

## Mark schemes

Q1.

(a) 
$$\frac{54 + 50 + 55}{3}$$

1

= 53 (°C)

*if no other mark awarded allow 1 mark for*

$$\frac{54 + 50 + 37 + 55}{4} = 49 \text{ (°C)}$$

1

- (b) (most reactive) magnesium zinc  
(least reactive) cobalt

*allow ecf from question (a)*

1

- (c) (18 ±) 2 (°C)

1

- (d) control

1

- (e) use the same mass of metal / powder

1

- (f) (A) progress of reaction

1

(B) activation energy

1

(C) products

1

[9]

Q2.

(a)  $(3 \times Mr \text{ H}_2\text{O} = 3 \times (2 + 16) =) 54$

$(Ar \text{ R} = 150 - 54 =) 96$

*ignore units*

1

alternative approach:

$(MRO_3 = 150 - 6 =) 144 \text{ (1)}$

$(AR = 144 - (3 \times 16) =) 96 \text{ (1)}$

*ignore units*

1

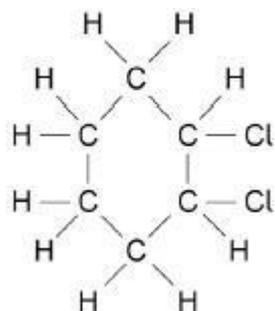
- (b) (R =) molybdenum / Mo  
*allow ecf from question (a)* 1
- (c) (total Mr of reactants) = 163 1
- (% atom economy =)  $\frac{119}{163} (\times 100)$   
*allow correct use of an incorrectly calculated value of total Mr* 1
- = 73 (%)  
*allow 73.00613 (%) correctly rounded to at least 2 significant figures* 1
- (d) Level 2: Some logically linked reasons are given. There may also be a simple judgement. 3-4
- Level 1: Relevant points are made. They are not logically linked. 1-2
- No relevant content 0
- Indicative content
- carbon and iron are the cheapest reactants
  - hydrogen is the most expensive reactant
  - separating solid products is expensive
  - separating solid products is time consuming
  - in method 1, tungsten needs to be separated from tungsten carbide
  - in method 1, some tungsten is lost as tungsten carbide
  - in method 1, the carbon dioxide produced will escape
  - in method 2, the water vapour produced will escape
  - in method 2, no separation of solids is needed
  - in method 3, tungsten needs to be separated from iron oxide
- [10]

Q3.

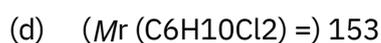
- (a) (test)  
 (add) bromine (water) 1
- (result)  
 (changes from) brown / orange to colourless  
*ignore clear*



(c)



*allow 1 mark for the structure of  
1, 1-dichlorocyclohexane or 1, 3-  
dichlorocyclohexane or 1, 4-  
dichlorocyclohexane*



$$(\% \text{ chlorine}) = \frac{71}{153} \times 100$$

*allow correct use of an incorrectly  
calculated value of  $M_r$*

$$= 46.4 (\%)$$

*allow 46.405228758 (%) correctly  
rounded to at least 2 significant figures*

[8]

Q4.

(a) gas

(b)  $-35\text{ }^\circ\text{C}$

*allow any value between  $-35\text{ }^\circ\text{C}$  and  
 $-100\text{ }^\circ\text{C}$*

(c) increase

increase

*allow become stronger*

(d) chlorine gas is toxic

- (e) increased 1
- chlorine (atoms) are now part of the solid (iron chloride)  
or  
the mass of the chlorine (atoms) is now also measured 1
- (f) burns very vigorously 1  
*allow burns violently*  
*allow brighter (orange) glow*  
*allow (orange) flame*  
*allow explodes*
- (g)  $2 \text{ Fe} + 3 \text{ Br}_2 \rightarrow 2 \text{ FeBr}_3$  1  
*allow multiples*
- (h)  $56 + (3 \times 80)$  1  
 $= 296$   
*ignore units* 1
- [11]

Q5.

- (total) mass before = 156.76 (g)  
and  
(total) mass after = 156.76 (g)  
*allow  $78.26 + 78.50 = 156.76$*   
*and*  
 *$108.22 + 48.54 = 156.76$*
- or
- increase in mass of beaker A and contents = 29.96 (g)  
and  
decrease in mass of beaker B and contents = 29.96 (g)  
*allow  $108.22 - 78.26 = 29.96$*   
*and*  
 *$48.54 - 78.50 = - 29.96$*  1
- (so) the mass of products equals the mass of the reactants  
or  
(so) there is no change in mass during the reaction  
*allow (so) no atoms were lost or made during the reaction* 1
- (b) filter / filtration

	<i>allow a description of filtration</i>	1
(c)	sodium nitrate (solution) or silver nitrate (solution) or sodium iodide (solution)  <i>allow correct formulae</i> <i>allow sodium / nitrate / silver / iodide ions</i>	1
(d)	to remove / evaporate the water <i>allow to dry (the solid)</i>	1
(e)	(total $M_r = 170 + 150 = 320$ ) <i>allow <math>(235 + 85) = 320</math></i>	1
	(% atom economy =) 235 $\frac{235}{320} \times 100$  <i>allow correct use of incorrectly calculated total <math>M_r</math></i>	1
	= 73.4375 (%)	1
	= 73.4 (%)  <i>allow an answer correctly calculated to 3 significant figures from an incorrect percentage calculation which uses the values in the question</i>	1
(f)	any one from: <ul style="list-style-type: none"> <li>• for sustainable development</li> <li>• for economic reasons</li> <li>• to produce a high(er) percentage of useful product</li> </ul> <i>allow to reduce waste</i>	1
		[10]
Q6.		
(a)	acid rain	1
(b)	oxygen	1

- carbon  
*must be in this order* 1
- (c) dimming 1
- (d)  $2 \text{CH}_4 + 3 \text{O}_2 \rightarrow 2 \text{CO} + 4 \text{H}_2\text{O}$   
*allow multiples* 1
- (e) air 1
- oxygen 1
- oxides of nitrogen  
*must be in this order* 1

[8]

Q7.

- (a) s 1
- (b) a gas escapes 1
- (c) from 0.47 (g) to 0.86 (g)  
*allow from 0.86 (g) to 0.47 (g)* 1
- (d)  
*an answer of 0.83 (g) scores 2 marks*  
*an answer of 0.74 (g) scores 1 mark*
- $$\frac{0.84 + 0.79 + 0.86}{3}$$
- 1
- = 0.83 (g) 1
- (e) independent 1
- (f) increases 1
- (g) 1.3 (g)  
*allow 1.30 (g)* 1

[8]

Q8.

(a)

*an answer of 77 (%) scores 2 marks  
an answer of 78.63247863 (%) correctly rounded to at least 2 significant figures scores 1 mark*

$$\frac{184}{(232 + 6)} \times 100$$

1

$$= 77 (\%)$$

*allow 77.31092437 (%) correctly rounded to at least 2 significant figures*

1

(b)

*an answer of 15 (kg) scores 2 marks*

$$\frac{38}{100} \times 40$$

1

$$= 15 (\text{kg})$$

*allow 15.2 (kg)*

1

(c)

*an answer of 102 scores 2 marks*

$$(2 \times 27) + (3 \times 16)$$

1

$$= 102$$

*ignore units*

1

(d)

*an answer of 89.3 (%) scores 3 marks*

$$\frac{28.4}{31.8} \times 100$$

1

$$= 89.3081761 (\%)$$

*allow 89.3081761(%) correctly rounded to at least 2 significant figures*

1

$$= 89.3 (\%)$$

*allow an answer correctly rounded to 3 significant figures from an incorrect calculation which uses the masses in the question*

1

(e) aluminium is more reactive than carbon  
*allow aluminium is above carbon in the reactivity series* 1

(so) carbon cannot displace aluminium  
*allow (so) carbon cannot replace aluminium*

or

(so) carbon cannot reduce aluminium oxide  
*allow (so) carbon cannot remove oxygen from aluminium oxide*  
*allow (so) carbon will not react with aluminium oxide*

1

[11]

Q9.

(a) 7 1

(b) small molecule 1

(c) F<sub>2</sub> 1

(d) the reactivity decreases (going down Group 7)  
*allow the reactivity decreases from chlorine to iodine* 1

(because) chlorine displaces bromine and iodine  
*allow (because) chlorine has two reactions*  
*allow (because) neither bromine nor iodine can displace chlorine*

1

(and) bromine displaces iodine or iodine does not react  
*allow (and) bromine has one reaction*  
*or iodine has no reactions*  
*allow (and) iodine cannot displace bromine*

1

(e) 80 1

(f) (1.2 kg =) 1200 (g)  
 or (900 g =) 0.9 (kg) 1

$$\left(\frac{900}{1200} \times 100\right) = 75(\%)$$

or

$$\left(\frac{0.9}{1.2} \times 100\right) = 75(\%)$$

allow an answer correctly calculated from:

$$\left(\frac{900}{\text{incorrect attempt at conversion of 1.2}} \times 100\right)$$

or

$$\left(\frac{\text{conversion of 900}}{1.2} \times 100\right)$$

an answer of 75 (%) scores 2 marks

1

[9]

Q10.

(a) gas

1

(b) the gas escapes

allow carbon dioxide escapes

do not accept references to evaporation

1

(c) 5.12 (g)

1

(d) 4.00 (g) trial 1

allow 2.89 written in either space, or ringed in the table, unless contradicted by mass of copper carbonate or trial number

1

(e) reheat

1

(and reweigh) until constant mass

1

an answer of heat to constant mass scores 2 marks

if no other mark scored allow for 1 mark heat for longer

or

(heat at a) higher temperature

alternative approach:

(1) continue heating and pass gas through limewater

(1) until the (lime)water stops bubbling

or

*until the limewater no longer turns cloudy*

(f) straight line of best fit  
*must touch at least 5 of the 6 plots* 1

(g) correct value read from line of best fit in the graph  
*allow tolerance of  $\pm\frac{1}{2}$  small square* 1

(h) (mass =)

$$168 \times \frac{\text{answer from question (g)}}{8.4}$$

*allow (mass =) answer from part (g)  $\times$  20*

1

correctly calculated value (g)

1

*a correctly calculated value from their answer to part (g) scores 2 marks*

[10]

Q11.

(a) incomplete combustion 1

(because) insufficient / limited oxygen supply 1

(b) any two from:

- carbon monoxide toxic / poisonous  
*allow description of how carbon monoxide is toxic / poisonous*  
*ignore carbon monoxide is harmful / dangerous / deadly*
- greater public concern / awareness about pollution  
*ignore comments about the effects of other pollutants*  
*ignore unspecified comments about carbon monoxide pollution*
- more cars so otherwise there would be more carbon monoxide entering atmosphere
- improved engine technology
- catalytic converters have been introduced

2

- (c) any one from:
- (to reduce) health problems  
*allow (to reduce) specified health problems e.g. breathing difficulties, asthma, lung cancer*
  - (to reduce) global dimming  
*allow (to reduce) the effects of global dimming e.g. reduced light levels*  
*allow (to reduce) smog*  
*allow (to reduce) the formation of particulates*  
*ignore global warming*  
*do not accept to reduce soot*
- 1
- (d) nitrogen (from atmosphere) reacts with oxygen (from atmosphere)
- 1
- at high temperature (in engine)  
*ignore heat / hot*
- or  
with a spark (from spark plug)
- 1
- (e)  $2 \text{NO}_2 \rightarrow \text{N}_2 + 2 \text{O}_2$
- allow multiples*  
*if incorrect, allow N2 for 1 mark*
- 2
- (f) any one from:
- acid rain  
*allow specific effects of acid rain*
  - respiratory problems  
*allow specific respiratory problems e.g. breathing difficulties, asthma*
  - carbon monoxide
  - global dimming or smog
- 2
- max 1 mark if global warming mentioned*
- (g) transition metals
- 1
- [12]

Q12.

- (a) precipitate / solid formed

- allow colour change*
- 1
- (b) total mass before = 257.68 g  
total mass after = 257.68 g
- 1
- so the mass of products equals  
the mass of the reactants
- 1
- (c) 0.01 g
- 1
- (d)  $207 + (2 \times 14) + (6 \times 16)$   
or  
 $207 + 2 \times [14 + (3 \times 16)]$
- 1
- = 331
- 1
- an answer of 331 scores 2 marks*
- (e)  $\text{CrO}_4^{2-}$
- 1
- (f) carbon dioxide is a gas  
*allow a gas is produced*
- 1
- the gas escapes during the reaction
- 1
- (so) the mass at the end is less than expected
- 1
- [10]

Q13.

- (a)  $\text{C}_5\text{H}_{12}$
- 1
- (b) 2:5
- 1
- (c) A
- 1
- (d) A
- 1
- (e) carbon dioxide
- 1
- water
- 1
- (f) propane

(g)  $(8 \times 1) + (3 \times 12)$

= 44

*an answer of 44 scores 2 marks*

1

1

1

[9]

Q14.

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

1

(b) (i) 2.1 (%)

1

(ii) correct bar for calcium at 3.6 %

1

*allow error of +/- 0.05%*

correct bar for iron at 5.0 %

1

*allow error of +/- 0.05%*

(c) (i) decomposition

1

(ii) carbon dioxide

1

(iii) carbon = 1

*allow one*

1

oxygen = 3

*allow three*

1

(iv) 44 (g)

*allow forty four*

1

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

1

(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*

3

[13]

Q15.

- (a) (i) (thermal) decomposition  
*allow decomposes or endothermic* 1
- (ii) copper oxide 1
- (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* 1
- the mass did not change or the limewater did not go cloudy 1
- because no carbon dioxide produced 1
- (ii) the less reactive the metal the more (easily) its carbonate will decompose/react or vice versa  
*needs to be a relative comparison* 2
- 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 1
- balanced correctly (2,3,4,3)  
*not ecf*  
*allow correct balanced equation but with 2Fe<sub>2</sub> on right for one mark* 1
- (iii) iron from the blast furnace is brittle 1
- steel produced is strong / flexible 1
- allow steel has more/specific uses*  
*allow steel is rust-resistant* 1

*"it" = iron*

- (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

[15]