AQA GCSE CHEMISTRY (HIGHER) · 8462

CHEMISTRY



MARK SCHEME

4.4.1 REACTIVITY OF METALS (PACK 3)

SCORE	PERCENTAGE
/225	%

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Q1.

(a) hydrogen **or** H_2

allow hydrogen gas
ignore H without the 2 subscript

1

(b) filtration / filter

*allow magnet **or** decant*
ignore heating

1

(c) (Mg) $\frac{0.12}{24}$ or 0.005 (moles)

mark is for ÷ by 24

1

(Fe) $\frac{2}{3} \times 0.005 = 0.00333 \times 56$

mark is for $\times \frac{2}{3}$

1

(mass Fe) = 0.00333 × 56

mark is for × 56

1

= 0.1866 (g)

1

= 187 (mg)

1

*an answer of 280 (mg) scores **4** marks*
*an answer of 0.280 scores **3** marks (no ratio from equation)*
*184 scores **0** [= (3 × 24) + (2 × 56)]*

OR

$(Mg) = \frac{0.12}{(3 \times 24 =)72}$ (1)

$= 0.00166$ **or** $\frac{1}{600}$ (moles) (1)

(mass of Fe) = 0.00166

or $\frac{1}{600} \times 112(2 \times 56)$ (1)

= 0.1866 (g) (1)

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187 (mg) (1)

OR

72 g Mg ⟶ 112g Fe (1)

$1\ g\ Mg \rightarrow \frac{112}{72}$ **or** 1.56 g Fe (1)

$0.12\ g\ Mg \rightarrow \frac{112}{72} \times 0.12$ (1)

= 0.1866 (g) (1)

= 187 (mg) (1)

*an answer of 185−190 (mg) scores **5** marks*
*an answer of 0.185−0.19 scores **4** marks*

(d) Fe^{3+}

1

(because) reduction is gain <u>of electrons</u>

allow change in oxidation state / (+)3 to 0

1

$Fe^{3+} + 3e^{(-)} \longrightarrow Fe$

1

[10]

Q2.

(a) reference to glow

1

(which) shows energy is being transferred to the surroundings

1

allow 'heat' for energy
allow (which) shows energy is being given out

(b) (M_r CuO =) 79.5

1

$\left(\text{moles copper oxide} = \frac{\text{mass}}{M_r} = \frac{1.59}{79.5}\right) = 0.02$

allow an incorrectly calculated value for M_r from step 1

1

(mass Cu = 0.02 × 63.5) = 1.27 (g)

1

alternative approach:
79.5 (g) CuO ⟶ 63.5 (g) Cu (1)
(mass Cu =) $\frac{63.5}{79.5} \times 1.59$ *(1)*
(mass Cu) = 1.27 (g) (1)
*an answer of 1.27 (g) scores **3** marks*

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

(c) hydrochloric acid reacts with zinc oxide

allow hydrochloric acid and zinc oxide produce zinc chloride

1

(to) form a solution (of zinc chloride)

1

copper does not react (with dilute acid)

1

(so copper) remains as a solid

allow (so copper) will collect in filter paper

1

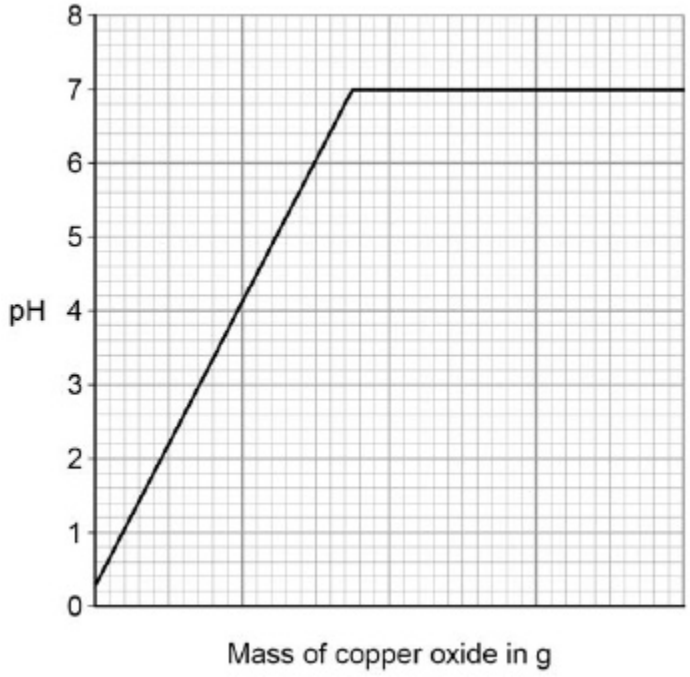
(d) zinc has been oxidised because the zinc atoms have lost electrons

1

[10]

Q3.

(a)



initial pH of hydrochloric acid is 0–3

1

pH increases as CuO is added

1

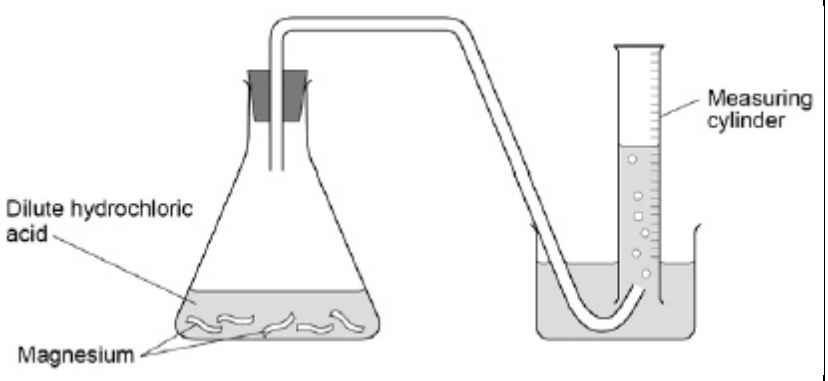
horizontal from pH = 7 (from any mass of copper oxide)

1

(b)

Level 2: The plan would lead to the production of a valid	4-6

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outcome. All key steps are identified and logically sequenced.	
Level 1: The plan would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.	1-3
No relevant content	0
Indicative content  **an ideal plan would be:** • use a rule to measure the length / use a balance to find the mass of the piece of magnesium • put magnesium into conical flask • use measuring cylinder for dilute hydrochloric acid • add dilute hydrochloric acid to conical flask • connect bung (& delivery tube) into conical flask • measuring cylinder is filled with water and inverted / upside down in bowl of water OR uses a gas syringe • hydrogen flows through a delivery / rubber tube into measuring cylinder • wait until all magnesium reacts / use excess dilute hydrochloric acid • record volume when bubbles stop **other things they could mention:** • use accurate / 2 dp balance • to collect gas use measuring cylinder / gas syringe with best resolution • add bung quickly to ensure no gas escapes • gas is collected in graduated apparatus (not test tube) • repeat experiment (with same length / mass of magnesium) • repeat at same temperature since volume of gas will be different	

6

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(c) (working)

$$\frac{\text{change in y-axis}}{\text{change in x-axis}}$$

data from candidate's graph

1

(answer)
0.8 (g of Cu per g of CuO)

1

(d) (working on graph)
extension of straight line and finding y value when x = 7.5

1

factor of ×10

1

(answer) 60 (g)

or

(using gradient)
y = 0.8 x

accept ecf from question part (c)

0.8 × 75

accept part (c) × 75

60

or

(stoichiometric method)

$$\frac{\text{mass of copper oxide}}{\text{Mr of copper oxide}} \times M_r\,(\text{Cu})$$

$$\frac{75}{79.5} \times 63.5$$

= 59.9 (g)

1

[14]

Q4.

(a)

Level 2: Relevant points (reasons/causes) are identified, given in detail and logically linked to form a clear account.	3-4
Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.	1-2
No relevant content	0
Indicative content	

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Ca / calcium (atom) loses two electrons / both outer electrons and is oxidised to Ca^{2+} ion F / fluorine (atom) gain one / an electron and is reduced to F^- ion **supporting points** • fluorine / F (atoms) gain electron(s) • negative ion produced • calcium (atoms) lose electron(s) • positive ion produced • reduction is gain of electrons • oxidation is loss of electrons	

4

(b) (because there are) strong electrostatic forces of attraction
or
ionic bonding

1

between Ca^{2+} and F^- ions / oppositely charged ions

1

(in a) giant structure / lattice

1

so a lot of energy is needed to overcome / break this attraction

1

(c) amount of $F_2 = \frac{0.95}{38}$ = 0.025 moles
mark is for ÷ 38

1

amount of $SF_6 = \frac{1}{3} \times 0.25$ = 0.008333 moles
mark is for ×1/3

1

mass of SF_6 = 0.008333 × 146
mark is for ×146

1

mass = 1.2166666

1

mass = 1.22 (g) 3 sig figs

1

[13]

Q5.

(a) has 2 electrons in the outer shell

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allow energy level for shell

1

(b) 3 : 2 : 6 : 18

1

(c)

$$\frac{9 \times 3}{537} \times 100$$

1

= 5.0 (%)

*an answer of 5.0 (%) scores **2** marks*
allow 1.7 (%)
allow 5.027932.. (%)

1

(d) correct formulae

1

correct balancing of correct formulae

allow multiples
allow an answer of
$BeCl_2 + 2K \rightarrow 2KCl + Be$
*for **2** marks*

1

(e) potassium is more reactive

1

so will displace beryllium

1

(f) **(test)**
place in (simple) electrical circuit

1

(result)
conducts electricity

(alternative test and result)
add (dilute) acid
produces hydrogen gas (with acid)

1

[10]

Q6.

(a) **(test)**
burning splint (held at open end of test tube)

1

(result)
a (squeaky) pop

1

(b)

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Level 3: The design/plan would lead to the production of a valid outcome. All key steps are identified and logically sequenced.	5-6
Level 2: The design/plan would not necessarily lead to a valid outcome. Most steps are identified, but the plan is not fully logically sequenced.	3-4
Level 1: The design/plan would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.	1-2
No relevant content	0
Indicative content • measure volume of hydrochloric acid • in a measuring cylinder • pour hydrochloric acid into suitable container • measure temperature of hydrochloric acid • using a thermometer • measure mass of magnesium • using a balance • add magnesium to hydrochloric acid • stir • measure maximum temperature reached • record maximum temperature reached • calculate the change / rise in temperature • repeat procedure for same mass of magnesium • find mean temperature rise • repeat with different masses of magnesium	

6

[8]

Q7.

(a) **Z**

1

(b) magnesium sulfate does not react with any of the metals

allow there is no change / increase in temperature with any

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of the metals

1

(c) temperature increase

1

(d) **Level 2 (3–4 marks):**
A detailed and coherent plan covering all the steps. The steps include the improvements and are set out in a logical manner.

Level 1 (1–2 marks):
Simple statements of improvements to the apparatus or steps are made but they may
not be set out in a logical manner.

0 marks:
No relevant content

Indicative content

Simple statements
- stir the solution
- use the same amount of each solution
- use the same concentration of solution
- put insulation or a lid on the beaker
- measure how high temperature goes

Coherent statements in a logical order
- pour a fixed, measured volume of the metal salt solution into a plastic / polystyrene cup
- measure and record the temperature of the solution
- stir and add 1 g of metal to the solution
- (put a lid on the cup)
- measure and record the temperature after a set time or measure and record
the greatest / highest temperature
- calculate and record the temperature increase
- (repeat each individual experiment at least two more times and calculate the mean temperature increase)

4

(e) Activation energy

1

(f) 386 (kJ) / 1370 × 100

1

28 %

1

[10]

Q8.

(a) 408 kg

1

(b) all points correct
± ½ small square

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2

*allow **1** mark if 5 points correct*

best fit line

1

(c) $\frac{1989 \times 100}{36}$

1

5525 dm^3

1

(d) relative formula mass of $TiCl_4$ is 190

1

25.26 %

1

Answer given to 3 significant figures = 25.3 %

1

*25.23% with or without working gains **3** marks*

(e) argon is unreactive

1

water (vapour) would react with sodium

allow water (vapour) would react with titanium(IV) chloride

1

and air contains oxygen that would react with reactants

allow and air contains oxygen that would react with products

1

(f) (titanium conducts electricity) because electrons in the outer shell of the metal atoms are delocalised

1

and so electrons are free to move

allow the delocalised electrons in the metal carry electrical charge through the metal

1

through the whole structure

1

[15]

Q9.

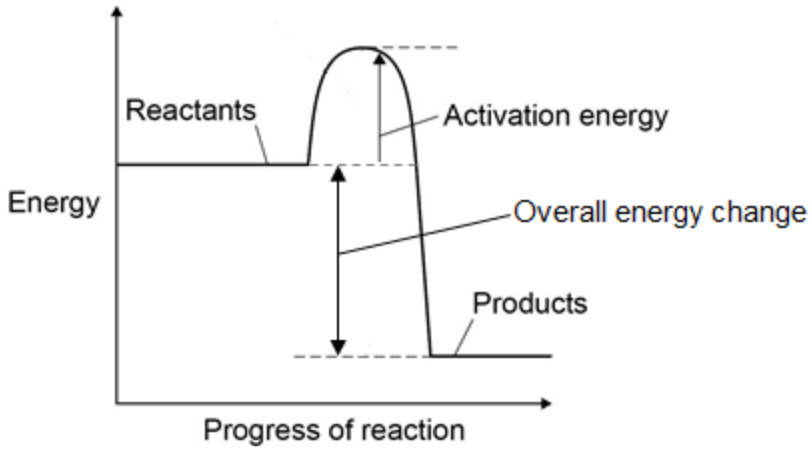
(a) the relative energies of the reactants, products and the overall energy change

1

the activation energy

1

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(b) (4 × 413) + (2 × 498) = 2 648

1

(2 × 805) + (4 × 464) = 3 466

1

(3466 − 2648 =) 818 (kJ / mol)

1

*allow max **2** marks for one ecf*

(c) **Level 3 (5–6 marks):**
A coherent method is described with relevant detail, which demonstrates a broad understanding of the relevant scientific techniques and procedures. The steps in the method are logically ordered with the dependent and control variables correctly identified. The method would lead to the production of valid results.

Level 2 (3–4 marks):
The bulk of a method is described with mostly relevant detail, which demonstrates a reasonable understanding of the relevant scientific techniques and procedures. The method may not be in a completely logical sequence and may be missing some detail.

Level 1 (1–2 marks):
Simple statements are made which demonstrate some understanding of some of the relevant scientific techniques and procedures. The response may lack a logical structure and would not lead to the production of valid results.

0 marks:
No relevant content

Indicative content

Named apparatus

- thermometer
- measuring cylinder
- stirring rod
- spatula
- plastic cup (with lid) or beaker
- stopwatch
- filter paper or watch glass
- balance

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Method

- weigh the same mass of each metal in each same state of division eg powder
- measure a set volume of sulfuric acid into a plastic cup or beaker
- measure and record the temperature of the sulfuric acid
- add metal W into the plastic cup or beaker
- stir and record the highest temperature or record the temperature after a set time
- calculate the increase in temperature
- repeat the method for metals X, Y and Z
- repeat for each metal at least three times to calculate a mean

Safe use

- comment on safe use should include wearing safety glasses

6

(d) **W>Y>X>Z**

1

reason for position of **W** and **Z**

***W** reacts with most solutions whereas **Z** reacts with none of the solutions*

1

reason for position of **X** and **Y**

***Y** is more reactive than **X** because **Y** reacts more with sulfuric acid*

1

(e) magnesium is most reactive because not displaced by any metal

1

zinc is second most reactive because displaced by only one metal

1

copper and hydrogen cannot be placed in order of reactivity or are least reactive because

1

they both are displaced by the most / three metals

1

experiment – add sulfuric acid to copper because copper is less reactive than hydrogen
then copper would not react with sulfuric acid to displace hydrogen

1

[19]

Q10.

(a) it goes up / increases

1

because the reaction is exothermic **or** transfers energy to the surroundings

allow gives out thermal / heat energy

1

(b) $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$

1

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(c) copper sulfate

1

(d) **X** bubbles of gas

1

Y no bubbles of gas

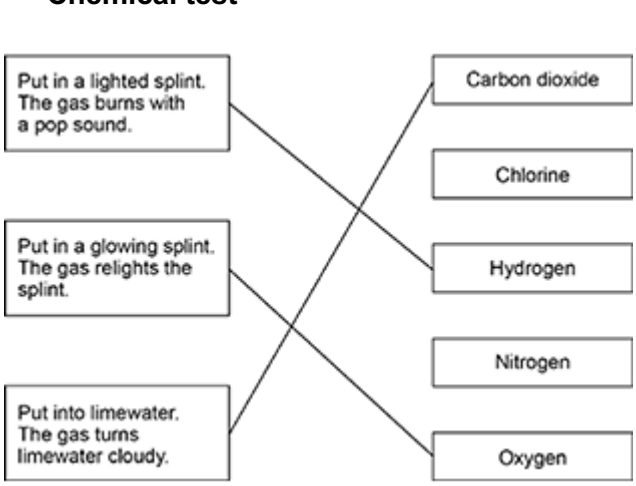
1

(e) calcium>magnesium>zinc>copper

*if not all correct allow **1** mark for at least two metals in the correct position*

2

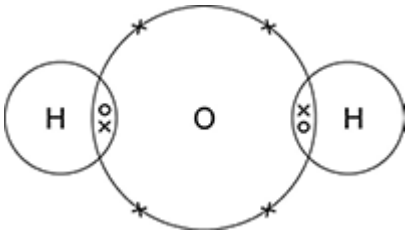
(f)



extra lines from a test negate the mark

3

(g)



two pairs of shared electrons

1

oxygen has four other electrons not bonded

1

[13]

Q11.

(a) Fe_2O_3 + 3 CO → 2Fe + 3 CO_2

correct formulae of reactants

1

correct formulae of products

1

correct balancing

1

(b) iron loses oxygen – reduction

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1

carbon gains oxygen – oxidation

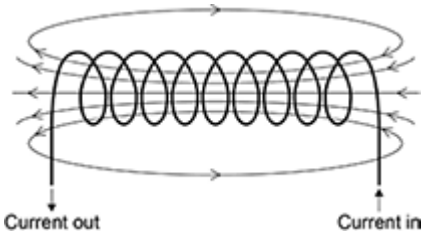
1

(c) any **four** from:

- resources for manufacture are limited
- recycling reduces the use of resources
- reduces energy consumption in extraction / manufacture
- reduces waste from processing and extraction
- reduces environmental impact of extraction

4

(d)



field lines going through and around coil

1

correct directional arrows

1

(e) any **two** from:

1 *mark for suggestion,* ***1*** *mark for correctly linked explanation*

- use many coils **or** tight coils **or** long wire (1)
- to give a strong magnetic field for lifting heavy objects (1)

explanation must be correctly linked to the suggestion to gain the mark

or

- add an iron core
- to increase field circuit for lifting

or

- include a switch in circuit
- so can drop / pick up cars

max. 4

[15]

Q12.

(a) did not appear because they had not been discovered **or** they are unreactive **or** they did not form compounds

1

(b) arranged in order of atomic / proton number

1

elements in the same group have the same number of electrons in the outer shell

1

(c) chlorine>bromine>iodine

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table shows that chlorine displaces bromine and iodine

1

and bromine displaces iodine

1

(d) $Cl_2(aq) + 2\ Br^-(aq) \rightarrow Br_2(aq) + 2\ Cl^-(aq)$

correct formulae

1

correct balancing

1

correct state symbol

1

(e) the further down the group, the halogen becomes less reactive because outer electrons are further from the nucleus

1

so less attractive force on an incoming electron

1

[10]

Q13.

(a) 1 950 / 2 500 × 100

1

78 (%)

1

(b) expected mass of aluminium

1950 × 54 / 102

1

= 1032.35

1

mass not collected

1032.35 − 1 000

= 32.4

*allow 32.4 with no working shown for **3** marks*

1

*incorrect number of sig. figs max **2** marks*

(c) because oxygen is formed at the anode

1

which reacts with the carbon anode to produce carbon dioxide

1

and wears it away

1

(d) power = $1.5 \times 10^5 \times 4$

1

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= 6.0×10^5 W

1

24 hours = $24 \times 60 \times 60 = 8.64 \times 10^4$ seconds

1

energy transferred = $6.0 \times 10^5 \times 8.64 \times 10^4$

allow ecf from power calculation

1

= 5.184×10^{10}

*allow 5.184×10^{10} with no working for **5** marks*

1

(e) 3 moles of electrons are needed to produce 27 g or 0.027 kg aluminium

1

so moles of electrons to produce 1 000 kg = 1 000 / 0.027 × 3

1

= 111 000

*allow 111 000 with no working shown for **3** marks*

1

*incorrect no. of sig. figs max **2** marks*

[16]

Q14.

(a) Ionic

1

(b) electrolyte

1

(c) because the ions are free to flow

1

(d) because potassium is higher in the reactivity series than hydrogen

1

so it is less easily discharged than hydrogen

1

(e) because water is covalent / molecular / contains molecules

1

so there are no free electrons to move **or** does not have an overall electrical charge

1

(f) conductivity of the solution increases with concentration

1

in a linear relationship **or** directly proportional

1

[9]

Q15.

(a) because they form hydroxides

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1

that give alkaline solutions (in water)

1

(b) the atoms have more electron shells (as move down the group)

1

so the electron in the outer shell is further away from the nucleus

1

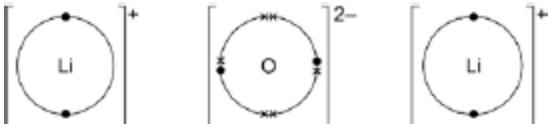
which reduces the attraction to the nucleus

1

so the electron is lost more easily from the atom

1

(c)



electronic structure of lithium drawn correctly

1

electronic structure of oxygen drawn correctly

1

correct charge on ions (Li^+ and O^{2-})

1

correct number of each ion (2 lithium, 1 oxygen)

1

[10]

Q61.

(a) (i) gold is unreactive

1

(ii) $2Fe_2O_3 + 3C \longrightarrow 4Fe + 3CO_2$

products may be in either order
***1** mark for correct symbols*
***1** mark for correct balancing*
allow correct multiples

2

(iii) aluminium is high in the reactivity series
or
aluminium is more reactive than carbon
allow aluminium is very reactive

1

(so) cannot be extracted with carbon
or
(so) requires electrolysis
*allow electrolysis is required (**1** mark)*
*(but) electricity / technology not available (**1** mark)*

1

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(b) lower density **and** higher strength

1

[6]

Q62.

(a) rare

or

very small amount in Earth's crust

ignore figures without qualification

1

(b) (i) electrolysis

1

(ii) (electrolysis) uses more energy

or

there are many stages in the process

ignore references to reactivity

accept uses a large amount of energy

1

[3]

Q63.

(a) rare

or

very small amount in Earth's crust

ignore figures without qualification

1

(b) (i) electrolysis

1

(ii) (electrolysis) uses more energy

or

there are many stages in the process

ignore references to reactivity

accept uses a large amount of energy

1

(c) $2Fe_2O_3 + 3C \rightarrow 4Fe + 3CO_2$

correct formulae for 1 mark

correct balancing of correct formulae for 1 mark

allow multiples

*accept for **2** marks:*
$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$

2

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[5]

Q64.

(a) (black) copper oxide formed

explanation must be linked to correct observation

1

loss in mass is due to carbon dioxide / gas production

1

limewater cloudy shows carbon dioxide produced

1

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

ignore references to reactivity

- (bunsen burner flame) not hot enough (to decompose potassium carbonate)

  accept temperature not high enough (to decompose potassium carbonate)
- not all Group 1 carbonates decompose

  allow potassium is in Group 1

1

(ii) potassium carbonate:

(mass) 13.8 g

1

(limewater) colourless

accept no change for colourless

ignore clear

1

zinc carbonate:

(limewater turns) cloudy

Metal carbonate	***Mass after heating in g***	***Limewater***
Potassium carbonate	*13.8*	*colourless*
Zinc carbonate		*cloudy*

1

[7]

Q65.

(a) (i) carbon is more reactive than iron / higher in reactivity series

accept carbon displaces / replaces iron

'it' = carbon

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1

therefore can reduce (iron oxide) / reduction reaction occurs

accept therefore removes oxygen from iron (oxide)

ignore carbon displaces oxygen
ignore carbon reacts with oxygen

*do **not** accept iron reacts with carbon*

1

(ii) left hand side correct: **2**Fe_2O_3 + **3**C

1

right hand side correct: **4**Fe + **3**CO_2

accept as correct if all numbers multiplied by same number eg

4Fe_2O_3 + ***6***C → ***8***Fe + ***6***CO_2

1

(b) (phytomining)
any **two** from:

- less atmospheric pollution / named pollutant eg sulfur dioxide

  allow harmful gases / fumes / smoke / metal particles

  ignore less waste
  ignore no pollution
  ignore carbon dioxide for this marking point

- phytomining (more) carbon neutral / less global warming

  *allow phytomining produces <u>less</u> carbon dioxide / greenhouse gases **or** smelting produces large amounts of carbon dioxide / greenhouse gases*

- phytomining helps clean polluted sites

- plants are a renewable (resource)

- uses less energy / fuel

2

[6]

Q66.

(a) (i) unreactive

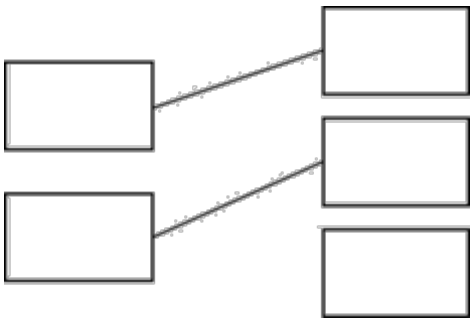
1

(ii) atoms

1

(b)

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extra line from particle negates mark

1

(c) (i) mixture of metals

accept mixture of a metal with other element(s)

1

(ii) to make it harder

accept to make it more resistant to wear / corrosion / tarnishing

allow keeps it shiny

allow makes it stronger

ignore bronze won't rust

ignore references to reactivity

1

[6]

Q67.

(a) because the traditional method of extraction produces large amounts of solid waste

1

because the traditional method of extraction would cause atmospheric pollution due to the release of carbon dioxide / sulphur dioxide

1

(b) (i) because iron is cheap

accept because iron is much more abundant than copper

1

(ii) iron is more reactive than copper

1

therefore iron displaces copper from solutions of its salts / copper sulfate solution

1

[5]

Q68.

(a) oxygen / O_2 / O

1

(b) (i) zinc boils / evaporates out of furnace because of its low boiling point

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1

therefore because lead has a high boiling point
it remains in the furnace

1

(ii) on cooling the zinc forms a solid and the lead remains liquid

accept because zinc is less dense it floats on lead

1

therefore the lead can be poured off / decanted from the zinc

accept therefore the zinc can be poured off / decanted from the lead

1

[5]

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Q1.

(a) 66% of students answered this question correctly. The most common incorrect answer was water.

(b) 47% of students appreciated the need for filtration or the use of a magnet. The most common incorrect responses were electrolysis, distillation, heating / evaporation or displacement using carbon.

Students need to understand the list principle. If they give two answers (one correct and one incorrect) when only one is required, no mark can be awarded. This was the case with those students who gave filter and another method that was incorrect e.g. simple distillation.

(c) Students found this question tough, but it discriminated well with higher-attaining students being able to achieve four or five marks (10%). 74% of students scored zero marks.

The most common mistake found in correct calculation methods was the absence of a conversion from g to mg. Some got to 0.185 g and then stopped or converted g to mg incorrectly. Common errors were dividing by 1000 rather than multiplying by 1000 or using a factor of 10 or 100 to convert g to mg.

Stoichiometry was not well understood which resulted in students obtaining an answers of:

- 280 mg or 0.280 g due to the omission of the stoichiometric ratio (× 2/3) or
- 124 mg or 0.124 g where they had divided by 72 and multiplied by 112, and had multiplied by 2/3 as well, so they had taken the ratio into account twice.

Some students got as far as 0.12/24 or 0.12/72 and then no further. Others tried to calculate RFMs for the compounds involved and got no further and gained no marks.

(d) The most common mark achieved was for stating that reduction was the gaining of electrons. Many students quoted OILRIG but gave an incomplete answer of ‘reduction was gain’, without stating what it was that was being gained.

Few students specifically identified the ‘reduced species’ being reduced. Some did identify iron was reduced but didn’t say which ion of iron, others gave magnesium or iron chloride.

Only a small number of students correctly wrote the half equation. 1% of students achieved two or three marks.

Q2.

(a) 65% of students achieved marks on this question by being able to identify the glow (spreading through the mixture) as the observation that would be made. Many also had the idea that energy was transferred to the surroundings, but some linked this point to allowing the mixture to cool in step five meant that heat was given out.

(b) 20% of students were able to calculate the mass of copper produced in this question

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that differentiated between students well. For those not achieving full marks, finding the relative formula mass for copper oxide was also achieved by 23% of students, though few of these students were able to continue to correctly calculate the number of moles present. Many gave this as 79.5 ÷ 1.59 or having calculated the relative formula mass of copper oxide then used 1.59 ÷ 63.5.

Few students gave a full explanation of what they were doing instead just using numbers in various formats. The front of the paper does state that working should be shown in calculations and this may well help to gain more marks for students. Most students who were able to calculate the number of moles correctly were then able to continue to use this value to calculate the mass of copper. Few students used the alternative approach allowed in the mark scheme.

(c) This proved a difficult question for students to score highly on, with 3% achieving three or four marks. A significant number of students' answers focused on zinc being more reactive and displacing copper, rather than the products of this reaction which was the mixture obtained in step five. In other cases, there was confusion about what had reacted; zinc reacting with hydrochloric acid for example.

Some students used the term 'dissolve', rather than react. Very few realised that copper remained as a solid as it did not react with hydrochloric acid and others just repeated the last part of the question.

(d) Students found this question difficult with two of the other distractors proving to be more popular responses. 28% of students achieved the mark.

Q61.

(a) (i) Only just over a quarter of the students could explain why gold is found in the earth's crust as the element. Common incorrect answers stated that 'gold is a pure metal' or 'it is made up of just one type of atom'.

(ii) Many errors were made in writing the correct symbol for iron and the correct formula for carbon dioxide. The same rules always apply to writing symbol equations. Upper and lower case letters must be clearly written, and subscripts must not be taller than half way up a capital letter. Quite a lot of diatomic iron was seen, as well as the symbol for cobalt being used instead of carbon and oxygen in carbon dioxide. Carbon dioxide was incorrectly represented as CO2, CO^2 or CO3.

(iii) Only half the students gained a mark, which was usually for a reference to electrolysis. Quite a lot gave the technology answer of 'electrolysis is needed but electricity was not invented until later' to gain two marks.

(b) A comparison of the properties of titanium and steel was asked for, and therefore comparative statements were required in the response. Comparisons of both strength and density were required for the mark. Many students only referred to the strength of titanium, and did not mention that it is less dense, so did not gain the mark.

Q62.

(a) Many students said that gold is rare or that there is a very low percentage in the Earth's crust. Some said that it is hard to find, which was insufficient for the mark. Common incorrect responses were that it is a pure metal or it is unreactive. A few assigned its value to its appearance or long lasting qualities.

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(b) (i) Only a few of the students who attempted this question knew that the process to extract aluminium is electrolysis. A variety of incorrect responses were seen, many of which related to crude oil, such as fractional distillation.

(ii) Less than one tenth of students gained the mark for saying that aluminium is more expensive to extract than iron because it uses a lot of energy or uses a large amount of electricity. Many just repeated the question or referred to the reactivity of the metals, which was insufficient to gain the mark. Some students said that the process was more difficult or took longer. Others quoted information from the table or answered in terms of the uses or properties of aluminium.

Q63.

(a) The majority of students said that gold is rare or that there is not a lot of it in the Earth's crust. Some said that it is hard to find, which was insufficient for the mark. Common incorrect responses were that "It is a pure metal" or "It is unreactive". A few assigned its value to its appearance or long lasting qualities.

(b) Less than a third of students gained the mark for saying that aluminium is more expensive to extract than iron because it uses a lot of energy or uses a large amount of electricity. Many students referred to the reactivity of the metals, or said that electrolysis was used. These were not sufficient to gain the mark. Some students said that the process was more difficult or it took longer. A lot of incorrect responses referred to the end cost of aluminium being higher, which is partly due to the extraction process, and so were insufficient.

(c) The question gave students the formula for iron oxide and told them that iron is extracted from iron oxide by reduction with carbon. Students who used this information gained 1 or 2 marks. If they did not give the correct formula and symbols they could not gain a mark. A variety of formulae for iron oxide were seen, and sometimes it was given as a product rather than a reactant. Some students gave the symbol for iron as Fe_2, Fe_3 or Fe_4. Carbon dioxide was frequently seen as a reactant, instead of carbon. Some students attempted to write ionic equations for the reaction, whilst others wrote word equations. A very common error was to represent the symbols and numbers incorrectly. Upper case letters were needed for C and O, with upper case F, followed by lower case e for iron. Subscripts should be no higher than halfway up the capital letter.

Q64.

(a) Less than half of the students gained one mark or more on this question. The main problem was that they did not link their explanation to an observation. Naming copper oxide as being a product was a common correct response, although some thought that copper was formed. Carbon dioxide was often given as the other product, but this only scored if it was linked to the loss in mass or the change in the colour of the limewater. A surprisingly large number of students linked the colour change of limewater to an incorrect gas, such as oxygen or hydrogen. Hardly any students scored 3 marks, failing for the most part to link the loss of mass with the production of carbon dioxide.

(b) (i) Only a tenth of students said that the temperature needed to be higher or that more energy was needed to decompose potassium carbonate. Many students referred to the compound or potassium being high in the reactivity series, which was ignored. Others said it had a high melting or boiling point.

(ii) Some students realised that the mass of potassium carbonate after heating

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would be 13.8 g. The response “9.4 g” was seen quite a lot. Other students said that the limewater would turn cloudy for zinc carbonate, but some struggled to describe the limewater for potassium carbonate. If they just said “clear” this did not gain the mark; they had to say “stayed clear”. “Nothing” or “none” were insufficient responses for the result with limewater. Quite a lot of students appeared to guess the results for limewater, writing the same answer in both boxes. There were quite few references to fizzing or bubbling.

Q65.

(a) (i) The mechanism of the process was poorly understood by most students. However, many students did state that carbon was more reactive than iron. Often there was just a straightforward description of the reaction rather than an explanation. Many students lost marks through incorrect chemistry or confusion about what was reacting eg stating that carbon reacted with iron.

(ii) Students found this question difficult with only a tenth of students gaining full credit.

(b) Again, students found this question difficult with about a quarter of students able to pick up at least one mark.

Q66.

(a) (i) The majority of students gave the correct response selecting ‘unreactive’. A few students selected ‘coloured’.

(ii) More than a third of students thought that gold is an element because all of its molecules are the same. Few selected that gold is an element because its symbols are the same.

(b) Many responses gave the numbers for protons and neutrons the wrong way round or the number of neutrons being the same as the mass number.

(c) (i) The most common response was a mixture of two metals. Some students went on to say that an alloy was stronger than a pure metal. Marks were lost when students said the metals formed a compound. Some responses simply gave examples of alloys, for example, steel or bronze, which was not enough for the mark.

(ii) Only a fifth of students answered this question correctly. Many students said bronze was cheaper than copper, even though the question stated that they cost the same. Other incorrect responses stated that bronze was less reactive, lighter, or easier to get than copper. Many thought that copper rusts.

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