

M1.(a) (zinc has) lost electron(s)
accept loss of electrons 1

(b) copper is the least reactive 1

because it gave the most negative voltage when it was metal 2
or
it gave the biggest voltage with chromium
or
it gave the most positive voltage when it was metal 1 1

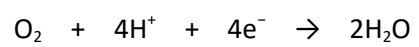
(c) -0.7 V 1

The voltage with chromium and copper is 1.2
accept use of other cell pairings such as tin with copper and tin with iron 1

The voltage with chromium and iron is 0.5 and copper is less reactive (than iron) 1

(d) hydrogen + oxygen = water 1

(e) $\text{H}_2 \rightarrow 2\text{H}^+ + 2\text{e}^-$ 1



1

[9]

M2.(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]

- M3.(a)** The ore is not pure or contains impurities or the ore does not contain 100% of the metal compound
allow to concentrate the metal or metal compound 1
- rock / other compounds need to be removed / separated 1
- (b) (i) (cast iron is) brittle
allow not strong
ignore weak 1
- (ii) the oxygen reacts with carbon
allow carbon burns in oxygen or is oxidised 1
- reducing the percentage of carbon in the mixture
or producing carbon dioxide 1
- (c) (i) aluminium has a low density 1
- (ii) (because copper) is in the central / middle (block of the periodic table) 1
- whereas aluminium is in Group 3 (of the periodic table) 1
- (iii) iron is more reactive (than copper)
ignore cost 1
- so copper is displaced / reduced 1
- [10]

- M4.** (a) (i) many ethene / molecules / monomers
accept double bonds open / break 1
- join to form a long hydrocarbon / chain / large molecule
accept addition polymerisation
ignore references to ethane
correct equation gains 2 marks 1
- (ii) (can be deformed but) return to their original shape (when heated or cooled)
ignore 'it remembers its shape' 1
- (iii) cross links / extra bonds in PEX
accept inter-molecular bonds
ignore inter-molecular forces 1
- molecules / chains in PEX are held in position
accept rigid structure 1
- molecules / chains in PEX unable to slide past each other / move
it = PEX throughout 1
- (b) any **four** from:
- less (hydrocarbon) fuels used
allow less energy
 - less / no electrical energy used
allow no electrolysis
 - reduce carbon / carbon dioxide emissions
allow less global warming
 - reduce / no pollution by sulfur dioxide / acid rain

- continuous process
allow less / no transportation
- conserve copper which is running out or only low-grade ores available
- reduce the amount of solid waste rock that needs to be disposed
allow less waste
- reduce the need to dig large holes (to extract copper ores)
allow less mining
ignore costs / sustainability / non-renewable

4

[10]

M5. (a) any **one** from:

- light(er) / less dense
ignore stronger
- resistant to acids / alkalis / chemical
accept resistant to corrosion

1

(b) any **two** from:

*it must be clear
list principle applies
allow reverse argument
ignore reference to temperature*

- magnesium is more reactive than titanium
magnesium is above titanium in the reactivity series
- titanium is more reactive than carbon
- magnesium is more reactive than carbon
- magnesium is most reactive
- carbon is least reactive

2

(c) any **three** from:

*it = titanium
ignore references to cost / easier / usefulness alone or references
to incorrect processes*

- takes a long time to process
- low abundance (of ore)
- small amount produced
- batch process used **or** blast furnace is continuous
- more stages used to manufacture titanium
allow ≥ 3 / many / several
- more energy used (per tonne of titanium)

allow high energy requirement
ignore references to temperature

- magnesium / chlorine is expensive
- labour intensive

3

[6]

M6. (a) react with oxygen / oxidise / burn in oxygen / burning / combustion **or**
tungsten to tungsten oxide **or** makes an oxide

key idea is oxidation

ignore breaking ignore fire / flames / exothermic

ignore react with air

1

(b) it is (very) unreactive / not reactive / inert / does not react with tungsten
or it is a noble gas **or** it is in group 0 or 8 or 18

*do **not** accept unreactive / inert metal **or** argon is not very reactive*

1

full outer shell (of electrons) / 8 electrons in outer shell

1

does not need to gain / lose / swap / transfer / share electrons **or** does not need to
form bonds

does not bond ionically / covalently

1

[4]

- M7.** (a) unreactive / near bottom of reactivity series 1
- (b) carbon more reactive / higher up reactivity series 1
- (c) very reactive / near top of reactivity series 1
- cannot use displacement methods / can only be extracted by electrolysis / had to wait discovery of electricity 1

[4]