Mark schemes

1

(a) Whether there was a reaction or not

1

(b) brown / orange / dark deposit on zinc
or
blue solution turns colourless / paler

1

(c)

Variable	**Measuring instrument**
Mass of metal powder	Balance
Volume of metal sulfate	Measuring cylinder
	Ruler
	Burette
	Thermometer
	Test tube

more than one line drawn from a variable negates the mark

2

(d) (Most reactive) **Magnesium**
Zinc
(Least reactive) **Copper**
must all be correct

1

(e) would not be safe **or**

too reactive
allow too dangerous

1

(f) Gold

1

(g) $2Fe_2O_3 + 3C \rightarrow 4Fe + 3CO_2$
allow multiples

1

(h) carbon

1

(i) Loss of oxygen

1

[10]

2 (a) any **two** from:

- concentration / volume of dilute hydrochloric acid
- mass of metal powder
- surface area of metal powder
- stirring (of any) / rate of stirring

allow reacted for the same length of time

2

(b) 4.2 °C

allow Magnesium Test 2

1

and any **one** from:

- lower mass of magnesium added
- surface area of magnesium too low
- magnesium coated in magnesium oxide (so took a while to start reacting)
- not stirred
- not stirred as quickly as the other metals
- not reacted for as long a time as the other metals

allow reason for break in circuit

1

(c) 17.4(°C)

1

(d) bubbles of gas

1

more (bubbles) seen with calcium than other metals

allow any correct comparison between two metals

1

(e) any value between 7.9 °C and 12.3 °C

1

[8]

3 (a) any **one** from:

- there was a flame
- energy was given out
- a new substance was formed
- the magnesium turned into a (white) powder

answers must be from the figure

1

(b) Magnesium oxide

1

(c) The reaction has a high activation energy

1

(d) 9

1

(e) They have a high surface area to volume ratio

1

(f) any **one** from:

- Better coverage
- More protection from the Sun's ultraviolet rays

1

(g) any **one** from:

- Potential cell damage to the body
- Harmful effects on the environment

1

(h) indication of $\frac{1}{1.6} = 0.625$

and

use of indices $10^{-9} - 10^{-6} = 10^{3}$

Both steps must be seen to score first mark

1

$0.625 \times 1000 = 625$ (times bigger)

1

[9]

4

(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) $H_2 \rightarrow 2H^+ + 2e^-$

1

$O_2 + 4H^+ + 4e^- \rightarrow 2H_2O$

1

[9]

5 (a) (i) calcium oxide

in either order

1

carbon dioxide

accept correct formulae

1

(ii) $C(s) + CO_2(g) \rightarrow \mathbf{2}CO(g)$

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 → 112

300 → 112 / 160 × 300

or

moles Fe_2O_3 = 1.875 (× 10^6) or 300 / 160

moles of Fe = 3.75 (× 10^6) or 2 × moles Fe_2O_3

mass Fe = moles Fe × 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]

6 (a) gold

1

(b) atom (s)

1

(c) (i) protons

any order

allow proton

1

neutrons

allow neutron

1

(ii) 3 / three

1

(d) (i) Al

ignore any numbers / charges

1

(ii) any **two** from:
- limited resource
- expensive in terms of energy / mining
- effects on the environment, such as, landfill, atmospheric pollution, quarrying

allow uses a lot of energy to extract.

2

(e) resistant to corrosion

1

does not react (with water or food)

*allow **one** mark for low density with a suitable reason given*

1

[10]

7 (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]

8 (a) any **one** from:

- solution becomes colourless or colour fades
- zinc becomes bronze / copper coloured

allow copper (forms) or a solid (forms)

- zinc gets smaller

allow zinc dissolves

- bubbles or fizzing.

ignore precipitate

1

(b) improvement:
use a plastic / polystyrene cup or add a lid

accept use lagging / insulation

1

reason - must be linked
reduce / stop heat loss
OR
improvement:
use a digital thermometer

allow use a data logger

reason - must be linked
more accurate or easy to read or stores data

allow more precise or more sensitive

ignore more reliable

ignore improvements to method, eg take more readings

1

(c) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information in the Marking Guidance and apply a 'best–fit' approach to the marking.

0 marks
No relevant content

Level 1 (1–2 marks)
There is a statement about the results.

Level 2 (3–4 marks)
There are statements about the results. These statements may be linked or may include data.

Level 3 (5–6 marks)
There are statements about the results with at least one link and an attempt at an explanation.

Examples of chemistry points made in the response:
Description:
Statements
Concentration of copper sulfate increases
Temperature change increases
There is an anomalous result
The temperature change levels off
Reaction is exothermic

Linked Statements
Temperature change increases as concentration of copper sulfate increases
The temperature change increases, and then remains constant
After experiment 7 the temperature change remains constant

Statements including data
The trend changes at experiment 7
Experiment 3 is anomalous

Attempted Explanation
Temperature change increases because rate increases
Temperature change levels off because the reaction is complete

Explanation
As more copper sulfate reacts, more heat energy is given off
Once copper sulfate is in excess, no further heat energy produced

6

[9]

9 (a) (i) iron

either order

1

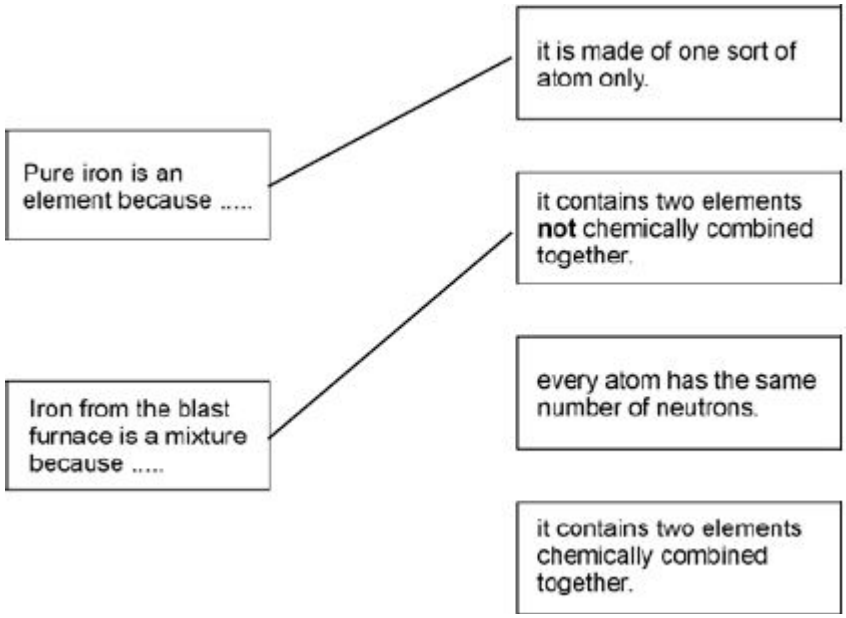
carbon dioxide

1

(ii) reduced

1

(b) (i)



*each correct line gains **1** mark*

extra lines from statement negate the mark

max. 2

(ii) the layers / rows are distorted / disrupted **or** it doesn't occur in layers **or** the atoms are different

1

so cannot **slide** over one another **or slide** less easily

1

[7]

10 (a) any **three** from:

- concentration of (salt) solution
- volume of (salt) solution

  ignore amount of solution
- **initial** temperature (of the solution)

  ignore room temperature
- surface area / form of metal
- moles of metal

  allow mass / amount

  ignore time

  ignore size of tube

3

(b) 20

1

32

1

12

allow ecf

1

(c) (i) four bars of correct height

tolerance is + / - half square

*3 correct for **1** mark*

2

bars labelled

1

(ii) *one variable* is non-continuous / categoric

accept qualitative or discrete

accept no values between the metals

1

(iii) magnesium

1

because biggest temperature change

accept gives out most energy

ignore rate of reaction

dependent on first mark

1

(iv) does not react / silver cannot displace copper

1

because silver not more reactive (than copper) **or** silver below copper in reactivity series

*do **not** accept silver is less reactive than copper sulfate*

1

(v) replace the copper sulfate

could be implied

1

with any compound of a named metal less reactive than copper

allow students to score even if use an insoluble salt

1

[16]

11 (a) pure copper is twice as good a conductor as 99% pure copper

accept reverse argument

*accept answers quoting 2 correct values from the graph scores **2***

*qualitative answer (e.g. pure copper is a better conductor than impure copper) scores **1***

or

*answers quoting a conductivity value from the graph scores **1***

2

(b) Marks awarded for this answer will be determined by the Quality of Communication (QC) as well as the standard of the scientific response.

0 marks
No relevant content

Level 1 (1–2 marks)
Simple list of a limited number of points given, with no linking between ideas

Level 2 (3–4 marks)
A broader set of points made. There will probably not be links between ideas

Level 3 (5–6 marks)
Answer includes linking between ideas, showing the consequence of either not recycling or the advantage of recycling. Answers such as less fossil fuel needed so less carbon dioxide produced **or** less carbon dioxide produced so less global warming

examples of the points made in the response

resources
(recycling) conserves supplies of ores
copper available for longer
as (at present rate of use) copper ores will run out in about 35 years
(recycling) conserves supplies of fossil fuels **or** energy
less fuel used at a lower cost

land pollution
mining scars landscape **or** produces noise pollution
mining destroys wildlife habitats
(recycling) less need to mine ores / fossil fuels
so less habitat destroyed or less scarring of landscape
(recycling) less need to use landfill for waste

atmospheric pollution
burning fossil fuels produces carbon dioxide / greenhouse gas
which (may) cause global warming **or** climate change
extraction produces sulfur dioxide
which causes acid rain
which can kill trees / fish

6

(c) grow plants

accept plants absorb copper (through roots)

1

then plants are burned

1

ash (from burning) contains copper compounds

1

[11]

12 (a) (i) economical

1

(ii) phytomining

1

(iii) carbon dioxide

1

(b) (i) copper / Cu

1

iron sulfate / $FeSO_4$

1

(ii) copper / ions have a positive charge

it = copper ions

allow copper ions have a different charge

accept copper / ions are free to move

accept to gain electrons

*accept copper / ions are attracted to the negative electrode **or** opposite charges attract*

1

(c) any **two** from:

ignore not biodegradable or does not decay

- copper ores are limited / running out

  allow copper is running out
- copper can be recycled
- copper can be reused
- copper is expensive
- landfill sites are filling up
- copper compounds are toxic

  allow copper is toxic

2

[8]

13 (a) (i) Positive impact

any **one** from:

- provides employment **or**
- improves local economy
- improved transport - new roads are built, new rail links
- after use the quarry could provide recreation facilities

1

Negative impact

any **one** from:

- destruction of animal habitats
- fewer plants and trees to absorb carbon dioxide
- visual pollution **or** noise pollution **or** atmospheric / air pollution
  allow dust pollution
- more traffic
- uses non-renewable resources
  allow pollutants from burning diesel

1

(ii) economical

1

(b) carbon / coke burns (in oxygen / air)
accept carbon / coke reacts with oxygen / air

1

(c) (i) iron oxide (reactant)
must be words

1

carbon dioxide (product)

1

(ii) reduction

1

(d) (i) oxygen reacts with carbon

1

or

oxygen and carbon produce carbon dioxide / carbon monoxide

carbon dioxide / carbon monoxide is a gas

or

the carbon is removed as a gas

1

(ii) much harder

1

(e) Advantage:

less carbon dioxide is produced

1

Disadvantage:

there are different types of steel which must be sorted

1

[12]

14 (a) (i) copper / Cu

1

(ii) 50 (p)

1

(iii) 25

1

(iv) tin

1

(b) any **one** form:

- high cost of copper
  allow metal is expensive
- less copper available **or** (copper ores exhausted / **only** low-grade ores available)
  allow copper is non-renewable
- high demand for copper
- high percentage (%) of copper in the coin
- inflation (of cost)

1

[5]

15 (a) (i) aluminium oxide
ignore (III) after aluminium

1

(ii) (because it provides) heat / energy (to overcome activation energy)

1

(b) (i) contains only one sort of atom

1

(ii) the atoms (in cast iron) are different sizes
*any mention of molecules, maximum **1** mark*
*accept layers are distorted **or** structure is disrupted*

1

which prevents the layers / rows sliding
accept an answer in terms of pure iron being softer than cast iron for both marks

1

(c) (i) because aluminium is more reactive than carbon

'it' = aluminium must be a comparison between the elements

or

because aluminium is above carbon in the reactivity series

*do **not** accept any comparison of the reactivity of aluminium and iron*

1

(ii) reduces / lowers the temperature for the process **or** lowers the operating temperature **or** allows ions to move

ignore any temperature values

allow reduces the (effective) melting point (of Al_2O_3)

1

(iii) 3

accept multiples

1

(iv) electrons are gained (by Al^{3+})

ignore any numbers

ignore any reference to oxygen

1

(v) electrodes are made of carbon

allow graphite / coke

1

oxygen is produced (at the positive electrode / anode)

accept $2O^{2-} \rightarrow O_2 + 4e^-$

1

so the electrodes react with the oxygen / are oxidised

1

producing carbon dioxide (gas)

accept $C + O_2 \rightarrow CO_2$ for marking points 3 and 4.

1

[13]

16 (a) (i) any **two** from:

- bubbles / effervescence / fizzing

  ignore hydrogen / gas produced
- lithium disappears / gets smaller

  allow dissolves

  *do **not** allow melts / burns*
- lithium moves on the surface of the water

  ignore floats
- (universal indicator) turns blue / purple

2

(ii) 2

left-hand side correct

1

2

right-hand side correct

allow multiples for full credit

1

(iii) light / burn, which will give a (squeaky) pop / explosion

1

(iv) all have 1 electron in their outer shell / energy level

allow have the same number of electrons in their outer shell / energy level

1

(b) They react with oxygen

1

They have low melting points

1

(c) (i) electronic structure [2,8,8] is drawn

*incomplete inner shells scores a maximum of **1** mark*

1

charge is +

*allow $[2,8,8]^+$ for **1** mark*

1

(ii) because (in potassium) the outer shell electron is further away from the nucleus **or** because potassium atoms are larger than sodium atoms

*it should be clear that the candidate is referring to the outer shell electron: if this is not clear a maximum of **2** marks can be awarded*

1

therefore the outer shell electron is less strongly attracted to the nucleus **or** is more shielded from the attraction of the nucleus and so the outer shell electron in potassium is more easily lost

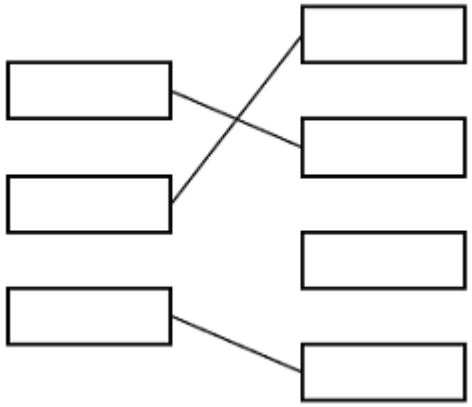
1

***3** marks can be scored for answering the question in terms of sodium*

1

[13]

17 (a)



one mark for each substance linked correctly to its description

*do **not** accept more than one line from each substance*

3

(b) 0 / zero / none / no charge

1

electron

1

(c) (i) nucleus

1

(ii) atomic number

1

(iii) mass number

1

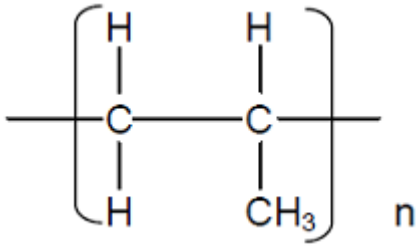
[8]

18 (a) (i) ethene

allow C_2H_4

1

(ii)



accept line drawn from word 'Monomer' or from the monomer box to the correct 'Polymer'

allow the correct 'Polymer' indicated by a tick, circled etc.

1

(b) (i) nickel

accept Ni

1

(ii) 75(%)

1

(iii) (stainless steel) is hard /strong / durable

it = stainless steel

accept (pure) iron is soft

1

(stainless steel) resistant to corrosion **or** unreactive

accept (pure) iron rusts / corrodes / reacts

*do **not** allow corrosive*

1

(c) **Advantage** : Conserves resources of crude oil and ores

*do **not** allow more than one tick in the advantage column*

1

Disadvantage : High cost of separating materials

*do **not** allow more than one tick in the disadvantage column*

1

[8]

19 (a) any **two** from:

- copper / ores are running out / harder to find
- there are no / very small amounts of high-grade copper ores left
- copper metal is in demand
- copper is expensive
- now economical to extract copper from low-grade ores

it = copper

allow new methods of extraction e.g. bioleaching and phytomining

*allow high-grade ores are running out for **2** marks*

2

(b) (i) large amounts / 98% of rock to dispose of as waste

accept contains toxic (metal) compounds / bioleacher

or

waste rock takes up a lot of space

1

(ii) (copper sulfide reacts with oxygen to) produce sulfur dioxide / SO_2

allow (sulfur reacts with oxygen to) produce sulfur dioxide / SO_2

1

that causes acid rain

*allow description of effects of acid rain **or** sulfur dioxide*

*if no other mark awarded allow CO_2 produced which causes global warming **or** CO_2 produced by burning fuel or heating the furnace for **1** mark*

1

(iii) any **one** from:

- large amounts of fuels / energy used (for the furnace and electrolysis)

  allow large amounts of electricity needed

  ignore high temperature / electrolysis unqualified

- (the extraction has) many steps / stages / processes

  allow (extraction) is a long process / takes a lot of time

- large amounts of ore / material have to be mined

  allow ores contain a low percentage of copper

1

(iv) (copper ions move towards) the negative electrode */ cathode*

1

because copper ions / Cu^{2+} are positively charged **or** are oppositely charged **or** copper ions need to gain electrons

*allow because metal ions are positive **or** opposites attract*

1

(v) (growing) plants

1

[9]

20 (a) (i) 2.8.3

any sensible symbol can be used to represent an electron

1

(ii) proton(s) **and** neutron(s)

both needed for the mark

1

(iii) number of protons is equal to number of electrons

allow positive and negative charges cancel out

allow same amount of protons and electrons

1

(b) (i) **2** Al + Fe_2O_3 → **2** Fe + Al_2O_3

equation must be balanced

1

(ii) aluminium is more reactive (than iron)

it = aluminium

accept converse

accept aluminium displaces iron

accept aluminium is higher in the reactivity series (than iron)

1

[5]

21 (a) any **one** advantage from:

- conserves resources (of crude oil / metal ores)

  ignore can be made into other items

  allow the materials (in the pen) are non-renewable

  allow less expensive than producing from the raw material

- reduces use of landfill

  ignore less waste

- less use of fuels/energy

- less carbon dioxide produced

  ignore global warming unqualified

1

any **one** disadvantage from:

- made of different polymers / alloys / materials

- difficulty / cost of separating the different materials

  allow not all the materials can be recycled

1

(b) hard / strong / durable

1

resistant to corrosion **or** unreactive

allow do not rust

*do **not** allow corrosive*

1

(c) (i) vapours (of decane)

ignore pressure / hot / heat

allow high temperature (≥150 °C)

1

passed over a catalyst **or** porous pot **or** aluminium oxide

allow catalyst even if incorrectly named

1

or

mixed with steam (1)

at a (very) high temperature (1)

if temperature quoted, must be ≥ 500 °C

(ii) many monomers **or** many ethene molecules

1

join / bond

allow addition polymerisation for second mark

1

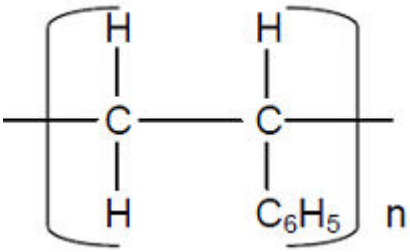
OR

monomers / ethene molecules (1)

form chains **or** very large molecules (1)

*if no other mark awarded allow double bond breaks / opens up **or** double bond forms a single bond for **1** mark*

(d)



allow bonds that do not extend through brackets

7 single bonds are used and are in the correct places with no additional atoms (1)

the brackets and the n are in the correct place (1)

2

[10]

22 (a) (i) current / charge couldn't flow

allow could not conduct (electricity)

1

because the ions / particles couldn't move

*do **not** accept electrons/ molecules / atoms*

or

(salt) needs to be molten / (1) dissolved (to conduct electricity)

so that the ions / particles can move (1)

*do **not** accept electrons / molecules / atoms*

1

(ii) he had status

*accept he had authority **or** experience*

or

he had evidence / proof

accept the experiment could be repeated

1

(b) hydrogen / H_2

*do **not** allow hydrogen ions*

1

the ions are positive

accept because opposite (charges) attract

1

potassium is more reactive (than hydrogen)

accept potassium ions are less easily discharged (than hydrogen)

***or** potassium ions are less easily reduced (than hydrogen)*

1

(c) (i) gain electron(s)

*accept fully balanced correct equation for **2** marks*

1

one electron

*if no other marks awarded allow (potassium ions) reduced for **1** mark*

1

(ii) $2\ Cl^- \rightarrow Cl_2 + \mathbf{2e^-}$

must be completely correct, including charge on electron

accept correct multiples

1

(iii) 2, 8, 8

accept any combination of dots, crosses, "e" or any other relevant symbol

ignore any charges if given

1

[10]

23 (a) (i) hydrogen

accept H_2

allow H

1

(ii) hydroxide

accept OH^-

allow OH

*do **not** accept lithium hydroxide*

1

(b) any **two** from:

'it' = potassium

potassium:

accept converse for lithium

- reacts / dissolves faster

  allow reacts more vigorously / quickly / violently / explodes
  ignore reacts more

- bubbles / fizzes faster

  allow fizzes more

  allow more gas

- moves faster (on the surface)

  allow moves more

- melts

  allow forms a sphere

- produces (lilac / purple) flame

  allow catches fire / ignites

  *do **not** accept other colours*

2

[4]

24 (a) reduction

1

(b) carbon is less reactive than aluminium

1

(c) aluminium (ions) / they are positively charged

they = aluminium ions

ignore particle names

accept aluminium (ions) / they are cations

allow aluminium (ions they have an opposite charge

1

so they are attracted **or** they move towards the negative electrode

OR

aluminium (ions) / they need to gain electrons (1)

which come from the negative electrode (1)

if no other marks awarded allow 'opposites attract' for ***1*** *mark*

1

(d) aluminium has a low density

1

aluminium is resistant to corrosion

1

(e) **advantage** less carbon dioxide is produced

1

disadvantage used aluminium cans have to be collected and transported

1

[8]

25 (a) (i) reduction

accept redox / smelting

1

(ii) 3 4 3

1

(b) (i) 55

ignore other units

(ii) Water

accept sodium hydroxide

accept correct formulae H_2O or NaOH

1

(iii) any **one** from:

- save energy / fuel for transporting the ore

  accept less (cost of) transport allow transported quickly

- (old) quarries nearby for waste/red mud

1

(c) **Environmental**

any **one** from:

- less mining / quarrying (of bauxite)
  allow loss of habitat / less qualified noise pollution
- less landfill space needed / used
  allow less red mud / waste
- less use of fossil fuels / energy
- less carbon dioxide produced

1

Ethical or social

any **one** from:

- saves resources
  allow using resources more than once
- creates (local) employment
  *if answers reversed and both correct award **1** mark*
- more people aware of the need for recycling
  allow less qualified noise pollution if not given in environmental

1

[7]

26 (a) (iron (steel) is) strong
*allow abundant **or** easy to extract **or** cheap*
ignore other correct properties

1

(b) <u>less</u> dense
allow low mass

1

<u>more</u> abundant
accept copper is 'running out'
allow copper is more expensive
ignore other correct statements

1

(c) (i) C_2H_4

1

(ii) double bond

1

(iii) poly(ethene)

1

[6]

27 (a) any **one** from:

- no method / electrolysis / equipment / technology
  allow 'didn't know how to' ***or*** *'no knowledge'*
- aluminium is a very reactive metal
- high melting point
  allow 'couldn't heat it enough'
- potassium had not been discovered

1

(b) because <u>others</u> / <u>scientists</u> / <u>they</u> could not repeat the experiment
ignore he could not repeat the experiment

or
<u>others</u> / <u>they</u> could not obtain the same results

1

(c) reaction is endothermic **or**
reaction <u>takes in</u> heat / energy
accept activation energy
ignore rate / high temperature
ignore bonds broken

1

(d) (aluminium chloride + potassium) → aluminium + potassium chloride
in either order
accept correct formulae
ignore metal
ignore balancing

1

(e) when tested it had the properties of a metal
accept a test for a metal property eg conductivity / reaction with acid

1

properties were different (from other known metals)
accept properties compared with other metals

1

[6]

28 (a) causes dust pollution

1

increases traffic

1

(b) (i) it is soft

accept the layers of atoms can slide over each other

ignore other properties

1

(ii) contains chromium / nickel

allow contains other <u>metals</u>

1

(c) (i) an element

1

(ii) hard

1

(iii) is resistant to corrosion

1

[7]

29 (a) (i) contains enough metal to <u>make it economical</u> to extract

1

(ii) Fe (+) CO_2

formula of both products must be correct

1

(Fe_2O_3) (+) ....3....(CO)

→

.....2.....(Fe) (+) .....3...(CO_2)

balancing correct

allow correct balancing using Fe_2

1

(iii) reduction

accept redox

1

(b) (i) oxygen <u>reacts</u> with the carbon to produce carbon dioxide

allow carbon monoxide for carbon dioxide

1

OR

carbon dioxide is produced (1)

which escapes as a gas (1)

1

(ii) to give steels with <u>different</u> / particular properties or for <u>different</u> / <u>particular</u> uses

ignore to make different alloys

1

(c) copper is very expensive

accept the metal (iron / steel) costs less than copper

ignore energy

1

because copper ores are 'low grade' / running out

allow copper is rare

ignore nickel

1

[9]

30

(a) (i) conducts electricity

1

(ii) <u>mix</u>ture (of metals)

(it = alloy)

1

(b) any **two** from:

ignore pollution without qualification

- noise
- dust

allow dirt

- traffic
- eyesore

2

[4]

31 (a) (i) low percentage / very little of metal (in the ore)

*accept only 0.5% metal in the ore **or** over 99% waste in the ore **or** nearly 100% waste in the ore*

*ignore reference to percentage of metal in the Earth's crust **or** energy used or pollution*

1

(ii) any **one** from

(it = iron)

- iron uses less energy / fuel for extraction

  ignore electrolysis / uses electricity / reactivity

- iron has more uses

- more demand for iron

  ignore high abundance in the Earth's crust / high percentage of metal in ore

- iron is stronger

  ignore harder

- cheaper / costs less

- easier to extract

1

(b) (i) has melting point lower than 950°C

(it = aluminium)

allow has a low melting point

ignore boiling point

1

(ii) electrode(s) made of carbon

1

oxygen reacts with electrode(s) / carbon

accept $C + O_2 (\rightarrow CO_2)$

*NB oxygen reacts with the carbon electrode(s) = **2** marks*

1

(iii) any **two** from:

- saves resources / non-renewable
  *accept aluminium / ore will run out **or** conserves aluminium*
- landfill problem
  accept aluminium does not corrode
- saves energy / fuel / electricity
  ignore global warming
- less carbon dioxide / carbon emissions **or** reduces carbon footprint
  ignore consequences of quarrying / mining
- less quarrying / mining
  ignore pollution / harms environment / costs / easy to recycle

2

[7]

32 (a) (i) removal of oxygen
*accept definition in terms of electrons **or** oxidation numbers*
ignore oxides

1

(ii) 2 (Cl_2)
allow correct multiples

1

(iii) no atoms are lost / made (during a chemical reaction)
or
the atoms are rearranged (during a chemical reaction)
accept because of (the law of) conservation of mass / matter

1

(b) (i) sodium is more reactive (than titanium)
*accept sodium is very reactive **or** titanium is less reactive*
*do **not** accept sodium is more reactive than argon*

1

(ii) any **one** from:

- sodium / titanium would react with oxygen / air
  accept air / oxygen is reactive
- sodium / titanium does not react with argon
  accept argon is unreactive / inert / a noble gas / in group O

1

(c) (i) all atoms are the same / it only contains one type of atom

accept all ions are the same

*do **not** accept only got one atom*

*do **not** accept all atoms are the same size*

ignore particles

1

(ii) two <u>different</u> / <u>types</u> atoms / elements / ions

accept more than one type of atom / ion / element

*do **not** accept different size*

1

bonded / joined together

accept definite proportions

*do **not** accept mixture*

1

[8]

33 (a) (carbon =) 1

1

(oxygen =) 3

1

(b) (i) heated

1

(ii) carbon dioxide

1

(c) (i) combustion

1

(ii) carbon is more reactive than zinc

1

(iii) zinc boils (in the furnace / below 1300°C)

ignore melting point / changes of state

1

lead does not boil / (only) melts in the furnace / boils above 1300°C

*if no other mark awarded allow zinc has a lower boiling point **or** lead has a higher boiling point*

***or** they / zinc **and** lead have different boiling points for **1** mark*

1

[8]

34

(a) (i) copper / Cu

1

(ii) 50(p)

1

(iii) 25

1

(iv) tin

1

(b) (i) any **one** from:

- high cost of copper
  allow metal is expensive
- less copper available ***or*** (copper ores exhausted / **only** low-grade ores available)
  allow copper is non-renewable
- high demand for copper
- high percentage (%) of copper in the coin
- inflation (of cost)

1

(ii) any **one** from:

- stronger / harder
  ignore rust
- cost of copper **or** copper is more expensive to extract **or** steel is cheap
  allow cheaper (to make)
- less copper available

  or
  (copper ores exhausted / **only** low-grade ores available)
- high demand for copper
- less copper is needed

1

[6]

35

(a) (i) C

must be correct symbol
*do **not** accept carbon*
any balancing must be correct

1

(ii) $Fe + CO_2$

correct formulae

1

2... . + 3... .

correct balancing
allow $Fe_2 + 3CO_2$ for this mark

1

(iii) layers / atoms in pure iron are able to slide over each other

it = pure iron
accept ions for atoms
ignore molecules / particles

or

layers / atoms in cast iron are unable to slide over each other (easily)

1

(b) any **three** from:

*mention of ozone = max **2***

- less iron ore used

  accept the idea that ores would be conserved but not unspecified conservation

- less other metals extracted / used to make different steels

  accept the idea that ores would be conserved but not unspecified conservation

- less fuel used

  accept the idea that fuels would be conserved

  ignore reduces energy requirements

- less specified pollution

  accept global warming / greenhouse effect / CO_2 / CO / carbon emissions / acid rain / SO_2 / global dimming /

  *do **not** accept ozone layer*

- less / no landfill space needed

  ignore reduces waste

- less / no mining needed **or** fewer specified effects of mining

  accept effect such as eyesore / loss of habitat

  *eg 'less mining iron ore' = **2** marks*

3

[7]

36 (a) atoms

1

(b) mixture

1

metal

1

structure

1

smart

1

(c) (i) any **two** from:

- saves raw materials / iron ore
- saves energy / fuels
  accept cheaper / saves money
- make new / useful items
- make money / it is economic
- <u>reduces</u> pollution
  allow less harmful for the environment
- decreases cost of steel cans
- reduces carbon dioxide emissions
- decreases waste materials / use of landfill

2

(ii) any **one** from:

- provide information / education of the need to recycle
- legislate against / charge for waste
- reward / pay people to recycle
  accept fine people for not recycling
- put labels on the cans
- provide recycling bags / bins / areas

1

[8]

37 (a) conducts (electricity) **or**
accept flexible

allows electrons / current to flow
ignore conducts heat

1

(b) electron

1

(c) (i) lithium>copper>tungsten **or**

Li>Cu>W

all correct

*allow **1** mark for one metal in the correct position*

2

(ii) has high / highest melting point

accept has high / highest boiling point

or

can withstand the highest temperature

1

(d) unreactive

1

[6]

38 (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]

39 (a) (an alloy) that can return to its original shape (after being deformed / bent / twisted)
accept (on heating / cooling) it returns to its shape

1

(b) any **two** from:

- brass / it is a mixture
  accept brass / it is not pure
- zinc changes structure / disrupts patterns or layers
- copper metal atoms / layers able to slide over each other
  accept zinc prevents atoms / layers sliding over each other

2

(c) (i) oxygen / O_2 / O

1

(ii) lead remains (in furnace) because of its high boiling point

1

zinc boils / evaporates (out of furnace) because of its low boiling point 1 if neither mark awarded then allow **1** mark for different boiling points

ignore references to melting points

1

[6]

40 (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]

41 (a) (i) contain enough metal to make it economical / worth while to extract

1

(ii) reduction

accept displacement

accept redox

1

(iii) $Fe + CO_2$

*do **not** accept Fe_2 / Fe_4*

1

correct balancing

accept multiples and halves

$\mathbf{2}Fe_2O_3 + \mathbf{3}C \rightarrow \mathbf{4}Fe + \mathbf{3}CO_2$

allow Fe_2 / Fe_4 as ecf

1

(b) **Pure Iron**

(in pure metal all the atoms are the same size and) able to slip / slide over each other – (property soft)

OWTTE

ignore references to molecules / particles

if they say 'move' both times, allow ***one*** *mark but 'crack' or 'split' is wrong..*

1

Cast iron

(in cast iron) different sized atoms / larger atoms **or** structure is distorted / disrupted

OWTTE

1

so it is difficult for layers of atoms to slip / slide over each other

OWTTE

1

(c) any **three** from:

- conserves / saves resources / metal ores
- saves energy resources (used for extraction / processing)

  accept cheaper / saves money
- decreases waste materials
- decreases a named pollution

  do ***not*** *accept acid rain*

3

[10]

42 (a) (i) any **one** from:

- iron ore is a limited resource / non-renewable
- iron is in high demand
- provide jobs
- economic advantage

1

(ii) any **two** from:

- would damage (wildlife) habitats / countryside / greenfield sites
- extra traffic
- visual (pollution) / eyesore
- noise (pollution) / sound (pollution)
- dust (pollution)
- river (pollution)
- carbon dioxide (from traffic) / adds to greenhouse effect / global warming
- damage roads / buildings by vibrations / shockwaves

2

(b) (i) carbon monoxide / carbon

accept formulae CO / C

1

(ii) atoms

accept (particles) are all the same (size) / type for one mark

1

are all the same (size) / type

1

(iii) any **two** from:

- impurities / carbon / different (sized) atoms **or** elements **or** metals
- changes the structure / disrupts the pattern or layers
- prevents layers sliding over each other
- it is an alloy

2

[8]

43 (a) (i) $Cu_2S + 2O_2 \rightarrow 2CuO + SO_2$

accept fractions and multiple

1

(ii) any **two** from:

- sulfur dioxide

  accept sulphur dioxide / sulphur oxide / SO_2

- causes acid rain

  ignore other comments eg global warming / ozone / global dimming / greenhouse effect

- consequence of acid rain eg kills fish / plants

2

(b) any **two** from:

- heat (copper oxide with carbon)
- oxygen is removed by carbon

  accept copper (oxide) loses oxygen

  or

  carbon gains oxygen

  accept carbon oxide

  or

  carbon monoxide / carbon dioxide is produced

  or

  carbon displaces copper

  accept a correct word or balanced symbol equation

- because carbon is more reactive than copper

  allow a correct comparison of reactivity

2

(c) (i) electrolysis

accept electroplating

1

(ii) (electrical) wiring / appliances / coins / pipes / cladding for buildings / jewellery / making alloys

1

or

named alloys

(d) any **three** explanations from:

<u>for recycling</u>

- less acid rain (pollution)
- copper reserves last longer / conserved

  or

  do not run out
- energy for extraction (saved)

  or

  less energy required
- less mining / quarrying
- less waste (copper) / electrical appliances dumped

  or

  less landfill

  <u>against recycling</u>
- collection problems
- transport problems
- difficult to separate copper from appliances
- energy used to melt the collected copper

  ignore electrolysis / pollution
  ignore ideas about less machinery / plant
  ignore idea of cost

3

[10]

44 (a) (i) 5(%)

1

(ii) 0.35

$$\frac{5}{10} \times 7$$

for 1 mark

2

(b) (i) reduction

accept (it's) reduced

*do **not** accept redox / deoxidation*

1

(ii) heat with / reduce / react with **or** (chemical) reaction

1

with a metal / element / substance higher in reactivity

ignore displace
*accept higher named elements **or** symbol*
accept carbon monoxide / coal / coke

*correct word equation for **2** marks*
*correct formulas for **1** mark*
*correct balanced symbol equation for **2** marks*

1

or

electrolysis:
molten (1)
electrolysis (1)

[6]

45 (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]

46 (a) (very) small percentage / amount (in the Earth's crust)

any indication that there is a small amount, eg not much (left)
accept rare (elements) / rarer
accept not commonly found
ignore cannot find easily
ignore hard to extract

1

(b) (i) oxygen / O_2 / O

*do **not** accept O^{2}*

1

(ii) any **one** from:

- potassium / K
- sodium / Na
- calcium / Ca
- magnesium / Mg

symbols must be correct
write name and incorrect symbol,
ignore symbol

1

(c) (i) heating (with) **or** hot air blown into furnace

accept high temperatures or (very) hot

1

carbon / carbon monoxide / coke / coking coal

*do **not** accept coal / charcoal accept balanced equation only*

or

carbon reacts with O_2 **or** carbon / coke burning (1)

accept balanced equation only CO / CO_2

CO reacts with the ore (1)

for naming the reducing agent

1

(ii) cost of melting ore / electricity
makes aluminium expensive (owtte)
or (large amount of) electricity used
or because you have to use electrolysis
or aluminium is higher in the reactivity series
or aluminium is harder to reduce
or unable to reduce with carbon
or the cost of purifying the bauxite

*do **not** accept harder to extract / produce*
*more energy is **not** enough*

1

[6]

47 (a) mixture

***not** compound*

1

of a metal with other element(s) / metals

***not** of elements*
***not** of a metal with other substances*

1

(b) steel

allow stainless steel

1

(c) stronger / increased strength / harder / less malleable / less brittle

***not** corrosion / rusting*

1

(d) copper and zinc

1

[5]

48 (a) gives out

heat

each for 1 mark

2

(b) chromium and aluminium oxide

1

(c) (i) chromium oxide

1

(ii) oxygen removed/gains electrons

1

[5]

49 (a) lead oxide + carbon = lead + carbon dioxide
(A symbol equation was accepted if correct)

1

(b) oxygen removed (or addition of electrons)

1

[2]

50 (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]

51 (a) $Zn + \mathbf{2}HC\,1 \rightarrow ZnC1_2 + H_2$

1

(b) (i) 12.5

1

(ii) steeper curve same volume of gas evolved

do not credit two intersects of straight lines

accept a sharp bend

2

(iii) any **two** from:

stir it

accept mix it better

heat it

accept warm it

use a more finely divided catalyst

accept use a better catalyst or more finely divided zinc

do not credit use acid of a higher

2

(c) (i) any **one** from

zinc is more reactive than copper

accept zinc is above copper in the reactivity series

zinc displaces copper

accept it is higher than copper in the reactivity series

1

(ii) zinc + copper sulphate → copper + zinc sulphate

*ignore the presence of acid **or** water*

accept a balanced equation

1

[8]

52 (a) (i) rings of 2, 8 and 3 electrons

credit 2, 8, 3 pay particular attention to the outer shell in diagrams

1

(ii) rings of 2, 8 and 7 electrons

credit 2, 8, 7 pay particular attention to the outer shell in diagrams

1

(b) (i)

labels not required on atoms
charges need to be shown on ions
reference to outer shell is required otherwise a maximum of two marks

structure of atoms/ions marks

(ring of 2, 8, 1 for sodium) **or** the outer shell of sodium only contains 1 electron

*credit 2, 8, 1 **or** an ion 2, 8 **or** two circles and 1 electron in outer shell*

1

(ring of 2, 6 for oxygen) **or** outer shell only contains 6 electrons

*credit 2, 6 **or** an ion 2, 8 **or** two circles*

1

transfer of electrons mark

two sodiums needed to supply two outer electrons to oxygen to complete the (one oxygen's) outer shell

award maximum of two marks if a covalent structure is given

credit two rings of electrons for sodium showing outer electrons transferring to outer shell of one oxygen for three marks

do not accept diagrams showing overlapping rings for third mark

1

(ii) loses an electron

*credit atoms lose electrons **or** oxygen takes the electron ignore oil rig*

1

[6]

53 (a) This part was not marked

1

(b) electrolysis

1

because calcium is more reactive (than aluminium **or** carbon)

accept it is more reactive
***or** very reactive*

1

OR

in a blast furnace

1

because calcium is less reactive (than carbon **or** lower)

1

(c) any equation from

1 mark for correct formulae

1 mark for balancing

$2ZnO + C \rightarrow 2Zn + CO_2$

$ZnO + CO \rightarrow Zn + CO_2$

$ZnO + C \rightarrow Zn + CO$

1

[5]

54

(i) idea that:

carbon is above lead in the reactivity series } NOT

for 1 mark

carbon is below aluminium in the reactivity series } OXIDE

for 1 mark

carbon can remove oxygen from/reduce lead <u>oxide</u>
or cannot remove oxygen from aluminium <u>oxide</u>
not aluminium more reactive than lead

for 1 mark

OR similar ideas in comparing bond strengths

3

(ii) (carbon + lead oxide) →*<u>lead</u> + *<u>carbon dioxide</u>

each for 1 mark

accept correct formulae CO_2 and CO **NOT** carbon oxide

2

[5]

55

(a) hydrogen

for 1 mark

1

(b) oxygen

for 1 mark

1

[2]

56

correct use of 'react'/'reaction'/reactants'/combine
(not mixed/added/join)
correct use of 'produce'/'products'/gives/forms/makes/creates
reactants correctly identified

each for 1 mark

products correctly identified
(Reactants must be correctly identified for 'react'
mark to be awarded. Similarly for products)
(magnesium reacts with zinc oxide to produce magnesium
oxide and zinc or similar, will gain all 4 marks)
Oxidise or reduce given correctly can be credited both
the marks for react and produce

[4]

57

(a) *ideas that it is a*

- compound of metal/metal oxide/combined (NOT mixed) cpd/
  named cpd O^{2-}/S^{2-}/CO_3^{2-} etc
- found naturally/in rocks/in Earth's Crust

for 1 mark each

2

(b) reduction (accept smelting/refining but not electrolysis)

for 1 mark

1

(c) One example. Al or above in Reactivity Series
ie Group I or II metals NOT Pb/Cu or compounds

for 1 mark

1

[4]