

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) CH<sub>4</sub>

allow H<sub>4</sub>C

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 <b>or</b> kills aquatic organisms <b>or</b> damages buildings / statues <b>or</b> causes respiratory problems <i>allow harmful to living things</i>	1
(c)	carbon / C <i>accept soot / particulates / charcoal</i>	1
(d)	any <b>four</b> from: <ul style="list-style-type: none"> <li>• (supports hypothesis) because when the fuel contained more carbon the temperature of the water went up more / faster (in 2 minutes)</li> <li>• (does not support hypothesis as) temperature change per gram decreases as the number of carbons increases</li> <li>• (does not support hypothesis) because the more carbon in the fuel the more smoke <b>or</b> the dirtier / sootier it is</li> <li>• only tested hydrocarbons / alkanes / fuels with between 5 and 12 carbon atoms</li> <li>• valid, justified, conclusion <i>accept converse statements</i></li> </ul>	4
(e)	(i) 0.15 <i>correct answer with or without working gains 2 marks</i> <i>if answer incorrect, M<sub>r</sub> carbon dioxide = 44 gains 1 mark</i> <i>allow 0.236 / 0.24 / 0.2357142 (ecf from M<sub>r</sub> of 28) for 1 mark</i>	2

(ii) 0.4(0)

1

(iii) C<sub>3</sub>H<sub>8</sub>

*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<sub>4</sub>H<sub>10</sub>

*1 mark*

*if just find ratio of C to H using fall-back values, get C<sub>2</sub>H<sub>5</sub>*

*allow 1 mark*

2

[19]