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 (°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) ($3 \times M_r$ H_2O = 3 × (2 + 16) =) 54

(A_r **R** = 150 – 54 =) 96

ignore units

1

alternative approach:
(M_r **R**O_3 = 150 – 6 =) 144 (1)

(A_r **R** = 144 – (3 × 16) =) 96 (1)

ignore units

1

(b) **(R** =) molybdenum / Mo

*allow ecf from question **(a)***

1

(c) (total M_r of reactants) = 163

1

(% atom economy =) $\frac{119}{163}(\times 100)$

allow correct use of an incorrectly calculated value of total M_r

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

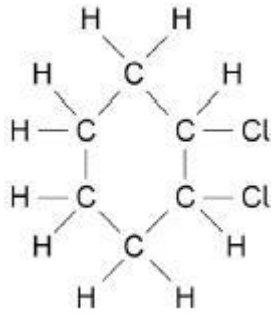
ignore clear

1

(b) C_nH_{2n-2}

1

(c)



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

2

(d) (M_r ($C_6H_{10}Cl_2$) =) 153

1

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

allow correct use of an incorrectly calculated value of M_r

1

= 46.4 (%)

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

1

[8]

Q4.

(a) gas

1

(b) -35 (°C)

allow any value between -35 °C and -100 °C

1

(c) increase

1

increase

allow become stronger

1

(d) chlorine gas is toxic

1

(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

allow burns violently
allow brighter (orange) glow
allow (orange) flame
allow explodes

1

(g) $2\ Fe + 3\ Br_2 \rightarrow 2\ FeBr_3$

allow multiples

1

(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

allow a description of filtration

1

(c) sodium nitrate (solution)
or
silver nitrate (solution)
or
sodium iodide (solution)

allow correct formulae

allow sodium / nitrate / silver / iodide ions

1

(d) to remove / evaporate the water

allow to dry (the solid)

1

(e) (total M_r = 170 + 150) = 320

allow (235 + 85) = 320

1

(% atom economy =) 235

$$\frac{235}{320} \times 100$$

allow correct use of incorrectly calculated total M_r

1

= 73.4375 (%)

1

= 73.4 (%)

allow an answer correctly calculated to 3 significant figures from an incorrect percentage calculation which uses the values in the question

1

(f) any **one** from:

- for sustainable development
- for economic reasons
- to produce a high(er) percentage of useful product

allow to reduce waste

1

[10]

Q6.

(a) acid rain

1

(b) oxygen

1

carbon

must be in this order

1

(c) dimming

1

(d) $2\ CH_4 + 3\ O_2 \rightarrow$ **2** $CO + 4\ H_2O$

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 (kg)

allow 15.2 (kg)

1

(c)

*an answer of 102 scores **2** marks*

(2 x 27) + (3 x 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_2

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

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

or

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

allow an answer correctly calculated from:

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

or

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

1

*an answer of 75 (%) scores **2** marks*

[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 ±½ small square

1

(h) (mass =)

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

*allow (mass =) answer from part **(g)** × 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** $NO_2 \longrightarrow N_2$ + **2** O_2

allow multiples

*if incorrect, allow N_2 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 × 14) + (6 × 16)
or
207 + 2 × [14 + (3 × 16)]

1

= 331

1

*an answer of 331 scores **2** marks*

(e) 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) C_5H_{12}

1

(b) 2:5

1

(c) **A**

1

(d) **A**

1

(e) carbon dioxide

1

water

1

(f) propane

1

(g) (8 × 1) + (3 × 12)

1

= 44

1

*an answer of 44 scores **2** marks*

[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 $2Fe_2$ on right for one mark

1

(iii) **iron** from the blast furnace is brittle

1

steel produced is strong / flexible

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]