

M1.(a) (i) calcium oxide

in either order

1

carbon dioxide

accept correct formulae

1



allow multiples

1

(iii) 210 (tonnes)

award 3 marks for the correct answer with or without working

allow ecf for arithmetical errors

if answer incorrect allow up to 2 marks for any of the steps below:

$$160 \rightarrow 112$$

$$300 \rightarrow 112 / 160 \times 300$$

or

$$\text{moles } Fe_2O_3 = 1.875 (\times 10^6) \text{ or } 300 / 160$$

$$\text{moles of Fe} = 3.75 (\times 10^6) \text{ or } 2 \times \text{moles } Fe_2O_3$$

$$\text{mass Fe} = \text{moles Fe} \times 56$$

105 (tonnes) scores 2 (missing 1:2 ratio)

420 (tonnes) scores 2 – taken M_r of iron as 112

3

(b) (i) aluminium is more reactive than carbon **or** carbon is less reactive than aluminium

must have a comparison of reactivity of carbon and aluminium

accept comparison of position in reactivity series.

1

(ii) (because) aluminium ions are positive

ignore aluminium is positive

1

and are attracted / move / go to the negative electrode / cathode

1

where they gain electrons / are reduced / $Al^{3+} + 3e^- \rightarrow Al$

accept equation or statements involving the wrong number of electrons.

1

(iii) (because) the anodes **or** (positive) electrodes are made of carbon / graphite

1

oxygen is produced (at anode)

1

which reacts with the electrodes / anodes

*do **not** accept any reference to the anodes reacting with oxygen from the air*

equation $C + O_2 \longrightarrow CO_2$ gains 1 mark (M3)

1

[13]

M2.(a) left hand: (conical) flask

*do **not** accept round bottomed flask or container which is not a flask*

1

right hand: beaker / trough

accept plastic box

1

(b) (i) 157

1

(ii) all calcium carbonate used up **or** reaction stopped

*do **not** accept all acid used up*

1

(c) (i) 0.007(272727...)

*correct answer with or without working gains 2 marks
if answer incorrect, allow (0.32 / 44) for 1 mark*

2

(ii) 0.007(272727...)

allow ecf from (c)(i)

1

(iii) $(M_r = \text{mass} / \text{moles} = 1 / 0.00727\dots) = 137.5$ or 138

allow ecf from (c)(ii)

if use 0.00943 moles then = 106

if use 0.007 allow 143 (142.857)

1

(iv) $(138) - 60 (= 78)$

23 / 85

1

$(78 / 2) = 39$

1

potassium

sodium / rubidium

*identity of metal ecf on A_r , but **must** be Group 1*

If no working max 1 mark

1

(d) (i) (relative atomic mass) would decrease

1

because the mass lost greater

1

so moles carbon dioxide larger **or** moles metal carbonate greater

1

(ii) no change

1

because the acid (already) in excess

1

so the amount carbon dioxide lost is the same

1

[17]

M3.(a) copper has delocalised electrons

accept copper has free electrons ignore sea of electrons or mobile electrons

1

(electrons) which can move through the metal / structure

allow (electrons) which can carry a charge through the metal / structure

1

(b) (i) ($M_r \text{ FeCl}_3 =$) 162.5

correct answer with or without working gains 3 marks can be credited from correct substitution in step 2

1

or

2 (moles of) $\text{FeCl}_3 = 325$

or

112 \rightarrow 325

$$\frac{11.20}{56} \times 162.5$$

allow ecf from step 1

accept $\frac{325}{112} \times 11.2$

1

= 32.5
accept 32.48

1

(ii) 74.8

accept 74.77 - 75

accept ecf from (b)(i)

if there is no answer to part(i)

or

if candidate chooses not to use their answer then accept

86.79 - 87

1

[6]

M4.(a) (i) CH₄

allow H₄C

do **not** allow lower-case h

do **not** allow superscript

1

(ii) single

1

(iii) alkanes

1

(b) (i) carbon / C

any order

1

hydrogen / H

allow phonetic spelling

1

- sulfur / sulphur / S 1
- (ii) air / atmosphere 1
- (iii) acid rain 1
- damages trees / plants **or** kills aquatic organisms **or** damages buildings /
statues **or** causes respiratory problems
allow harmful to living things 1
- (c) carbon / C 1
- accept soot / particulates / charcoal*
- (d) any **four** from:
- (supports hypothesis) because when the fuel contained more carbon the temperature of the water went up more / faster (in 2 minutes)
 - (does not support hypothesis as) temperature change per gram decreases as the number of carbons increases
 - (does not support hypothesis) because the more carbon in the fuel the more smoke **or** the dirtier / sootier it is
 - only tested hydrocarbons / alkanes / fuels with between 5 and 12 carbon atoms
 - valid, justified, conclusion
- accept converse statements* 4
- (e) (i) 0.15 2
- correct answer with or without working gains 2 marks*
if answer incorrect, M_r carbon dioxide = 44 gains 1 mark
allow 0.236 / 0.24 / 0.2357142 (ecf from M_r of 28) for 1 mark

(ii) 0.4(0)

1

(iii) C_3H_8

correct formula with or without working scores 2 marks

$$0.15 / 0.05 = 3$$

allow ecf from (e)(i)

and

$$0.4 / 0.05 = 8 (1)$$

allow ecf from (e)(ii)

allow 1 mark for correct empirical formula from their values

If use 'fall-back-values:

$$0.50 / 0.05 = 10$$

and

$$0.20 / 0.05 = 4$$

1 mark

C_4H_{10}

1 mark

if just find ratio of C to H using fall-back values, get C_2H_5

allow 1 mark

2

[19]