Mark schemes

## Q1.

(a) limestone

**1**

sodium carbonate

**1**

(b) (advantage) stronger

**1**

(reason) less easily damaged

**1**

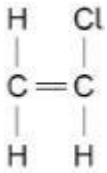
(c) (advantage) lower density

**1**

(reason) lighter (to install)

**1**

(d)



**1**

(e) (add damp) litmus paper

**1**

(litmus paper) is bleached
**or**
(litmus paper) turns white
*ignore (litmus paper) turns red*

**1**

(f) (polymers)
last a long time
*ignore references to cost*
*allow break down slowly*

**1**

(wood)
renewable
*allow trees can be replanted*
*allow aesthetic reasons*

**1**

(g) (percentage of aluminium =)

$$\frac{5.94}{6.00} \times 100$$

**1**

= 99 (%)

**1**

(h) (alloy is) harder (than pure aluminium)

*allow (alloy is) stronger (than pure aluminium)*

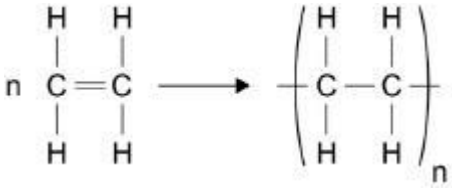
*ignore references to cost*

**1**

**[14]**

## Q2.

(a)



*if equation incorrect*

*allow **1** mark for 5 single bonds*

***or***

*allow **1** mark for n*

**2**

(b) (poly(ethene)) melts

*allow converse statements about thermosetting polymers*

*allow thermosoftening polymers melt*

**1**

(so) can be reshaped (into new products)

**1**

(c) use different (reaction) conditions

*allow use different temperatures / pressures*

**1**

(d) (in HDPE) polymer chains / molecules are closer together

*allow converse statements about LDPE*

*allow (HDPE has) unbranched polymer chains / molecules*

**1**

(so) more atoms per unit volume

*allow (so) more molecules per unit volume*

**1**

(e) circle around HO– **or** –OH on monomer **A**

**1**

(f) $H_2O$

**and**
HCl

*must be in this order*

**1**

**[9]**

## Q3.

(a) (lead is) toxic / poisonous

*allow (lead is) harmful*

*ignore (lead is) dangerous / deadly / lethal*

**1**

(b) the proportions (of metals) are different

**1**

(c) any **three** from:

- recycling conserves copper ores
- recycling uses less energy
- recycling reduces waste

*ignore references to cost*

*allow copper ores are finite*

*allow recycling reduces use of landfill*

- mining / quarrying cause environmental impacts

*allow description of environmental impact caused by mining / quarrying*

**3**

(d) grow plants (on land containing copper ores)

*allow named plant*

**1**

plants are burnt (to produce ash)

**1**

ash dissolved in acid (to produce a solution of a copper compound)

**1**

electrolysis of solution (containing a copper compound)
**or**
displacement (of copper) from solution (containing a copper compound)

*allow addition of scrap iron to the solution (of a copper compound)*

**1**

(e) any **two** from:

- high grade ores still available
- land not available
- phytomining takes a long time
- new technology

*allow demand not high enough*

**2**

**[11]**

## Q4.

(a) tin

**1**

(b) any **one** from:

- ornaments
- musical instruments
- hinges / knobs / screws

*allow any correct use of brass*

**1**

(c) (**A)** 12 (carat)

**1**

(**B**) 3 (grams)

**1**

(d) any **two** from:

- (alloy of gold is) harder
- (alloy of gold is) cheaper
- aesthetic reasons

*allow converse statements about pure gold*

**2**

(e) any **one** from:

- does not corrode

*allow will not rust*

- does not react with water
- is hard

**1**

(f) low carbon steel

**1**

**[8]**

## Q5.

(a) disposal at the end of useful life

**1**

(b) heating in a furnace

**1**

shaping wet clay

**1**

(c) polymers

**1**

propene

*allow (a) monomer*

**1**

(d) cracking

**1**

fractional distillation

**1**

(e) covalent

**1**

(f) thermosetting

**1**

(g) polymer **A** has crosslinks (between polymer molecules)
**or**
polymer **B** has no crosslinks (between polymer molecules)

**1**

**[10]**

## Q6.

(a) any **two** from:

energy used in:
- extraction of raw materials
- processing raw materials

*allow energy used to make food plate materials*

- manufacturing
- transportation
- cleaning non-disposable plates
- disposal
- recycling

**2**

(b) **Level 2:** A judgement, strongly linked and logically supported by a sufficient range of correct reasons, is given.

**3–4**

**Level 1**: Some logically linked reasons are given. There may also be a simple judgement.

**1–2**

**No relevant content**

**0**

**Indicative content**

**Raw materials**
- Trees are renewable
- Crude oil and clay are finite

**Manufacturing and packaging**
- Paper plates use the least packaging so conserve raw materials
- Paper plates need less transportation overall as more plates in a 10 $dm^3$ cardboard box

**Use and operation**
- Paper plates are single use so must be replaced most often
- Ceramic plates last longer than polymer plates so must be replaced less often

**Disposal**
- Polymer / ceramic plates take up landfill which is running out
- Paper / polymer plates can be used to make new products
- Recycling conserves raw materials

**Reasoned judgement**

(c) (wet) clay is shaped

**1**

(and) heated in a furnace

*allow (and) heated in a kiln / oven*
*allow (and) fired*

**1**

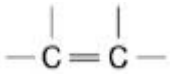
**[8]**

## Q7.

(a) covalent

**1**

(b)



**1**

(c) composite

**1**

(d) limestone

**1**

sand

**1**

*either order*

(e)

*ignore corrosion / erosion / rotting / rusting*

any **two** from:
(makes the board)
- strong
- hard
- tough

- waterproof
- durable
  *allow long lasting*
- aesthetic reasons
- rigid
- less friction
  *allow streamlined / smooth*
- protection
  *allow prevents damage*

**2**

(f) (advantages of addition polymers)
low(er) cost
*allow cheap(er)*

**1**

low(er) density
*allow light(er)*

**1**

(disadvantages of addition polymers)
weak(er)
*allow (more) likely to break*

**1**

hard(er) to dispose of
*ignore references to recycling or use as a fuel*

**1**

(g)
*an answer of 0.035 ($m^3$) scores **3** marks.*
*allow **2** marks for an answer of 0.105 ($m^3$) (addition polymer)*

$$150 = \frac{5.25}{\text{volume}}$$

**1**

$$(\text{volume} =)\ \frac{5.25}{150}$$

**1**

(volume =) 0.035 ($m^3$)

**1**

**[14]**

## Q8.

(a) **Level 3:** The design/plan would lead to the production of a valid outcome. All key steps are identified and logically sequenced.

**5–6**

**Level 2:** The design/plan would not necessarily lead to a valid outcome. Most steps are identified, but the plan is not fully logically

sequenced.

**3–4**

**Level 1:** The design/plan would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.

**1–2**

**No relevant content**

**0**

**Indicative content**

**Plan – allow diagrams to indicate content**

- three test tubes containing nails
- test tube 1 – open test tube with water
- test tube 2 – stoppered test tube with drying agent
- test tube 3 – test tube with boiled water
- test tube 3 – sealed with oil
- leave for several days
- observe results

**Results**

- test tube 1 – nail rusts
- test tube 2 – nail does not rust
- test tube 3 – nail does not rust

(b) 0.11 (g)

**1**

(c)

$$\left(\frac{0.08 + \mathbf{X} + 0.09}{3}\right)$$

= 0.09 (g)

*allow 0.09(3333….)*
*allow ecf* ***from part (b)***

**1**

**[9]**

## Q9.

(a) C=C bond in correct position

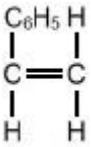
**1**

3× C-H **and** 1× C-C bond in correct positions

*do* ***not*** *accept any additional bonds or atoms*
*ignore brackets and n before and after displayed structural formula*

**1**

*an answer of*




*scores **2** marks*

(b) carboxylic acid (group)

*allow carboxyl (group)*

**1**

(c) water

*allow $H_2O$*

**1**

(d) (polyester is) thermosoftening

*allow (polyester is) thermoplastic*

*ignore thermoforming*

**1**

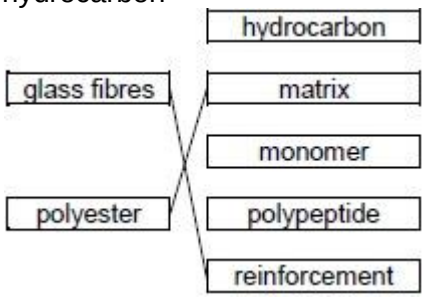
(polyester has) no cross-links

*allow intermolecular forces are weak*

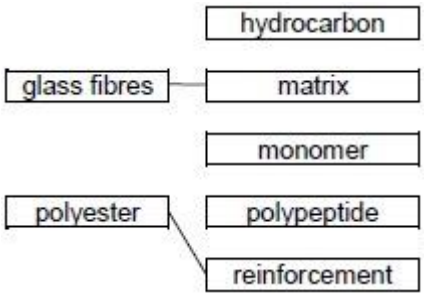
*do **not** accept references to breaking covalent bonds or breaking chains*

**1**

(e) hydrocarbon




*allow for 1 mark:*




**2**

(f) any **two** from:
(to make the board)

- harder
- stronger
- tougher
- more rigid

*must be implied comparative*

*statements*

- waterproof

**2**

**[10]**

## Q10.

(a) Tube 1: (nail) rusts because air / oxygen **and** water present

**1**

Tube 2: (nail) does not rust because no water

*allow Tube 2: (nail) does not rust because only air / oxygen*

**1**

Tube 3: (nail) does not rust because no air / oxygen

*allow Tube 3: (nail) does not rust because only water*

**1**

Tube 4: (nail) does not rust because paint is a barrier (to water / air / oxygen)

*allow Tube 4: (nail) does not rust because paint is a protective layer / coating (against water / air / oxygen)*

***or***

*allow Tube 4: (nail) does not rust because paint protects it from water / air / oxygen*

**1**

Tube 5: (nail) does not rust because stainless steel resistant to corrosion

*allow Tube 5: (nail) does not rust because stainless steel does not corrode*

*allow Tube 5: (nail) does not rust because stainless steel contains nickel / chromium*

**1**

*If no other mark awarded allow 1 mark for correct rusting pattern in all 5 tubes*

(b)

*allow converse*

magnesium is more reactive (than iron)

*allow magnesium is more reactive (than steel)*

**1**

(so magnesium) provides sacrificial protection

*allow (so magnesium) corrodes / reacts instead of iron / steel*

*allow (so magnesium) corrodes / reacts before iron / steel*

*ignore references to protective layers*
*ignore references to magnesium rusting*

**1**

(c) (aluminium has a coating of) aluminium oxide

**1**

(so the aluminium oxide) protects the metal (from further corrosion)
*allow (so aluminium oxide) prevents water / air / oxygen from reaching the metal*

**1**

**[9]**

## Q11.

(a)

| **property** | **J** | **K** |
|---|---|---|
| density in g/cm$^3$ | | |
| melting point in °C | | ✓ |
| flame resistance | | ✓ |
| water absorption | ✓ | |

*three correct = **2** marks*
*one or two correct = **1** mark*

**2**

(b) $\frac{1.4 \times 6.0}{0.90}$

**1**

= 9.3 (kg)

*allow 9.3(333…)(kg)*

**1**

*an answer of 9.3(333… )(kg) scores **2** marks*

(c) polymer **L** will not melt

**1**

(d) polymers are more hard-wearing

**1**

(e) any **two** from:

- (wool / sheep) renewable
  *allow wool grows back, etc.*
- (wool) will not run out

*ignore (wool is) readily available*

- (crude oil) non-renewable
  *allow finite*
- (crude oil) will run out
  *ignore references to cost*
  *ignore properties from tables 1 and 2*

**2**

**[8]**

## Q12.

(a) tin

**1**

(b) 70 (%)

**1**

(c) $\frac{90}{100} \times 1100$

**1**

= 990 (g)

**1**

(d) mixture of metals

**1**

(e) (red brass) contains more copper
*allow converse*

**1**

(so) layers slide more easily
**or**
layers are less distorted

**1**

(f) 24

**1**

**[8]**

## Q13.

(a) 50

**1**

(b) 5%

**1**

(c) any **two** from:

- cost (9 carat is cheaper)
- pure gold is soft
  **or**
  24 carat gold is soft

**or**
9 carat gold is harder
*allow 9 carat gold is stronger*
*allow gold is an alloy in 9 carat gold*

- can change the colour

**2**

**[4]**

## Q14.

(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.

**6**

(d) iron + oxygen + water

*all three needed for **2** marks*

*2 correct = **1** mark*

*ignore air*

**2**

**[13]**

## Q15.

(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]**

## Q16.

(a) (i) hard

*ignore strong*

**1**

(ii) hundred

**1**

(b) (i) Covalent

**1**

(ii) 3

**1**

(iii) Soft and slippery

**1**

(c) (i) cross-links

*allow bonds*

*ignore links*

*do **not** accept intermolecular*

**1**

(ii) melt

**1**

(iii) any **two** from:

- temperature

  *allow heat(ing)*
- pressure
- catalyst

**2**

(d) (i) $CH_4$

**1**

(ii) Small molecules

**1**

**[11]**