AQA GCSE CHEMISTRY (HIGHER) · 8462

CHEMISTRY



MARK SCHEME

4.3.1 CHEMICAL MEASUREMENTS, CONSERVATION OF MASS AND QUANTITATIVE INTERPRETATION OF EQUATIONS (PACK 3)

SCORE	PERCENTAGE
/190	%

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Q1.

(a) B

1

(b) calcium oxide **or** CaO

1

carbon dioxide **or** CO_2

1

either order

(c) decomposition

1

(d) endothermic

1

(e) 32 (g)

allow 31−33 (g)

1

(f) $\frac{32}{5.2} \times 24$

1

148 (g)

allow a range 143−153 (g)

or

uses graph e.g. 12 dm^3 gives 74 (g) (1)

(then factors up so that 24 dm^3 gives) 148 (g) (1)

allow a range 143−153 (g)

1

*an answer of 148 (g) scores **2** marks*
*allow ecf from part **(e)***

(g) (mistakes)
increase in mass = 3 (not 4)

allow mistakes in either order

1

inserted numbers inversely into formula

allow numbers wrong way round

1

(calculation)

*an answer of 250 scores the **2** calculation marks*

1

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$\text{gradient} = \frac{750}{3}$

allow $\frac{1000}{4}$

250 (cm^3 per g)

if no calculation marks awarded

allow $\frac{750}{4}$ ***or*** *187.5* ***or*** $\frac{3}{750}$

or *0.004 for* ***1*** *mark*

1

(h) 3 × 16 or 48

1

(48) + 12 or 60

allow their mass of oxygen + 12

1

84 − (60) **or** 24

allow 84 − their mass of carbonate

1

magnesium **or** Mg

*magnesium **or** Mg without working scores this mark*

1

*an answer of 24 scores the **3** calculation marks*

[16]

Q2.

(a) CaO

1

CO_2

1

either order
ignore names

(b) [12 + (3 × 16)]
or 60

1

(197 − 60 =) 137

1

barium **or** Ba

*barium **or** Ba without working scores this mark*

1

*an answer of 137 scores the **2** calculation marks*

(c) (working) Y increase and X increase measured from graph and substitution

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into $\frac{\Delta Y}{\Delta X}$

y-axis	*80−85*	*162−170*	*248−252*	*330−335*
x-axis	*0.5*	*1.0*	*1.5*	*2.0*
=	*160−170*	*162−170*	*165−168*	*165−168*

1

(answer) 167

allow answer in range 160−174

1

(units) cm^3/g

allow $cm^3\ g^{-1}$

1

*if no other mark awarded allow **1** mark for the inverse ($\frac{\Delta Y}{\Delta X}$)*
***or** 0.006*
*an answer of 160−174 scores the **2** calculation marks*

(d) (from graph)
volume to 240 cm^3 mass
= 1.45 g

allow answer based on any reading from the graph
(e.g. 250 cm^3 = 1.5 g)

1

ratio is $\frac{1}{100}$ (ie $\frac{24000}{240}$)

allow ratio from their volume
eg $\frac{24000}{250}$

1

100 × 1.45

$\left(\frac{24000}{250}\right) \times 1.5$

1

145

allow range 140−150

1

or

allow method using answer from part **(c)**

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$x = \frac{y}{m}$ (1)

*(rearrangement of $y = mx$ where m = answer from part **(c)**)*

24 (dm^3) to 24 000 (cm^3) (1)

$$\frac{24\,000}{\text{answer from part (c)}}$$ (1)

144 (1)

allow range 140−150

[12]

Q3.

(a) lines from:

- independent to size of marble chips

1

- control to volume of acid

1

ignore arrowheads

*do **not** accept if more than one line from one box*

(b) calcium chloride

carbon dioxide

*do **not** accept carbon oxide*

water

*do **not** accept hydrogen oxide*

2

*all three needed for **2** marks*
*allow **1** mark if two correct*

(c) stops loss of acid

allow stops loss of water / liquid
allow to ensure that only the gas escapes

*do **not** accept stops acid evaporating*

*do **not** accept stops gas / CO_2 / water vapour escaping*

1

(d) 0.053

allow 0.05
allow 0.053333…

*do **not** accept 0.052*
ignore units

1

(e) g/s

1

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(f) all points correctly plotted

*allow **1** mark for 5 points correctly plotted*
allow ± ½ a small square

2

line of best fit

should be a curve nearer to (10,0.8) than the anomaly (20, 0.6) and through all other points
if plotting incorrect allow 1 mark for appropriate line of best fit through student's points

1

(g) the eight small marble chips have a larger surface area, so more frequent collisions

1

[11]

Q4.

(a) a mixture designed as a useful product

1

(b) mass = 14 520 g

1

$(=)\frac{14\,520}{80\ (\text{mol})}$

allow correct substitution of incorrectly converted mass
must use M_r given (80) to gain marks in steps 2 and 3

1

(=) 181.5 (mol)

1

(=) 1.8×10^2 (mol)

allow answer correctly given in standard form to correct sig figs from an incorrect calculation

1

*an answer of 1.8×10^2 (mol) gains **4** marks*

(c) (giant) lattice

allow giant structure

1

ionic

1

strong bonds **or** strong electrostatic forces

*do **not** accept strong intermolecular forces / bonds*

1

large amounts of energy needed to overcome

ignore heat

1

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max 2 marks *for incorrect reference to bonding* ***or*** *structure* ***or*** *particles*

[9]

Q5.

(a) let the glow spread

1

(b) 1.27 (g)

1

(c) solid

1

(d) zinc

1

(e) displacement

1

(f) A

1

(g) any **one** from:

- (good electrical) conductor
- can be bent easily

ignore malleability

- does not corrode

ignore does not rust

1

allow is ductile

(h) 2 : 3

1

(i) conserves copper ores

1

less energy used

1

[10]

Q6.

(a) melting points decrease (as the atomic number increases)

allow negative correlation

1

(b) 55
and
29 (°C)

allow values in range 28−32 (°C)

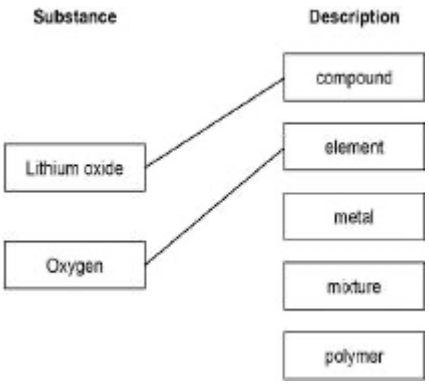
1

(c) 1

1

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(d)



1
1

(e) $4\ Li + O_2 \longrightarrow 2\ Li_2O$

allow correct multiples

1

(f) ionic

1

(g) $(M_r) = (2 \times 7) + 16$

1

$= 30$

1

*an answer of 30 scores **2** marks*

[9]

Q7.

(a) shared electron pair

allow electrons drawn as dots, crosses, circles or $e^{(-)}$

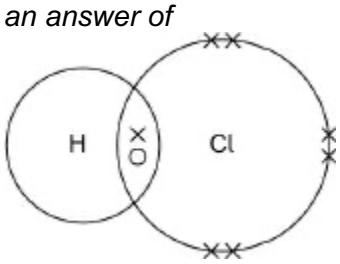
1

1 hydrogen electron and 7 chlorine electrons drawn on outer shells

ignore inner shell electrons drawn on chlorine

1

an answer of



*scores **2** marks*

(b) correct symbols and formulae

1

correct balancing of equation containing HCl

allow correct multiples

1

*an answer of $H_2 + Cl_2 \longrightarrow 2HCl$ scores **2** marks*

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(c) A activation energy

1

B (overall) energy change

1

(d) energy of products is less than the energy of the reactants

1

(e) hydrogen chloride molecules do not have an overall electric charge

allow hydrogen chloride does not contain ions

1

hydrochloric acid contains ions*

1

(which) are free to move so charge can flow*

1

do **not accept reference to delocalised electrons*

[10]

Q8.

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

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(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]

Q9.

(a) alkali metals

1

(b) any **one** from:

- small piece of metal
- large volume of water
- use a (safety) screen
- keep a safe distance (between teacher / students and apparatus)

1

(c) reactivity increases down the group

1

any **two** from:

- speed increases (down the group)
- sodium / potassium melts but lithium does not
- flame is seen with potassium, but no flame with lithium / sodium

2

(d) rubidium is too reactive

allow reaction would be violent

1

(e) $2Na + 2H_2O \longrightarrow 2NaOH + H_2$

allow correct multiples

1

(f) sodium hydroxide

1

(g) an answer in the range 0.373−0.495 (nanometres)

1

(h) 3.04×10^{-10} m

1

(i) batteries increased from 10 to 28

or

batteries increased by 18

allow batteries increased approximately ×3

1

producing ceramics and / or glass increased from 10 to 22

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or

producing ceramics and / or glass increased by 12

allow ceramics and / or glass increased by approximately ×2

1

lubricants decreased from 8 to 6

or

lubricants decreased by 2

allow lubricants decreased by a quarter

1

*if no other marks awarded allow **1** mark for batteries and glass / ceramics increased, lubricants decreased, with no or incorrect data*

[13]

Q10.

(a) oxygen

1

(b) correct symbol for cell / battery with positive terminal connected to anode

ignore + and − symbols on cell / battery
*do **not** accept voltmeter if connected in series*

1

correct symbol for ammeter connected in series

1

correct symbol for variable resistor connected in series

allow variable power supply in place of variable resistor

1

ignore additional components that would not affect the circuit working

any order of components

(c) calculation / statement including data to show effect of doubling current on mass of copper deposited

*allow **1** mark for recognising that comparing doubling of one quantity to doubling of another is needed*
or
*allow **1** mark for recognising that a scaling factor needs to be applied*

or

calculation of **two** quotients, e.g.

$$\frac{0.24}{0.047} = 5.11$$

could be opposite way round (giving around 0.2)

$$\frac{0.48}{0.095} = 5.05$$

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2

(therefore) results support student **A**
or
results show direct proportionality

this mark must be supported by relevant calculations / statements

1

(however) there is an anomalous result at 0.36 A, 0.057 g

allow in terms of quotient (6.32 instead of ~5 or 0.16 instead of ~0.2)

1

(d) $\frac{0.142}{63.5}$

allow an answer that rounds to 0.00224

1

= 2.24×10^{-3}

allow an answer that rounds to 2.2 × 10−3

1

*an answer of 2.24×10^{-3} scores **2** marks*
*an answer of 0.00224 scores **1** mark*

(e) increase the time the circuit is switched on for

1

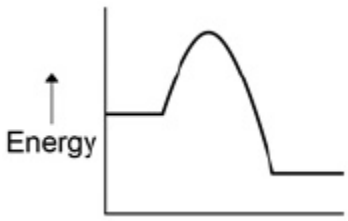
[11]

Q11.

(a) (a reaction that) transfers energy to the surroundings

1

(b)



1

(c) 2 × 16 (= 32)

1

(M_r =) 44

1

72.7 (%)

1

(d) 2 2

allow multiples

1

(e) 3.2 g of O_2 produced from 6.8 g of H_2O_2

1

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32 (g)

1

[8]

Q12.

(a) $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

1

(b) toxic

accept causes death

1

acid rain
or
respiratory problems

accept respiratory problems / asthma

1

global dimming

1

(c)

Level 3: A judgement, strongly linked and logically supported by a sufficient range of correct reasons, is given.	5-6
Level 2: Some logically linked reasons are given. There may also be a simple judgement.	3-4
Level 1: Relevant points are made. They are not logically linked.	1-2
No relevant content	0
Indicative content • methane is the best fuel because it gives more energy per gram than coal, and gives less carbon dioxide per kJ of energy produced • petrol is best because it being a liquid is easier to handle than gas or coal - although the energy content is lower than the others, it gives out less carbon dioxide than coal • methane has more energy per gram than coal • coal produces most carbon dioxide • coal can produce sulfur dioxide	

6

[10]

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Q13.

(a) 408 kg

1

(b) all points correct

± ½ *small square*

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]

Q14.

(a) (medicine is) a mixture **and**

(designed as) a useful product

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1

(b) sugar / flavouring

1

to make it taste better

or

colouring

to make it look more attractive

1

(c) $C_8H_9NO_2$

any order of elements

1

151

1

(d) mass of acetylsalicylic acid = 0.3 g

1

$= \frac{0.3}{100}$ (mol)

method mark – divide mass by M_r

1

= 0.00167 (mol)

allow 0.0016666(66)

1

1.67×10^{-3} (mol)

*correct answer with or without working scores **4** marks*

allow ecf from steps1, 2 and 3

1

[9]

Q15.

(a) $2Al + 3H_2SO_4 \longrightarrow Al_2(SO_4)_3 + 3H_2$

formulae correct

1

balancing correct

1

(b) 40 + 2(14 + (3 × 16))

1

= 164

*allow 164 with no working shown for **2** marks*

1

(c) (17.4 + 17.6 + 16.9) / 3

1

= 17.3

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*allow 17.3 with no working shown for **2** marks*

1

[6]

Q16.

(a) **Level 3 (5–6 marks):**
A full, detailed and coherent plan covering all the major steps is provided, which outlines
the apparatus required and sets out the steps needed in a logical manner that could be followed by another person to produce a pure, dry sample of copper nitrate.

Level 2 (3–4 marks):
The substantive content of a plan is present but may be missing some steps. The plan
may not be in a completely logical sequence but leads towards the production of a pure,
dry sample of copper nitrate.

Level 1 (1–2 marks):
Simple statements relating to relevant apparatus or steps are made but they may not be
in a logical order. The plan would not allow another person to produce the sample.

0 marks:
No relevant content

Indicative content

- pour a suitable volume of nitric acid into a suitable container
- add a small amount of copper carbonate to the acid and stir until the effervescence stops
- continue to add small amounts of copper carbonate to the acid and each time stir until any effervescence stops
- eventually when there is no reaction / effervescence when the copper carbonate is added filter the mixture to remove the excess copper carbonate
- pour the filtrate (copper nitrate solution) into an evaporating basin and heat to evaporate a small amount of the water
- leave the copper nitrate solution to crystallise
- remove the crystals from the solution remaining and dry the crystals

6

(b) 1 mole carbon dioxide = 14 + (16 × 2) = 46 g

1

14 g is 0.30 mole

1

1 mole is 6.02×10^{23} molecules

1

so 14 g has 1.81×10^{23} molecules

*allow 1.81×10^{23} with no working shown for **4** marks*

1

*answer not given in standard form max. **3** marks*

[10]

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Q64.

(a) black

1

(b) limewater

accept calcium hydroxide (solution)

1

[2]

Q65.

(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

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[7]

Q66.

(a) (acids) <u>react</u> with calcium carbonate / shells

1

(so) shells will be (chemically) eroded

*do **not** allow melts*

allow dissolved / are thinner / worn away / corroded

ignore weakened / break down

1

(b) (i) mass of products should equal mass of reactants

allow loss in mass

or

4.4 g lost

1

(there is a difference because the) gas <u>escapes</u>

ignore gas produced / evaporated

1

[4]

Q67.

(a) **economic**

any **one** from:

- increases jobs
- more money in local economy
- increase in local trade
- more shops / businesses
- better transport links

1

environmental

any **one** from:

- future development of quarry eg to lake / reservoir
- future development to recreational area
- provides different habitat

1

(b) calcium oxide and carbon dioxide

both products required for mark

allow CaO for calcium oxide

allow CO_2 for carbon dioxide

allow quicklime for calcium oxide

1

(thermal) decomposition

1

(c) (i) $CaO + H_2O \rightarrow Ca(OH)_2$

correct formulae

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*3 correct for **2** marks*
*2 correct for **1** mark*
ignore attempts to balance equation

2

(ii) carbon dioxide

1

solution goes cloudy (then clear again)
accept milky / forms a white precipitate

1

[8]

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Q1.

(b) Even though the stem informed students that the products were a metal oxide and a gas, very few students (6%) could name both of the products formed when calcium carbonate ($CaCO_3$) is heated.

(c) 63% of students knew that the type of reaction when a compound breaks down is called decomposition.

(d) 60% of students knew that the type of reaction that takes in energy from the surroundings is called an endothermic reaction.

(g) This question discriminated between students well. The two mistakes made in the student's calculation were often poorly expressed or ambiguous such as, 'the calculation is wrong'; 'used the wrong numbers'; 'the volume is wrong'; and 'readings are taken from the wrong place'.

Many students correctly identified at least one of the mistakes but several of these students continued to use either the incorrect mass or the inverse formula for their calculation.

13% of students expressed the mistakes well and correctly calculated the gradient. There were 12% of students who did not attempt to answer this question.

Q2.

(a) The question was not answered well, with large numbers of students missing the key word 'formula' in the question stem. As a result, lots of responses included the names of a wide range of chemicals. Quite a few knew the formula for carbon dioxide.

(b) Those students who were aware that carbonate had a formula of CO_3 usually came up with the correct answer. Many opted for more well-known Group 2 carbonates such as calcium and magnesium, usually with little justification.

(c) A good number of students could successfully calculate the gradient. Most students knew the method but could not get the correct figures from the graph. Students seemed to make their life very difficult when selecting values from the graph to calculate the gradient.

The easiest methods would have been to:

- use the increase in mass from 0 g to 1 g, with the equivalent volume increase of 167 cm^3, to give a simple calculation of 167 ÷ 1
- increase in mass from 0 g to 0.5 g, or 0 g to 2 g would have also given relatively easy calculations.

There were very few inverted equations but very few correct units, these were invariably inverted as g/cm^3

When determining a gradient students should be encouraged to draw the sides of their triangle as large as possible, as this reduces the error in reading the *x* and *y* values from the graph.

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(d) This question was answered well by only the highest-attaining students with 4% achieving full marks. Their working followed those methods in the mark scheme or routes based upon these, which also achieved full credit. These students could either see the link from the graph, where 240 cm^3 had a mass of 1.45 g, and the subsequent conversion from 240 cm^3 to 24 dm^3 or they divided the volume (in cm^3) by their gradient.

Some students used a volume on the *y*-axis of 24 cm^3, which gave a mass of approximately 0.15 g on the *x*-axis, which scaled up to (a correct answer of) 150. However, because their scale was so small, some got the mass as 0.16 g. As this is within half a small square and scaled up to 160, these students were also awarded full credit.

Students should be aware that when larger values are taken from the *x* and *y*-axes, errors in subsequent calculations are minimised.

Q3.

(a) A substantial number of students found selecting the independent and control variable challenging. Of these students, some gave multiple suggestions, and others gave the control variable as the independent variable and vice versa. The mass lost from the flask, and the time taken were frequently selected. A number of students ignored the instruction to 'Draw **one** line from each type of variable' and drew several. 30% of students achieved one mark and 15% achieved two marks.

(b) 24% of students were able to name all the products of the reaction, although 40% named two. Among the incorrect responses, many students named elements in the products (e.g. hydrogen or calcium), and others were unable to distinguish reactants from products.

While some students appeared to readily recognise $H_2O_{(l)}$ as water, others referred to it as hydrogen oxide. Other students were unable to name calcium chloride, leaving it as 'calcium'. Many incorrect responses included cobalt.

(c) 6% of students answered this question correctly. Of these, only a very small proportion of students realised that the cotton wool prevents acid or water escaping from the flask. By far the most commonly seen response suggested that the cotton wool prevents the escape of gas from the flask. Other students suggested that it prevented heat loss, or stopped air or oxygen from getting in the flask.

(d) 72% of students successfully calculated the mean rate of the reaction. Of those who did not succeed, most had difficulties with powers of ten, giving answers such as 5.3 or 0.53. A smaller proportion of students inverted the calculation, giving the answer as 18.75 (= 30 ÷ 1.6). Some students attempted to multiply 1.6 × 30.

(e) 78% of students selected the correct response, g/s. The most popular incorrect responses were g and s.

(f) This question discriminated well with a nice spread across the mark range. 66% of students achieved at least one mark, with 11% achieving all three.

Lower-attaining students were challenged by the *y*-axis scale and attempted to plot a graph using a scale of one small square to 0.1 g rather than two small squares to 0.1 g.

The points requiring a reading of the *y*-axis scale for 0.8 g and 1.8 g proved more difficult than those at 0.6 g and 1.6 g. This resulted in difficulty drawing a sensible

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line of best fit. Some students omitted to plot the point at (0,0).

A number of students who succeeded in plotting the points correctly interpreted the term 'line of best fit' as requiring a straight line, whereas a curve was correct. The term 'line of best fit' applies to either a straight line or a curve. Most students realised that the point at 20 s was an anomaly, and excluded it from their line of best fit. Some students attempted a bar chart.

(g) Most of the responses were almost equally divided between the 2nd and 4th responses, indicating that students were aware that more frequent collisions were involved, but unsure whether thee eight small marble chips had a larger or smaller surface area than the large marble chip.

Q4.

(a) 22% of students knew the definition from the specification or were able to give an equivalent statement. Often students mentioned only that it was 'a mixture or chemicals mixed together' but omitted the idea of 'to form a useful product'. Some students were able to give examples, but not a definition.

As the question stem mentioned fertilisers, a few students answered the question with phrases such as a substance / something to help plants grow or to enhance plant growth.

(b) 5% of students achieved full marks but many students (63%) gained some credit for their calculation. The most common answers that achieved two marks were 0.18 or 0.1815, (not converting 14.52 kg to g and an omission or incorrect conversion of their calculation into standard form to two significant figures).

An answer of 1.8×10^{-1} achieved three marks, the calculation being correct, but the students had not undertaken the initial conversion of kg into g. Several students had multiplied an answer within their calculation by Avogadro's number.

(c) 51% of students achieved some credit on this question. However, there were many references to intermolecular forces (often strong intermolecular forces), covalent bonds and molecules, all of which limited the response to a maximum of two marks.

Many students described in detail how potassium, being in Group 1 of the periodic table would transfer one electron to chlorine which is in Group 7 to obtain full outer shells meaning that the compound would have a high melting point. 'Ionic bonds' was often seen but normally as part of a lengthy explanation of how and why potassium transfers one electron to chlorine.

1% of students achieved full marks, with 7% of students achieving three marks; the description of a 'lattice' or 'giant structure' was seldom seen.

Q5.

(a) Students found this difficult with more students giving the distractor of the mixture being heated to show that the reaction was exothermic than the correct response.

(b) 33% of students were able to correctly use the law of conservation of mass to calculate the answer. Incorrect responses gave a variety of methods of using the three numbers given in the question.

(c) Students found using the state symbols in the equation to determine the physical state of zinc oxide difficult, with gas being the most common response.

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(d) 45% of students were able to identify zinc as the substance which had been oxidised.

(e) More students answered in terms of the reaction between zinc and copper oxide being an example of combustion rather than displacement.

(f) 44% of students were able to identify the structure of atoms in pure copper.

(g) Most correct responses were in terms of electrical conduction, with a few continuing to give a detailed description of how the metal conducted electricity which was not required at this level. 57% of students achieved this mark. A few answered in terms of flexibility. Some didn't realise that the question related to electrical wiring and gave responses in terms of thermal conductivity.

(h) 67% of students were able to identify the simplest ratio from the data used in the question.

(i) 52% of students were able to identify both of the correct advantages of recycling copper, with nearly all obtaining at least one mark. Conserves copper ores was more commonly known than less energy used.

Q6.

(a) 70% of students identified the decrease in melting point as the trend with others correctly answering in terms of negative correlation. A number of students referred to boiling points rather than melting points.

(b) Nearly all students correctly identified the atomic number of caesium as 55. But a significant number failed to read the scale on the graph correctly in order to obtain the melting point of caesium, usually giving an incorrect response of 24 °C or 25 °C. 61% of students achieved the mark.

(c) The most common distractor was '3', where students had determined the number of electrons in a lithium atom rather than in the outer shell. 40% of students were able to select the correct response.

(d) Most students were able to identify oxygen as an element but many thought lithium oxide was a metal. 76% of students achieved at least one mark.

(e) Students found complete the balancing of the equation difficult with the vast majority of responses placing 2 in front of Li. 15% of responses were correct.

(f) More students thought lithium oxide was covalent rather than ionic.

(g) 20% of students gave the correct answer of 30. Incorrect calculations were seen involving every possible combination of the numbers 7 and 16. 112 (7 × 16) was the most common incorrect response.

Q7.

Foundation

(a) 28% of students did not attempt this question. Of those that did the majority of students were able to draw a bonding electron pair. However, many were not able to work out or recall that chlorine had seven electrons in its outer shell and included 17 electrons on the outer shell. Others tried to draw the inner shells and then overlapped these with the hydrogen electron shell. 23% of students achieved full

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credit.

(b) This question was not answered well with 6% of students achieving one or two marks.

Most students were not able to recall that chlorine gas is a molecule with the formula Cl_2 but some were however able to access mark point two which required the correct balancing of an equation with HCl given. Others, despite Figure 1 showing a hydrogen chloride molecule, gave formulas such as H_2Cl_2 or H_2Cl

Some students gave a word equation despite the instruction in the question to complete a balanced chemical equation.

(c) 5% of students achieving one or two marks. A variety of responses were seen including amplitude and wavelength descriptions. Very few students appeared to know the term 'activation energy' and even less that B was the overall energy change.

(d) Responses needed to be specifically linked to the reaction profile diagram rather than stating what an exothermic reaction is. 3% of students managed to obtain this mark with many describing the pattern, for example, it goes up then down or talking about an energy decrease but without a link. 27% of students did not attempt this question.

(e) 30% of students did not attempt this question. Those that did attempt the question displayed a lack of understanding of the structure of a small molecule. Many students stated that gases do not conduct electricity but liquids do.

6% of students achieved one mark which was usually for stating that hydrochloric acid contains ions. A few students could also state that hydrogen chloride does not contain ions. Hardly any students referred to how these ions would enable an electric current to flow.

Higher

(a) 59% of students were able to work out or knew that chlorine had seven electrons in its outer shell and consequently complete the diagram correctly. Others who gave an incorrect number of electrons were usually able to draw a bonding electron pair.

(b) Many students were not able to recall that chlorine gas is a molecule with the formula Cl_2 but some were able to access mark point two which required the correct balancing of an equation with HCl given. Others, despite figure 1 showing a hydrogen chloride molecule, gave formulas such as H_2Cl_2 or H_2Cl.

(c) This question was not well answered with a variety of responses seen from products and reactants to wavelength descriptions. Activation energy was the most common correct response. Few knew B was the overall energy change, with students often giving insufficient responses about energy released or lost, with no reference to change, for this marking point. 35% of students were able to achieve full or partial credit.

(d) Responses needed to be specifically linked to the reaction profile diagram rather than stating what an exothermic reaction is. There were some responses showing that reactants were higher than products on the diagram but few related this to energy. 20% of students achieved the mark.

(e) Generally there was a lack of understanding of the structure of a small molecule. 8% of students achieved two or three marks.

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The first marking point was the lowest achieved of the three, with answers in terms of full outer shells and also suggesting that the non-conductance was due to the gaseous state and the larger spacing of the molecules. Those who did obtain this mark usually gave hydrogen chloride not containing ions rather than the lack of an overall charge.

A significant number of students gave answers for marking point two and three in terms of (delocalised) electrons rather than ions even though ions were mentioned in the stem of the question. For the third marking point, students often said that ions were free to move but failed to say how this facilitated conduction.

Q8.

(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 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.

Q9.

(a) Around two thirds of students correctly identified the Group 1 elements as alkali metals. Other responses were fairly evenly spread between the other options.

(b) By far the most common response was 'gloves', followed by 'apron/lab coat'. Credit was not given for these precautions relating to general good laboratory practice, although it was pleasing to see that most students were aware of them. The answers required related to this particular experiment. The highest scoring correct response was 'safety screen' − described in an assortment of ways, some of which (e.g. barriers) were not accepted.

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(c) Around 10% of students did not attempt this question. Many interpreted ‘describe the trend’ as ‘describe the similarities’, tending to state ‘they all…’ rather than comparing the reactions of the elements. Thus, more than half of students scored no marks. A few attempted to explain the trend in terms of the size of the atom; however, the command words here were ‘describe’ and ‘give’, not ‘explain’.

(d) Around 10% of students did not attempt this question. To be awarded the mark, students needed to communicate that the reaction was less controllable in some way, so statements such as ‘very reactive’ were insufficient, as potassium is also very reactive. Many students recognized the higher reactivity of rubidium, but the most common correct response referred to the reaction being dangerous.

(e) Approximately one quarter of students did not attempt this question. Of those who made an attempt, a significant number did not realise that to balance an equation involved putting numbers in front of the substances shown. Some students wrote the name of the substance, others put symbols for various elements or compounds. Even though this should have been a familiar equation, many students tried to add additional reactants or products. Some students who realised that they had to balance the numbers of atoms of the different elements involved struggled to do this correctly. However, around one quarter of students gained the mark for this question.

(f) About three quarters of students correctly identified NaOH as being sodium hydroxide. ‘Sodium dioxide’ was the least popular option.

(g) Any value lying between the diameters of the sodium atom and the rubidium atom was credited as being acceptable, therefore allowing around 80% of students to gain the mark. It appeared that some students had realised what the value was, but did not put the decimal point in front, so answers of 444 and similar were seen. Some students chose a number which was nowhere near any of the values in the table.

(h) More than half opted for the incorrect answer of 3.04×10^{-9} m. There was a fairly even spread between the correct answer of 3.04×10^{-10} m and the incorrect answer of 3.04×10^{-8} m, with very few choosing the fourth option.

(i) Around 10% of students scored all three marks, with a further 10% scoring two marks.

The question asked students to include data from figure 4 in their answer. When students did not achieve all the marks, the main reason was that data was not included, was read incorrectly off the graph or did not include interpretation of the data, such as ‘increased’ or ‘decreased’. Some gave correct data for one use but then generalized for the other two.

Some students were able to gain one mark for the general statement that the amount of lithium used in batteries and in the production of ceramics and glass had increased, whereas the use in lubricants had decreased.

A significant number interpreted the command word ‘describe’ as ‘explain’ and attempted to give reasons for why lithium was used more in batteries, etc. Some students mis-interpreted the question as being about the use of batteries, for example, and again attempted explanations as to why more batteries were being produced.

Q10.

(a) The correct answer (Oxygen) was chosen by, just over 10 % of students. ‘Sulfur’

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and ‘sulfur dioxide’ were equally popular incorrect choices and accounted for around two thirds of student responses.

(b) Some who made an attempt did not seem to realise they would need a cell / battery or an ammeter, and the vast majority omitted a variable resistor. Where students had included some of these components, they often did not know the correct circuit symbols or how to connect them in the circuit.

Fewer than 2% achieved all three marks, with 40% gaining no marks.

(c) Only 1% gained all four marks, with nearly 70% scoring no marks at all.

A common misconception was that because the mass of copper deposited increased as the current increased, this showed direct proportionality.

A large number of students referred to the first set of results as being proportional, but the rest were not, indicating that they have an incorrect understanding of proportionality.

Few supported their claims with any calculations; of those who attempted to do so, these were often incorrect, e.g. ‘the mass of copper is double the current’.

A few realised that if the current doubles, the mass of copper deposited should also double. However, most of these went on to say that for the first two results, doubling the mass of copper would give 0.048g, whereas it is only 0.047g, so this shows they are not proportional.

Very few realised that if mass is proportional to current, then mass/current would be a constant. The few who calculated this constant for all six pairs of data were able to identify the anomalous result at 0.36A.

(d) Of those who made an attempt, many did not realise that they needed to use the table to find the mass of copper which was deposited when the current was 0.72A. They then took the values of current and relative atomic mass and added, subtracted, multiplied or divided in various combinations.

Students who correctly identified the mass as being 0.142g were usually able to calculate the number of moles correctly. However, many either did not realise that the question asked for the answer in standard form, or they did not know how to do this.

(e) Just over half of students chose the correct response of ‘increase the time’. ‘Increase the distance between the electrodes’ was the least chosen, with the other two responses being almost equally chosen.

Q64.

(a) Around half of the students correctly said that copper oxide is black. The most common distractor was “green”.

(b) Only a few students knew that limewater was used to test for carbon dioxide. Limestone was quite a common response, with others giving substances that are used in other chemical tests, such as bromine.

Q65.

(a) Less than half of the students gained one mark or more on this question. The

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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 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.

Q66.

(a) This question was standard demand. There were many confused responses with poor terminology. 1 mark was for stating that acids react with calcium carbonate or shells. A lot of students thought the acid reacted with calcium and surprisingly few students used the word react. The second mark was for saying the shells would be eroded, but words such as cracked, rotted, destroyed or broken were insufficient.

(b) Only a few students said that the mass of products should equal the mass of reactants, but still gained the first marking point if they said that there was a decrease in mass. To gain the second mark it had to be clear that the gas would escape from the test tube, which could be phrased in several ways. Most simply stated that a gas was produced, which was in the stem of the question so was insufficient for the mark. Others said the calcium carbonate or the gas evaporated, which was incorrect. Once again poor scientific terminology let a lot of students down.

Q67.

(a) Some students answered the question in terms of advantages and disadvantages of quarries, rather than economic and environmental reasons. They did not realise that the company would want to present advantages for both reasons and gave a variety of arguments against the opening of a new quarry. Many students gained a mark for the economic reason of providing more jobs. A lot of students incorrectly thought that the quarry would be a tourist attraction.

(b) Both products were required to gain one mark. Students often named either carbon dioxide or calcium oxide only, or one of the products was named incorrectly. Common incorrect products were limewater or slaked lime. Incorrect processes named were combustion, melting, cracking and distillation. Students would benefit from learning definitions and examples of all these processes.

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(c) (i) A third of students answered this question correctly. A symbol equation was asked for, but many students wrote a word equation so gained no marks. The most common errors were incorrect formulae. Calcium oxide was represented incorrectly as CaO_2 or Ca. Calcium hydroxide was usually written correctly, as it was given in the question. A surprising number did not know the formula of water. Students could not gain the marks if formulae were written with lower case letters or superscripts.

(ii) Compared to the January 2012 exams more students knew the test for carbon dioxide. However, a variety of other gases and chemicals were named. Similarly, a variety of colour changes were given. Students mixed up tests for hydrogen, oxygen and carbon dioxide. The tests for carbon dioxide and for unsaturation are the only two that students need to learn for Unit 2 C1. Almost a fifth of students did not make any attempt at answering this question.

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