at different temperatures

*allow fractions have different boiling points*

1

(b) any **four** from:

*answer yes or no does not gain credit*

*ignore references to volume of milk held / number of bottles used / biodegradability / habitats / pollution / mining / dust*

*each marking point must be a comparison*

milk bag points

- uses (75%) less **crude oil** to make (than a plastic milk bottle)  
*allow eg uses 75% less*  
*poly(ethene) which is made from crude oil*
- uses less **energy** / fuel to make (than a plastic / glass milk bottle)
- produces less **carbon dioxide** to manufacture (than a plastic / glass milk bottle)  
*allow produces less greenhouse gases / causes less global warming*  
*allow produces less CO<sub>2</sub> on burning*
- produces less **waste** (than a plastic / glass milk bottle)  
*allow takes up less landfill (space)*  
*allow an argued case for more waste eg milk bags are discarded / cannot be reused*
- less fuel used for **transport** than glass milk bottles
- (produces waste because) milk bags are only used once whereas glass bottles can be **re-used**  
*allow milk bags are discarded but glass bottles can be reused (24 / many times)*  
*allow glass bottles can be reused but milk bags can't*

poly(ethene) points

- uses a limited **raw material** / crude oil whereas the raw materials for glass are almost unlimited
- **less** (5%) poly(ethene) is **recycled** (compared to glass (35%))  
*allow (35%) glass is recycled or (5%) poly(ethene) (bottles) recycled BUT milk bags aren't / are discarded*  
**or**  
*recycled poly(ethene) is not used to make new bags whereas recycled glass is used to make new bottles*

52

(a) mixture is cooled / cooling

1

so ammonia / it condenses

**or**so ammonia turns into a liquid (but nitrogen and hydrogen remain as gases)

1

(b) (i) exothermic reaction

*accept reverse reaction is endothermic***or**

equilibrium / reaction moves in the direction which raises the temperature

*ignore answers based on rate or collisions*

1

(ii) they / particles / molecules move faster **or** have more (kinetic) energy*allow atoms instead of particles**ignore particles move more / vibrate**do **not** accept electrons (max1)*

1

any **one** from:

- particles / molecules collide more often / more frequently / more likely to collide  
*ignore collide faster*  
*ignore more collisions*
- more of the collisions are successful **or** particles collide with more energy / harder **or** more of the particles have the activation energy  
*accept more successful collisions*

1

(iii) more molecules / particles / moles / volumes on LHS (of equation than RHS)

*accept 4 molecules / particles / moles / volumes on LHS and 2**molecules / particles / moles / volumes on RHS***or**

greater volume on LHS (than RHS)

**or**

equilibrium / reaction moves in the direction which reduces the pressure / volume

*accept converse*

1



(iv) cost

**or**

difficulty in containing such a high pressure

*allow risk of explosion**ignore dangerous*

1

(c) (i) 60

1

(ii) 2.4(2857....)

*correct answer gains 3 marks with or without working**accept any answer that rounds to 2.4**ignore units**if answer is incorrect look for evidence of correct working to a maximum of 2 marks.**moles of N<sub>2</sub> = 2/28 = (0.0714)**moles of ammonia = 2 × 0.0714 = (0.1428)**mass of ammonia = 0.1428 × 17 = (2.4276)***or***28 → 34**1g → 34/28**2g → 2.4... ..*

3

(d) (i) 15

1

(ii) unreacted gases are recycled

*allow unreacted gases are reused*

1

rate (of production) is fast

*accept production is continuous**ignore compromise between rate and yield*

1

**[14]****53**

(a) (i) low percentage / very little of metal (in the ore)

*accept only 0.5% metal in the ore **or** over 99% waste in the ore **or** nearly 100% waste in the ore**ignore reference to percentage of metal in the Earth's crust **or** energy used or pollution*

1

(ii) any **one** from

*(it = iron)*

- iron uses less energy / fuel for extraction  
*ignore electrolysis / uses electricity / reactivity*
- iron has more uses
- more demand for iron  
*ignore high abundance in the Earth's crust / high percentage of metal in ore*
- iron is stronger  
*ignore harder*
- cheaper / costs less
- easier to extract

1

(b) (i) has melting point lower than 950°C

*(it = aluminium)*

*allow has a low melting point*

*ignore boiling point*

1

(ii) electrode(s) made of carbon

1

oxygen reacts with electrode(s) / carbon

*accept  $C + O_2 \rightarrow CO_2$*

*NB oxygen reacts with the carbon electrode(s) = 2 marks*

1

(iii) any **two** from:

- saves resources / non-renewable  
*accept aluminium / ore will run out or conserves aluminium*
- landfill problem  
*accept aluminium does not corrode*
- saves energy / fuel / electricity  
*ignore global warming*
- less carbon dioxide / carbon emissions **or** reduces carbon footprint  
*ignore consequences of quarrying / mining*
- less quarrying / mining  
*ignore pollution / harms environment / costs / easy to recycle*

2

[7]

54

#### Reused

- saves raw materials / crude oil
  - *unable to reuse many times*
  - *bags easily split*
- saves energy / fuel / transport
- fewer bags needed / made
- reduces carbon / CO<sub>2</sub> emissions
- reduces use of landfill
- saves cost of a new bag
- no waste

1

Recycled

- saves raw materials / crude oil
  - *has to be collected / transported / washed / separated / melted*
- saves energy / use of fuel
- reduces carbon / CO<sub>2</sub> emissions
- reduces use of landfill
- can be used for new products
  - ignore uses energy*

1

Burned

- heat / energy released can be used (for heating / generating electricity)
  - *has to be collected / transported*
- reduces use of landfill
  - *wastes the resource / plastic*
  - *releases harmful gases / toxic gases / CO<sub>2</sub>*

1

Dumped

- collected / transported with household waste
  - *wastes the resource*
  - *plastic uses landfill*
- (slowly) biodegrades **or** produces methane which can be used as a fuel
  - *produces methane which is a greenhouse gas / could cause explosions*
- (not biodegradable so) does not release CO<sub>2</sub> / green house gas into the air
  - *not biodegradable / take years to decompose*

ignore cost / litter / waste / global warming / habitats unless mentioned above

1

**[4]****55**

(a) increases

1

(b) the reaction is reversible

1

(c) A liquid

1

(d) recycled / reused (owtte)

*accept returned to pump / start*

1

**[4]****56**

(a) filtered: removes insoluble / solid

*Ignore named substances / minerals*

*do **not** accept ions*

1

chlorine: kills microorganisms / microbes / bacteria / disinfects (water)

*allow kills germs / pathogens **or** sterilises*

*allow chlorine is a disinfectant*

*ignore cleans water or removes impurities / bacteria*

1

(b) (i) advantages of portable:

*accept converse throughout*

any **two** from :

- costs less
- little training needed
- water can be tested within 10 seconds / immediately / quicker
- can be used anywhere

2

disadvantage of portable

less precise / sensitive

*allow only detect down to 0.1 mg*

*ignore less accurate*

1

(ii) (PIWE) is unbiased

*it / they = PIWE*

*allow honest / trusted / respected / reliable*

*ignore professional / scientific / skilled*

**or**

company may be biased

*allow company trying to sell products*

1

**[6]**