AQA GCSE CHEMISTRY (HIGHER) · 8462

CHEMISTRY



MARK SCHEME

4.4.1 REACTIVITY OF METALS (PACK 1)

SCORE	PERCENTAGE
/334	%

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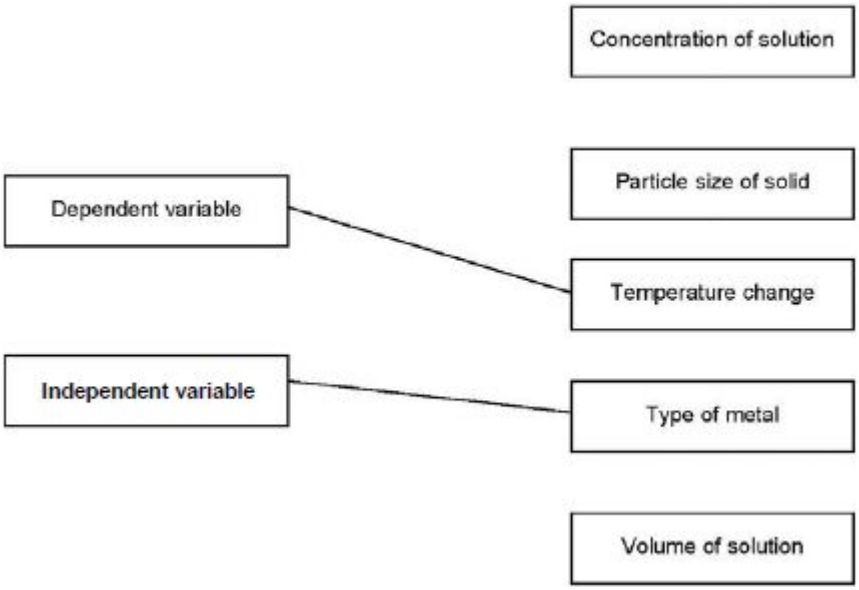
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Q1.

(a)



*allow **one** mark if answers are reversed*

1
1

(b) polystyrene is a better insulator

1

(c) both bars labelled

1

both bars correctly plotted

allow tolerance of ±½ small square

ignore width and spacing of bars

*if no other mark scored, allow **1** mark for any one bar correctly plotted and labelled*

1

(d) temperature increases

allow (because) energy / 'heat' is transferred to the surroundings

or

temperature does not decrease

energy / 'heat' is not taken in from the surroundings

allow the energy of the products is less than the energy of the reactants

1

(e) (most reactive)

magnesium

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(zinc)

nickel

this order only

1

(f) suitable method described

1

the observations / measurements required to place in order

1

an indication of how results would be used to place the unknown metal in the reactivity series

1

approaches that could be used:

approach 1:
add the unknown metal to copper sulfate solution (1)

measure temperature change (1)

place the metals in order of temperature change (1)

approach 2:
add the metal to salt solutions of the other metals
or
heat the metal with oxides of the other metals (1)

measure temperature change (only if salt solutions used)
or
observe whether a chemical change occurs (1)

compare temperature change or whether there is a reaction to place in correct order (1)

approach 3:
add all of the metals to an acid (1)

measure temperature change or means of comparing rate of reaction (1)

place the metals in order of temperature change or rate of reaction (1)

approach 4:
set up electrochemical cells with the unknown metal as one electrode and each of the other metals as the other electrode (1)

measure the voltage of the cell (1)

place the metals in order of voltage (1)

(g) D

1

(h) C

1

[12]

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Q2.

(a) sodium oxide

allow Na_2O

1

(b) oxidation

1

(c) 13

1

(d) sodium hydroxide

1

(e) OH^-

1

(f) $(\text{volume} =) \frac{250}{1000}$ or ¼

or 0.25 (dm^3)

1

or

$(\text{mass per } cm^3 =) \frac{40}{1000}$ (g)

or 0.04 (g)

$(\frac{250}{1000} \times 40 =) 10$ (g)

1

*an answer of 10 (g) scores **2** marks*

(g) all points correct

allow a tolerance of ±½ a small square
*allow **1** mark for 3 points correct*
ignore any attempt at a line of best fit

2

(h) 39 °C

allow any value from 34 to 46 (°C)

1

[10]

Q3.

(a) FeS_2

*do **not** accept equations*

1

(b) 26

1

30

1

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26

must be this order

1

(c) any **two** from:

- iron has a high(er) melting / boiling point
- iron is dense(r)
- iron is hard(er)

allow iron is less malleable / ductile

- iron is strong(er)
- iron is less reactive

allow specific reactions showing difference in reactivity

- iron has ions with different charges
- iron forms coloured compounds
- iron can be a catalyst

allow iron is magnetic

allow the converse statements for sodium
allow transition metal for iron
allow Group 1 metal for sodium

ignore references to atomic structure

ignore iron rusts

2

(d) carbon is more reactive (than nickel)

allow converse

1

(so) carbon will displace / replace nickel (from nickel oxide)

allow (so) nickel ions gain electrons

or

(so) carbon will remove oxygen (from nickel oxide)

allow (so) carbon transfers electrons to nickel (ions)

1

(e) (total M_r of reactants =) 87

1

(percentage atom economy)

$$= \frac{59}{87} \times 100$$

allow (percentage atom economy)

$$= \frac{59}{\text{incorrectly calculated } M_r} \times 100$$

1

= 67.8 (%)

allow an answer from an incorrect calculation to 3 sig figs

1

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*an answer of 67.8 (%) scores **3** marks*

*an answer of 67.8160919 (%) or correctly rounded answer to 2, 4 or more sig figs scores **2** marks*

an incorrect answer for one step does not prevent allocation of marks for subsequent steps

[11]

Q4.

(a) all 4 metals labelled and suitable scale on *y*-axis

magnesium value must be at least half the height of the grid

1

all bars correctly plotted

allow a tolerance of ±½ a small square

ignore width and spacing of bars

*allow **1** mark if copper not included and other 3 bars plotted correctly*

1

(b) temperature increases

allow (because) energy / 'heat' is transferred to the surroundings
allow energy / 'heat' is given out

or

temperature does not decrease

allow energy / 'heat' is not taken in (from the surroundings)
allow the energy of the products is less than the energy of the reactants

1

ignore because it is exothermic
ignore references to copper

(c) suitable method described

1

the observations / measurements required to place in order

dependent on a suitable method

1

an indication of how results would be used to place the unknown metal in the reactivity series

1

a control variable to give a valid result

1

approaches that could be used

approach 1:
add the unknown metal to copper sulfate solution (1)

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measure temperature change (1)

place the metals in order of temperature change (1)

any **one** from (1):
- same volume of solution
- same concentration of solution
- same mass / moles of metal
- same state of division of metal

approach 2:
add the metal to salt solutions of the other metals
or
heat the metal with oxides of the other metals (1)

measure temperature change (only if salt solutions used)
or
observe whether a chemical change occurs (1)

place the metals in order of temperature change **or**
compare whether there is a reaction to place in correct order (1)

any **one** from (1):
- same volume of salt solutions
- same concentration of salt solutions
- same (initial) temperature of salt solutions
- same mass / moles of metal **or** metal oxide
- same state of division of metal **or** metal oxide

approach 3:
add all of the metals to an acid (1)

measure temperature change or means of comparing rate of reaction (1)

place the metals in order of temperature change or rate of reaction (1)

any **one** from (1):
- same volume of acid
- same concentration of acid
- same (initial) temperature of acid
- same mass / moles of metal
- same state of division of metal

approach 4:
set up electrochemical cells with the unknown metal as one electrode and each of the other metals as the other electrode (1)

measure the voltage of the cell (1)

place the metals in order of voltage (1)

any **one** from (1):
- same electrolyte
- same concentration of electrolyte
- same (initial) temperature of acid
- same temperature of electrolyte

(d) correct shape for exothermic reaction

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the reactant and product lines needed not be labelled

*do **not** accept incorrectly labelled reactant and product lines*

1

labelled activation energy

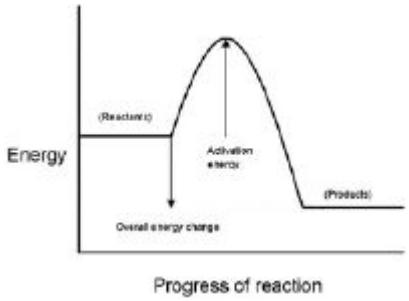
1

labelled (overall) energy change

1

ignore arrow heads

an answer of:



*scores **3** marks*

[10]

Q5.

(a) chlorine is toxic

allow carbon monoxide is toxic

allow poisonous for toxic
ignore harmful / deadly / dangerous

allow a poisonous gas is used / produced

allow titanium chloride is corrosive

1

(b) any **one** from:

- very exothermic reaction

  allow explosive
  allow violent reaction
  ignore vigorous reaction
  ignore sodium is very reactive

- produces a corrosive solution

  allow caustic for corrosive
  ignore alkaline

- produces hydrogen, which is explosive / flammable

  allow flames produced
  ignore sodium burns

1

(c) argon is unreactive / inert

allow argon will not react (with reactants / products / elements)

1

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oxygen (from air) would react with sodium / titanium
or
water vapour (from air) would react with sodium / titanium

allow elements / reactants / products for sodium / titanium

1

(d) metal chlorides are usually ionic

allow titanium chloride is ionic

1

(so)(metal chlorides) are solid at room temperature
or
(so)(metal chlorides) have high melting points

allow titanium chloride for metal chlorides

1

(because) they have strong (electrostatic) forces between the ions

ignore strong ionic bonds

or
(but) must be a small molecule or covalent

allow molecular

1

allow alternative approach:

*titanium chloride must be covalent **or** has small molecules (1)*

with weak forces between molecules
*do **not** accept bonds unless intermolecular bonds(1)*

(but) metal chlorides are usually ionic (1)

(e) sodium (atoms) lose electrons

*do **not** accept references to oxygen*

1

(f) $Na \longrightarrow Na^+ + e^-$

*do **not** accept e for e^-*

1

(g) (M_r of $TiCl_4$ =) 190

$$(\text{moles Na} = \frac{20\,000}{23} =) \ 870 \ (\text{mol}) \ *$$

1

$$(\text{moles } TiCl_4 = \frac{40\,000}{190} =) \ 211 \ (\text{mol}) \ *$$

1

allow **1 mark for 0.870 mol Na **and** 0.211 mol $TiCl_4$*

allow use of incorrectly calculated M_r from step 1

either
(sodium is in excess because) 870 mol Na is more than the 844 mol needed

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or

(because) 211 mol $TiCl_4$ is less than the 217.5 mol needed

the mark is for correct application of the factor of 4

other correct reasoning showing, with values of moles or mass, an excess of sodium or insufficient $TiCl_4$ is acceptable

allow use of incorrect number of moles from steps 2 and / or 3

1

alternative approaches:

approach 1:

(M_r of $TiCl_4$ =) 190(1)

(40 kg $TiCl_4$ needs)

$\frac{40}{190} \times 4 \times 23$ *(kg Na) (1)*

(=) 19.4 (kg) (1)

so 20 kg is an excess (1)

approach 2:

(M_r of $TiCl_4$ =) 190(1)

(20 kg Na needs)

$\frac{20}{4 \times 23} \times 190$ *(kg $TiCl_4$) (1)*

(=) 41.3 (kg) (1)

so 40 kg is not enough (1)

(h) (actual mass =) $\frac{92.3}{100} \times 13.5$

or

(actual mass =) 0.923 × 13.5

1

= 12.5 (kg)

allow 12 / 12.46 / 12.461 / 12.4605 (kg)

1

*an answer 12.5 (kg) scores **2** marks*

[15]

Q6.

(a) 4 Na + O_2 ⟶ $2Na_2O$

allow multiples

1

(b) (sodium) gains oxygen

1

(c) purple

1

(d) aluminium chloride

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1

(e) **Level 2 (3-4 marks):**
Relevant reasons are identified, given in detail and logically linked to form a clear account.

Level 1 (1-2 marks):
Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.

Level 0
No relevant content

Indicative content

conclusion 1
- pH values above 7 are alkaline
- sodium oxide, calcium oxide and magnesium oxide do form alkaline solutions (so correct for those)
- not all metal oxides form solutions (so incorrect for zinc oxide)

conclusion 2
- pH values below 7 are acidic
- carbon dioxide, sulfur dioxide and phosphorus oxide do form acidic solutions (so correct for those)
- not all non-metal oxides form solutions (so incorrect for silicon oxide)]

4

(f) metal oxides produce alkaline solutions if they dissolve in water

*allow **1** mark for most metal oxides produce alkaline solutions*

2

[10]

Q7.

(a) Whether there was a reaction or not

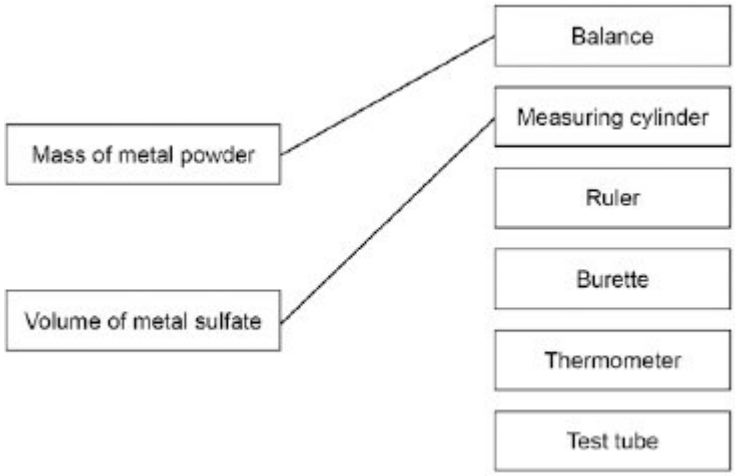
1

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

1

(c) **Variable** **Measuring instrument**

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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]

Q8.

(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

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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]

Q9.

(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

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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 × 1000 = 625 (times bigger)

1

[9]

Q10.

(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]

Q11.

(a) (i) (thermal) decomposition
allow decomposes or endothermic

1

(ii) copper oxide

1

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(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]

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Q12.

(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

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

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

1

[13]

Q13.

(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]

Q14.

(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

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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]

Q15.

(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

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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

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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]

Q16.

(a) (i) iron

either order

1

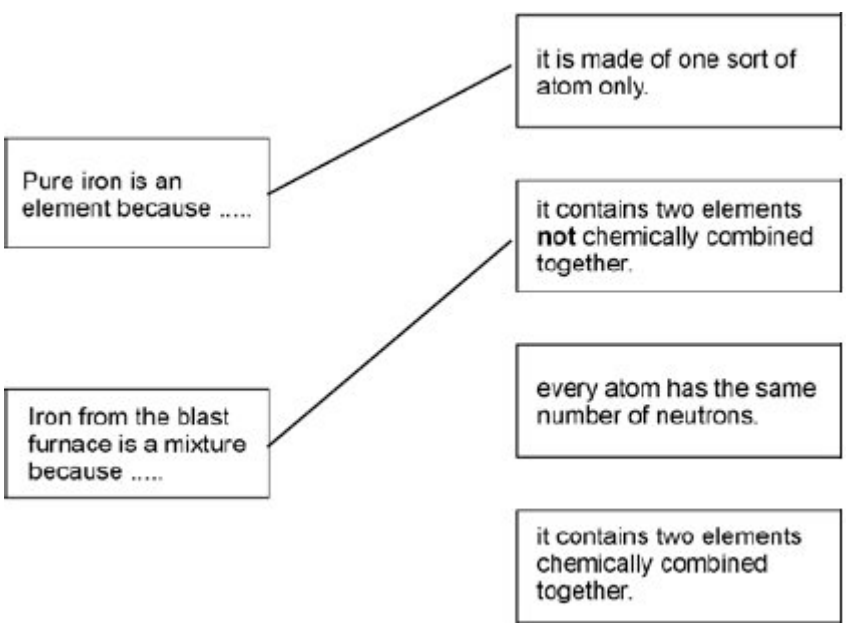
carbon dioxide

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]

Q17.

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(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

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1

with any compound of a named metal less reactive than copper

allow students to score even if use an insoluble salt

1

[16]

Q18.

(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

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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]

Q19.

(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]

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Q20.

(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 <u>reacts with</u> carbon

1

or

oxygen and carbon produce carbon dioxide / carbon monoxide

carbon dioxide / carbon monoxide is a <u>gas</u>

or

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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]

Q21.

(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]

Q22.

(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

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(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]

Q23.

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

- bubbles / effervescence / fizzing

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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*

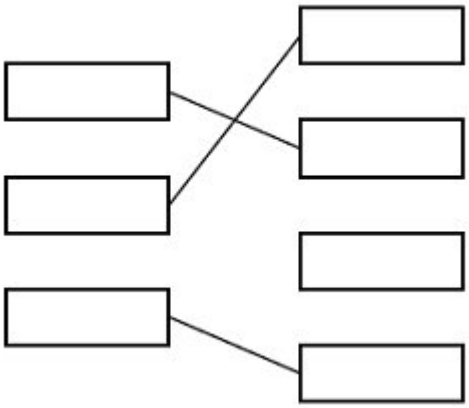
1

[13]

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Q24.

(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]

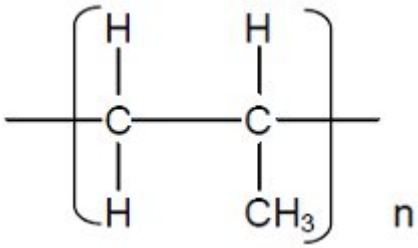
Q25.

(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

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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]

Q26.

(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
- <u>copper</u> 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) <u>large</u> 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

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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]

Q27.

(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

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

1

[5]

Q28.

(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) <u>many</u> monomers **or** <u>many</u> ethene molecules

1

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join / bond

allow addition polymerisation for second mark

1

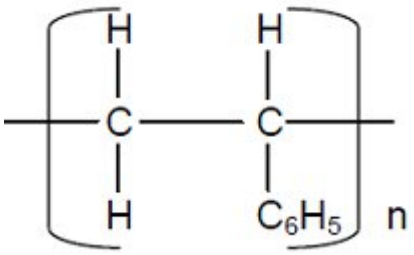
OR

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]

Q29.

(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

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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]

Q30.

(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

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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]

Q31.

(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]

Q32.

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(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]

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Q33.

(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]

Q34.

(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

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(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]

Q35.

(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]

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