AQA GCSE Chemistry | 8462

SPECIFICATION POINT 4.4.1.1

Metal oxides

Mark schemes and examiner comments

Tier	**Higher**
Question groups	**64**
Available paper years	**2007–2025**

Using this booklet

1. Booklet answer numbers match the question booklet.
2. Use the original question number within marking tables.
3. Examiner comments are included where available.

Name: _____ **Date:** _____

Where a precise marking extract is unavailable, the full source document is included in an appendix. Any missing mark scheme is explicitly identified.

4.4.1.1 Metal oxides

Answer 01 · Mark scheme January 2007 | CHY1H | Original Q3 | Legacy

Question 3

	answers	extra information	mark
(a)(i)	contain enough metal to make it economical / worth while to extract		1
(ii)	reduction	accept displacement accept redox	1
(iii)	Fe + CO_2	do **not** accept Fe_2 / Fe_4	1
	correct balancing	accept multiples and halves	1
	2Fe_2O_3 + **3**C → **4**Fe + **3**CO_2	allow Fe_2 / Fe_4 as ecf	
(b)	**Pure Iron** (in pure metal all the atoms are the same size and) able to slip / slide over each other – (property soft)	OWTTE ignore references to molecules / particles. if they say 'move' both times, allow **one** mark but 'crack' or 'split' is wrong.	1
	Cast iron (in cast iron) different sized atoms / larger atoms **or** structure is distorted / disrupted	OWTTE	1
	so it is difficult for layers of atoms to slip / slide over each other	OWTTE	1
(c)	any **three** from: • conserves / saves resources / metal ores • saves energy resources (used for extraction / processing) • decreases waste materials • decreases a named pollution	accept cheaper / saves money do **not** accept acid rain	3
total			10

4.4.1.1 Metal oxides

Answer 02 · Mark scheme June 2007 | CHY1H | Original Q2 | Legacy

The full source mark scheme begins on page 91. Follow original question 2 in that document.

Answer 03 · Mark scheme November 2007 | CHY1A | Original Q7 | Legacy

Seven	**4**	**4**	**2**	**2**

Answer 04 · Mark scheme January 2008 | CHY1H | Original Q4 | Legacy

No matching mark scheme was available in the supplied archive for this question.

Answer 05 · Mark scheme January 2008 | CHY2H | Original Q5 | Legacy

The full source mark scheme begins on page 104. Follow original question 5 in that document.

Answer 06 · Mark scheme June 2008 | CHY1AP | Original Q3 | Legacy

Three	**1**	**4**	**3**	**1**

4.4.1.1 Metal oxides

Answer 07 · Mark scheme June 2008 | CHY2H | Original Q3 | Legacy

question	answers	extra information	mark
3(a)(i)	sulfuric	accept $\underline{H_2SO_4}$ accept sulphuric allow phonetic spellings	1
3(a)(ii)	$CuO + H_2SO_4 \rightarrow CuSO_4 + H_2O$	**1** mark for reactants **1** mark for products ignore state symbols max **1** mark for incorrect balancing	2
3(b)	any **two** from: • particles gain energy **or** particles have more energy • particles move faster • collide more often • collide more energetically • more of the collisions are successful **or** more particles have the activation energy	allow have more activation energy allow they collide faster / quicker ignore move / vibrate more allow more collisions **NB** more successful collisions alone = **1** mark if particles are identified as electrons = max **1** mark	2
Total			**5**

4.4.1.1 Metal oxides

Answer 07 · Mark scheme June 2008 | CHY2H | Original Q3 | Legacy

COMPONENT NUMBER: CHY2H

COMPONENT NAME: Additional Science / Chemistry

STATUS: Final

DATE: June 2008

Answer 08 · Mark scheme March 2009 | CHY1AP | Original Q2 | Legacy

Two	**A**	decomposed	**2**	
	B	acidified	**3**	
	C	reduced	**4**	
	D	extracted	**1**	

	A	**B**	**C**	**D**

Answer 09 · Mark scheme March 2009 | CHY1AP | Original Q9 | Legacy

Nine	**2**	**2**	**3**	**1**

Answer 10 · Mark scheme March 2009 | CHY1BP | Original Q5 | Legacy

Five	**3**	**3**	**1**	**3**

Answer 11 · Mark scheme June 2009 | CHY1AP | Original Q7 | Legacy

Seven	**4**	**1**	**4**	**1**

4.4.1.1 Metal oxides

Answer 12 · Mark scheme June 2009 | CHY1AP | Original Q9 | Legacy

Nine	**3**	**3**	**2**	**3**

Answer 13 · Mark scheme November 2009 | CHY1AP | Original Q2 | Legacy

Two	**A** Formulae **A** ($ZnCO_3$) **2** **B** Formulae **B** (C) **4** **C** Formulae **C** (CO_2) **3** **D** Formulae **D** (ZnO) **1**			
	A	**B**	**C**	**D**

Answer 14 · Mark scheme November 2009 | CHY1AP | Original Q7 | Legacy

Seven	**2**	**3**	**2**	**4**

Answer 15 · Mark scheme November 2009 | CHY1AP | Original Q8 | Legacy

Eight	**1**	**1**	**3**	**4**

Answer 16 · Mark scheme March 2010 | CHY1AP | Original Q2 | Legacy

Two	**A** reduction **4** **B** combustion **2** **C** thermal decomposition **1** **D** corrosion **3**			
	A	**B**	**C**	**D**

4.4.1.1 Metal oxides

Answer 17 · Mark scheme March 2010 | CHY1AP | Original Q3 | Legacy

Three	**2**	**3**	**2**	**2**

Answer 18 · Mark scheme June 2010 | CHY1AP | Original Q2 | Legacy

Two	**A**	Substance **A**	**3**		
	B	Substance **B**	**2**		
	C	Substance **C**	**4**		
	D	Substance **D**	**1**		
	A		**B**	**C**	**D**

Answer 19 · Mark scheme June 2010 | CHY1AP | Original Q3 | Legacy

Three	**2**	**1**	**1**	**2**

Answer 20 · Mark scheme June 2010 | CHY1AP | Original Q9 | Legacy

Nine	**2**	**4**	**4**	**3**

4.4.1.1 Metal oxides

Answer 21 · Mark scheme

June 2010 | CHY1H | Original Q3 | Legacy

Question 3

question	answers	extra information	mark
3(a)(i)	C	must be correct symbol do **not** accept carbon any balancing must be correct	1
3(a)(ii)	$Fe + CO_2$ 2…. + 3….	correct formulae correct balancing allow $Fe_2 + 3CO_2$ for this mark	1 1
3(a)(iii)	layers / atoms in pure iron are able to slide over each other **or** layers / atoms in cast iron are unable to slide over each other (easily)	it = pure iron accept ions for atoms ignore molecules / particles	1

Question 3 continues on the next page

4.4.1.1 Metal oxides

CHY1H

Question 3 continued

question	answers	extra information	mark
3(b)	any **three** from: • less iron ore used • less other metals extracted / used to make different steels • less fuel used • less specified pollution • less / no landfill space needed • less / no mining needed **or** fewer specified effects of mining	mention of ozone = max **2** accept the idea that ores would be conserved but not unspecified conservation accept the idea that ores would be conserved but not unspecified conservation accept the idea that fuels would be conserved ignore reduces energy requirements accept global warming / greenhouse effect / CO_2 / CO / carbon emissions / acid rain / SO_2 / global dimming / do **not** accept ozone layer ignore reduces waste accept effect such as eyesore / loss of habitat eg 'less mining iron ore' = **2** marks	3
Total			**7**

4.4.1.1 Metal oxides

Answer 21 · Mark scheme June 2010 | CHY1H | Original Q3 | Legacy

CHY1H

Answer 22 · Mark scheme November 2010 | CHY1AP | Original Q1 | Legacy

Question	Key		
One	**A**	uses another metal	**3**
	B	does **not** use a chemical reaction	**2**
	C	could be done in a blast furnace	**4**
	D	is called electrolysis	**1**

Answer 23 · Mark scheme November 2010 | CHY1AP | Original Q4 | Legacy

Four	**3**	**2**	**1**	**2**

Answer 24 · Mark scheme November 2010 | CHY1AP | Original Q8 | Legacy

Eight	**3**	**2**	**2**	**2**

4.4.1.1 Metal oxides

Answer 25 · Mark scheme

Question 1

question	answers	extra information	mark
1(a)(i)	very little / low percentage of metal (in the ore)	accept only 0.5% metal in the ore **or** over 99% waste in the ore **or** nearly 100% waste in the ore ignore reference to percentage of metal in the Earth's crust **or** energy used or pollution	1
1(a)(ii)	any **one** from • iron uses less energy / fuel for extraction • iron has more uses • more demand for iron • iron is stronger • cheaper / costs less • easier to extract	(it = iron) ignore electrolysis / uses electricity / reactivity ignore high abundance in the Earth's crust / high percentage of metal in ore ignore harder	1
1(b)(i)	has melting point lower than 950°C	(it = aluminium) allow has a low melting point ignore boiling point	1
1(b)(ii)	electrode(s) made of carbon oxygen reacts with electrode(s) / carbon	 accept C + O_2 (→ CO_2) NB oxygen reacts with the carbon electrode(s) = **2** marks	1 1

Question 1 continues on the next page

4.4.1.1 Metal oxides

CHY1H

Question 1 contd

question	answers	extra information	mark
1(b)(iii)	any **two** from: • saves resources / non renewable • landfill problem • saves energy / fuel / electricity • less carbon dioxide / carbon emissions or reduces carbon footprint • less quarrying / mining	accept aluminium / ore will run out or conserves aluminium accept aluminium does not corrode ignore global warming ignore consequences of quarrying / mining ignore pollution / harms environment / costs / easy to recycle	2
Total			**7**

4.4.1.1 Metal oxides

Answer 25 · Mark scheme

January 2011 | CHY1H | Original Q1 | Legacy

CHY1H

4.4.1.1 Metal oxides

Answer 26 · Mark scheme

January 2011 | CHY2H | Original Q2 | Legacy

Question 2

question	answers	extra information	mark
2(a)(i)	65	correct answer with or without working = **2** marks if answer incorrect evidence of (81 – 16) for **1** mark ignore units	2
2(a)(ii)	zinc	accept error carried forward from (a)(i) allow correct symbol answer given should be element / metal closest to their answer do **not** allow compounds	1
2(b)(i)	• it loses electrons • three electrons	sharing / covalency = max **1** mark	1 1
2(b)(ii)	8 electrons shown in second shell.	accept dots / crosses / mixture of dots and crosses / e electrons do not need to be paired do **not** allow extra electrons in first shell	1
Total			**6**

4.4.1.1 Metal oxides

Answer 26 · Mark scheme January 2011 | CHY2H | Original Q2 | Legacy

CHY2H

Answer 27 · Mark scheme March 2011 | CHY1AP | Original Q2 | Legacy

Two	**A** Metal **A**		**2**	
	B Metal **B**		**3**	
	C Metal **C**		**4**	
	D Metal **D**		**1**	
	A	**B**	**C**	**D**

Answer 28 · Mark scheme March 2011 | CHY1AP | Original Q3 | Legacy

Three	**1**	**2**	**1**	**4**

Answer 29 · Mark scheme March 2011 | CHY1AP | Original Q8 | Legacy

Eight	**2**	**2**	**1**	**2**

Answer 30 · Mark scheme June 2011 | CHY1AP | Original Q1 | Legacy

Question	Key		
One	**A**	electrons	**2**
	B	bonds	**3**
	C	products	**1**
	D	elements	**4**

Answer 31 · Mark scheme June 2011 | CHY1AP | Original Q5 | Legacy

Five	**2**	**2**	**1**	**3**

4.4.1.1 Metal oxides

Answer 32 · Mark scheme

June 2011 | CHY1H | Original Q3 | Legacy

Question 3

question	answers	extra information	mark
3(a)		any mention of molecules / compounds = max **1** allow ions for particles throughout it = brass	
	brass is an alloy **or** brass is a mixture (of metals) **or** brass has different sized / types of atoms / particles	accept brass does not have a regular structure **or** has a disrupted / irregular structure	1
	or in copper all the atoms / particles are the same **or** are the same size / type	accept copper has a regular structure	
	(so) in brass layers / atoms / particles cannot (easily) slide **or** in copper layers / atoms / particles can slide (more easily)	ignore moves easier	1
3(b)(i)	(thermal) decomposition	accept endothermic (reaction) do not accept combustion / burning	1
	by heating	accept in a furnace / kiln	1
3(b)(ii)		they = zinc or lead	
	carbon is more reactive than lead / zinc		1
	(so) lead / zinc oxide is reduced **or** oxygen is removed (by carbon)	accept so lead / zinc oxide reacts with carbon / carbon monoxide accept carbon displaces zinc / lead (from their oxide) allow carbon reacts with the oxygen accept word equation **or** balanced symbol equation	1

Question 3 continues on the next page . . .

4.4.1.1 Metal oxides

CHY1H

Question 3 continued . . .

question	answers	extra information	mark
3(b)(iii)	(zinc separates / escapes because) zinc boils / turns to a gas (at the temperature of the furnace) **or** the boiling point of zinc is below the temperature of the furnace	ignore density ignore evaporates	1
	lead separates because it melts but does not boil **or** the temperature of the furnace is above the melting point of lead but below its boiling point	ignore density accept lead is molten for lead melts	1
		if no other mark awarded allow **1** mark for they (zinc and lead) have different boiling points **or** zinc's boiling point is lower than lead's or vice versa	
Total			**8**

4.4.1.1 Metal oxides

Answer 32 · Mark scheme

June 2011 | CHY1H | Original Q3 | Legacy

CHY1H

4.4.1.1 Metal oxides

Answer 33 · Mark scheme

June 2011 | CHY2H | Original Q2 | Legacy

Question 2

question	answers	extra information	mark
2(a)	because they are gases	ignore vapours / evaporate / (g) allow it is a gas	1
2(b)(i)	80 / 79.5	correct answer with or without working = **2** marks ignore units if no answer **or** incorrect answer then evidence of 64 / 63.5 + 16 gains **1** mark	2
2(b)(ii)	80 / 79.87 / 79.9 / 79.375 / 79.38 / 79.4	correct answer with or without working = **2** marks if no answer **or** incorrect answer then evidence of $\frac{64}{80}$ **or** $\frac{63.5}{79.5}$ (x100) gains **1** mark accept (ecf) $\frac{64 or 63.5}{answer(b)(i)}(\times 100)$ for **2** marks if correctly calculated. if incorrectly calculated evidence of $\frac{64 or 63.5}{answer(b)(i)}(\times 100)$ gains **1** mark	2
2(b)(iii)	3.2	correct answer with or without working = **1** mark allow (ecf) 4 x ((b)(ii)/100) for **1** mark if correctly calculated	1

Question 2 continues on the next page

Question 2 continued

question	answers	extra information	mark
2(c)(i)	3.3	accept 3.33…….. or $3\frac{1}{3}$ or 3.3$^{\cdot}$ or 3.3^{r}	1
2(c)(ii)	measure to more decimal places **or** use a more sensitive balance / apparatus	allow use smaller scale (division) **or** use a smaller unit ignore accurate / repeat	1
2(c)(iii)	any **two** from: • different balances used **or** faulty balance • reading / using the balance incorrectly **or** recording error • spilling copper oxide / copper • copper oxide impure • not all of the copper oxide was reduced / converted to copper **or** not enough / different amounts of methane used • heated for different times • heated at different temperatures • some of the copper made is oxidised / forms copper oxide • some of the copper oxide / copper blown out / escapes (from tube) • some water still in the test tube	ignore systematic / human / apparatus / zero / measurement / random / weighing / reading errors unless qualified ignore dirty apparatus accept incorrect weighing of copper / copper oxide allow some copper left in tube allow impure copper (produced) accept not all copper oxide (fully) reacted accept Bunsen burner / flame at different temperatures ignore some copper oxide / copper lost	2
Total			**10**

4.4.1.1 Metal oxides

Answer 33 · Mark scheme June 2011 | CHY2H | Original Q2 | Legacy

CHY2H

4.4.1.1 Metal oxides

Answer 34 · Mark scheme

June 2011 | CHY2H | Original Q4 | Legacy

Question 4

question	answers	extra information	mark
4(a)	gives out heat / energy **or** energy / heat transferred to surroundings	allow more energy given out in making bonds than is used in breaking bonds ignore light	1
4(b)	activation	allow phonetic spelling	1
4(c)(i)	2 crosses on inner circle **and** 8 crosses on outer circle	accepts dots / e / — for electrons	1
4(c)(ii)	opposite charges (attract)	allow electrostatic forces (attract) do **not** accept intermolecular attraction / shared electrons	1
Total			**4**

4.4.1.1 Metal oxides

Answer 34 · Mark scheme June 2011 | CHY2H | Original Q4 | Legacy

CHY2H

Answer 35 · Mark scheme November 2011 | CHY1AP | Original Q4 | Legacy

Four	**3**	**2**	**1**	**2**

4.4.1.1 Metal oxides

Answer 36 · Mark scheme

Question 4

question	answers	extra information	mark
4(a)(i)	reduction	accept redox / smelting	1
4(a)(ii)	3 4 3		1
4(b)(i)	55	ignore other units	1
4(b)(ii)	water	accept sodium hydroxide accept correct formulae H_2O or NaOH	1
4(b)(iii)	any **one** from: • save energy / fuel for transporting the ore • (old) quarries nearby for waste/red mud	accept less (cost of) transport allow transported quickly	1

Question 4 continues on the next page …….

CH1HP

Question 4 cont'd…

question	answers	extra information	mark
4(c)	**Environmental** any **one** from: • less mining / quarrying (of bauxite) • less landfill space needed / used • less use of fossil fuels / energy • less carbon dioxide produced **Ethical or social** any **one** from: • saves resources • creates (local) employment • more people aware of the need for recycling	 allow loss of habitat / less qualified noise pollution allow less red mud / waste allow using resources more than once if answers reversed and both correct award **1** mark allow less qualified noise pollution if not given in environmental	1 1
Total			**7**

4.4.1.1 Metal oxides

Answer 36 · Mark scheme

January 2012 | CH1HP | Original Q4 | Legacy

CH1HP

4.4.1.1 Metal oxides

Answer 37 · Mark scheme

June 2012 | CH2HP | Original Q5 | Legacy

Question 5

question	answers	extra information	mark
5(a)	52.9(411765) / 53	correct answer with or without working = **2** marks if answer incorrect allow 2 x 27= 54 **or** 27/102 x 100 **or** 26.5 for **1** mark	2
5(b)(i)	because it lowers the melting point (of the aluminium oxide) so less energy is needed (to melt it)	allow lowers the temperature needed do **not** accept lowers boiling point accept so that the cell / equipment does not melt	1 1
5(b)(ii)	**2** O^{2-} on left hand side **4e**$^{-}$ on right hand side	accept correct multiples or fractions accept –**4e**$^{-}$ on left hand side	1 1
5(b)(iii)	because the electrode reacts with oxygen **or** because the electrode burns to form carbon dioxide **or** electrode made from carbon / graphite		1 1
Total			8

4.4.1.1 Metal oxides

Answer 37 · Mark scheme

June 2012 | CH2HP | Original Q5 | Legacy

CH2HP

4.4.1.1 Metal oxides

Answer 38 · Mark scheme

question	answers	extra information	mark
7(a)	(because to produce low-carbon steel) oxygen is needed to react with / oxidise carbon	accept (to produce low-carbon steel) oxygen removes carbon as carbon dioxide	1
	(to produce titanium) an atmosphere of argon is used because it is unreactive		1
	any oxygen / air would react with / oxidise magnesium or titanium	ignore magnesium chloride / titanium chloride reacts with oxygen	1
7(b)		it = titanium ignore references to abundance / usefulness / temperature / amounts / relative reactivity / equipment	
	for titanium:	allow converse arguments for iron	
	• there are more stages in its manufacture	accept slower rate of production **or** is more labour intensive **or** a batch process is used or the process used is not continuous	1
	• larger amounts of energy are needed	accept the titanium chloride is cooled and reheated which is not energy efficient	1
	• magnesium / chlorine / argon have to be produced **or** are expensive **or** are used		1

4.4.1.1 Metal oxides

Answer 38 · Mark scheme

CH1HP

question	answers	extra information	mark
7(c)	titanium is below magnesium and above iron (in the reactivity series of metals)	allow similar position to aluminium **or** carbon **or** zinc	1
	because magnesium removes chlorine from titanium chloride **and** titanium removes oxygen from iron oxide **OR** magnesium more reactive than titanium because it removes chlorine from titanium chloride (1) titanium more reactive than iron because it removes oxygen from iron oxide (1)	allow magnesium displaces titanium **and** titanium displaces iron accept magnesium more reactive than titanium because it displaces titanium accept titanium more reactive than iron because it displaces iron	1
Total			**8**

4.4.1.1 Metal oxides

Answer 38 · Mark scheme

January 2013 | CH1HP | Original Q7 | Legacy

CH1HP

4.4.1.1 Metal oxides

Answer 39 · Mark scheme June 2013 | CH1HP | Original Q1 | Legacy

Question 1

question	answers	extra information	Mark
1(a)(i)	2.8.3	any sensible symbol can be used to represent an electron	1
1(a)(ii)	proton(s) **and** neutron(s)	both needed for the mark	1
1(a)(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
1(b)(i)	**2** Al + Fe_2O_3 → **2** Fe + Al_2O_3	equation must be balanced	1
1(b)(ii)	aluminium is more reactive (than iron)	it = aluminium accept converse accept aluminium displaces iron accept aluminium is higher in the reactivity series (than iron)	1
Total			**5**

4.4.1.1 Metal oxides

Answer 40 · Mark scheme June 2014 | CH1HP | Original Q4 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
4(a)(i)	phytomining		1	1 / 1.3.1g	G
4(a)(ii)	*(the land contains)* very little copper	*allow low grade ore* ***or*** *large amounts of waste* *ignore quarrying / benefits of using plants*	1	3 / 1.3.1f/g	E
	uneconomical	*accept (smelting) uses a lot of energy / fossil fuels* *allow expensive*	1		
4(a)(iii)	Cu **2** CuO + C → **2** Cu + CO_2	*allow 2 CuO + C → Cu_2 + CO_2 for* ***1*** *mark*	1 1	2 / 1.3.1f	E
4(b)(i)	iron is more reactive (than copper) iron is cheap(er than copper)	*allow cheaper* ***or*** *uses less energy than electrolysis*	1 1	1 + 2 / 1.3.1h	E
4(b)(ii)	*any* ***two*** *from:* • copper / ions move **or** are attracted to the negative electrode / *cathode* • where they are reduced **or** gain (two) electrons • *where they form copper (metal / atoms)*		2	1 / 1.3.1h	E
Total			**9**		

4.4.1.1 Metal oxides

Answer 40 · Mark scheme

June 2014 | CH1HP | Original Q4 | Legacy



4.4.1.1 Metal oxides

Answer 41 · Mark scheme June 2014 | CH2HP | Original Q4 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
4(a)(i)	so ions can move (and carry charge)	accept so current can flow *allow so it can conduct (electricity)* *allow so charged particles can move* *do **not** accept so electrons can move*	1	1 / 2.7.1a/b	E
4(a)(ii)	because zinc ions gain electrons 2 (electrons) zinc is formed	accept because zinc ions are reduced *accept correct half equation for **3** marks* *if no mark gained allow* *positive ions go to negative electrode **or*** *opposites attract **or*** *reduction (of zinc) **or*** *(zinc) gains electrons for **1** mark*	1 1 1	1 + 2 / 2.7.1b/c/e	E
4(a)(iii)	**2** Cl^- ⟶ Cl_2 + **2** e^-	must be completely correct	1	1 / 2.7.1g	E
4(b)(i)	because the magnesium is *a gas*	*allow magnesium goes from solid to gas*	1	2 / 2.6.1a	E
4(b)(ii)	(a reaction which) takes in energy (from the surroundings)	*accept more energy needed to break bonds than released by forming bonds* *accept correct reference to energy level diagram* *allow (a reaction which) takes in heat (from the surroundings)*	1	1 / 2.5.1a/b	E

4.4.1.1 Metal oxides

Answer 41 · Mark scheme June 2014 | CH2HP | Original Q4 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
4(b)(iii)	*(*M_r MgO =) 40	*accept (2* M_r MgO =) 80	1	2 / 2.3.3c	E
	1.2/24 (x40) **or** 0.05 (x40) **or** 40/24 (x1.2) **or** 1.67 (x1.2)	allow ecf from step 1	1		
	2(.0)	allow ecf carried through from step 1 correct answer with or without working gains **3** marks	1		
4(b)(iv)	75(%)		1	2 / 2.3.3e	E
4(b)(v)	any **one** from: • the reaction is reversible • *some lost /escaped/ released (when* separated) • some of the reactant may react in different ways from the expected reaction • *impure reactant(s)*	*accept incomplete reaction* *ignore equilibrium not reached* *ignore measurement and calculation errors*	1	1 / 2.3.3d/f	E
Total			**12**		

4.4.1.1 Metal oxides

Answer 41 · Mark scheme

June 2014 | CH2HP | Original Q4 | Legacy



4.4.1.1 Metal oxides

Answer 42 · Mark scheme June 2014 | CH2HP | Original Q6 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
6(a)(i)	any **two** from: • *100% of (type 1 and type 2) bacteria are killed with a particle size of 7.5 to 8.5 nm* • *as the size increases (beyond 8.5 nm), nanoparticles are less effective at killing (type 1 and type 2) bacteria* • *type 1 shows a linear relationship **or** type 2 is non-linear* • type 1 bacteria more susceptible than type 2 (at all sizes of nanoparticles shown on the graph)	*ignore any conclusion drawn referring to data below 7.5 nm or above 20 nm* *accept nanoparticles in the range of 7.5 to 8.5 nm are most effective at killing (type 1 and type 2) bacteria* *allow type 2 bacteria are harder to kill*	2	3 / 2.2.6a	E
6(a)(ii)	(yes) because you *could confirm the pattern that has been observed* **or** (no) because trend/*conclusion* is already clear	*allow would reduce the effect of anomalous points / random errors* *allow would give better line of best fit* *ignore references to reliability / precision / accuracy / reproducibility / repeatability / validity*	1	3 / 2.2.6a	E

4.4.1.1 Metal oxides

Answer 42 · Mark scheme June 2014 | CH2HP | Original Q6 | Legacy

6(b)		reference to incorrect particles **or** incorrect bonding **or** incorrect structure = max **3**		1 / 2.1.1c/f	E
	magnesium loses electron(s)		1		
	oxygen gains electron(s)		1		
	<u>two</u> electrons (per atom)		1		
	gives full outer shells (of electrons) ***or*** *eight electrons in highest energy level*	*accept noble gas structure*	1		
	or				
	(electrostatic) attraction between ions **or** forms ionic bonds				
Total			**7**		

4.4.1.1 Metal oxides

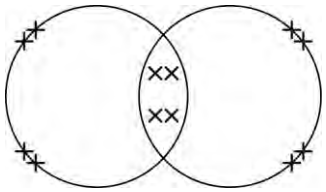
Answer 42 · Mark scheme

June 2014 | CH2HP | Original Q6 | Legacy



4.4.1.1 Metal oxides

Answer 43 · Mark scheme June 2014 | CH2HP | Original Q7 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
7(a)	*weaker bonds* ***or*** *fewer bonds* ***or*** *disruption to lattice*	*allow (other substances) react with the silicon dioxide* *ignore weaker / fewer forces* *do **not** accept reference to intermolecular forces / bonds*	1	2 / 2.2.3a	E
7(b)(i)	Na_2O	*do **not** accept brackets or charges in the formula*	1	2 / 2.1	E
7(b)(ii)	 2 bonding pairs 2 lone pairs on each oxygen	*electrons can be shown as dots, crosses, e or any combination* *accept 4 electrons within the overlap* *accept 4 non-bonding electrons on each oxygen*	1 1	1 / 2.1	E
7(c)	*lattice / regular pattern / layers / giant structure / close-packed arrangement* (of) positive ions **or** (of) atoms (with) delocalised / free electrons	reference to incorrect particles **or** incorrect bonding **or** incorrect structure = max **2**	1 1 1	1 / 2.1.1h/i	E
Total			**7**		

4.4.1.1 Metal oxides

Answer 44 · Mark scheme

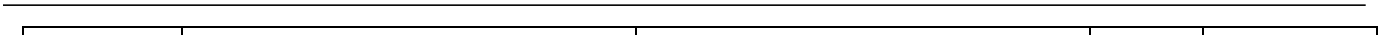
June 2015 | CH2HP | Original Q5 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.
5(a)(i)	silver nitrate	allow $AgNO_3$	1	**AO3** 2.6.1d
5(a)(ii)	potassium carbonate **or** sodium carbonate	allow K_2CO_3 allow Na_2CO_3	1	**AO3** 2.6.1d
5(b)	base	allow ionic ignore insoluble or soluble ignore alkali	1	**AO1** 2.6.2a
5(c)(i)	evaporate **or** crystallise	allow heat or boil or leave (to evaporate) allow cool ignore filtration unless given as an alternative do **not** accept freeze or solidify	1	**AO1** 2.6.1c
5(c)(ii)	2 (HNO_3)	accept multiples	1	**AO2** 2.6.1b
5(c)(iii)	9	accept nine	1	**AO2** 2.6.1b 2.1.1a
5(d)	6.21/207 0.72/16 = 0.03 = 0.045 2 3 Pb_2O_3	**1** mark for dividing mass by A_r **1** mark for correct proportions (allow multiples) **1** mark for correct whole number ratio (allow multiples). Can be awarded from formula. allow O_3Pb_2 **ecf** allowed throughout if sensible attempt at step 1 correct formula with no working gains **1** mark	1 1 1 1	**AO2** 2.3.3b
Total			**10**	

4.4.1.1 Metal oxides

Answer 44 · Mark scheme

June 2015 | CH2HP | Original Q5 | Legacy



4.4.1.1 Metal oxides

Answer 45 · Mark scheme

June 2016 | CH1HP | Original Q3 | Legacy

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
3(a)(i)	(thermal) decomposition	allow decomposes or endothermic	1	AO1 1.2.1b/c
3(a)(ii)	copper oxide		1	AO2 1.2.1b/c
3(b)(i)	the (potassium) carbonate did not decompose/change/react (when heated) the mass did not change or the limewater did not go cloudy because no carbon dioxide produced	allow temperature not high enough do **not** allow potassium did not decompose ignore references to reactivity	1 1 1	AO1+AO2 +AO3 1.2.1c/e; 4.5.4a
3(b)(ii)	the less reactive the metal the more (easily) its carbonate will decompose/react or vice versa	needs to be a relative comparison 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	2	AO3 1.2.1 c; 1.3
3(c)(i)	make it economical (to extract the metal/iron)	allow make it worth extracting allow so they can make money/profit	1	AO1 1.3.1a
3(c)(ii)	Fe balanced correctly (2,3,4,3)	 not ecf allow correct balanced equation but with $2Fe_2$ on right for one mark	1 1	AO2 1.1.3b; 1.3.2c

4.4.1.1 Metal oxides

Answer 45 · Mark scheme

3(c)(iii)	**iron** from the blast furnace is brittle **steel** produced is strong / flexible	"it" = iron allow steel has more/specific uses allow steel is rust-resistant	1 1	AO1 1.3.2a/b/c
3(c)(iv)	(recycling) is used to conserve iron (ore) **or** energy **or** resources **or** minimise pollution **or** reduce the need to quarry (not reuse) because of damage, paint removal, rusting/corrosion, metal fatigue/weaker (not landfill) because sites have limited space **or** loss of habitats	allow reverse arguments. allow to reduce the use of landfill	1 1 1	AO1+AO2 1.3.1j
Total			**15**	

4.4.1.1 Metal oxides

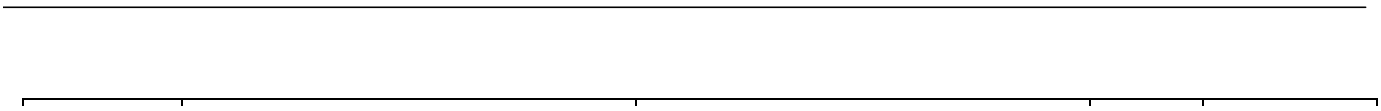
Answer 46 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
1(a)(i)	same number of protons **or** 12 protons in each	ignore electrons ignore it is the same element do **not** allow same number of neutrons	1	**AO2** 1.1.1f,g
1(a)(ii)	(the mass number is) the sum of the protons and neutrons (so the atoms contain) different numbers of neutrons	ignore electrons in shells do **not** allow electrons in nucleus allow 12, 13 and 14 neutrons for two marks if no other mark awarded allow one mark for isotopes	1 1	**AO1** **AO2** 1.1.1g
1(b)(i)	3 / three		1	**AO2** 1.1.3a,b
1(b)(ii)	7 / seven		1	**AO2** 1.1.3a,b
1(c)	319 g($CuSO_4$) and 36 g(H_2O)		1	**AO3** 1.1.3b,c
1(d)	any **two** changes from: • limewater turns cloudy • solution turns blue • mass decreases • copper carbonate **or** (green) solid disappears • bubbles / fizzing / effervescence explanation: because carbon dioxide is produced **or** copper sulfate is produced **or** calcium carbonate is produced	allow milky / white allow weight decreases explanation must be linked to their observation	2 1	**AO1** **AO2** **AO3** 1.2.1e,f
Total			**9**	

4.4.1.1 Metal oxides

Answer 46 · Mark scheme

June 2017 | CH1HP | Original Q1 | Legacy



Answer 47 · Mark scheme

June 2017 | CH2HP | Original Q3 | Legacy

The full source mark scheme begins on page 119. Follow original question 3 in that document.

Answer 48 · Mark scheme

June 2017 | CH2HP | Original Q4 | Legacy

The full source mark scheme begins on page 119. Follow original question 4 in that document.

4.4.1.1 Metal oxides

Answer 49 · Mark scheme June 2018 | 8462/1H | Original Q1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	any **one** from: • metal • (metal) hydroxide • (metal) carbonate • alkali	allow named example allow correct formula ignore base allow ammonium hydroxide allow ammonium carbonate allow soluble base allow ammonia	1	AO1 4.4.2.1 4.4.2.2 4.4.2.3
01.2	$Ca(NO_3)_2$	allow $Ca^{2+}(NO_3^-)_2$	1	AO2 4.4.2.2

4.4.1.1 Metal oxides

Answer 49 · Mark scheme

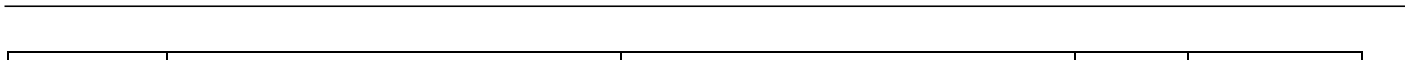
June 2018 | 8462/1H | Original Q1

Question	Answers	Mark	AO / Spec. Ref.
01.3	**Level 3:** The method would lead to the production of a valid outcome. All key steps are identified and logically sequenced.	5–6	AO1 4.4.2.3
	Level 2: The method would not necessarily lead to a valid outcome. Most steps are identified, but the method is not fully logically sequenced.	3–4	
	Level 1: The method 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 • use magnesium oxide and sulfuric acid • add sulfuric acid to a beaker • warm sulfuric acid • add magnesium oxide • stir • continue adding until magnesium oxide is in excess • filter • using a filter paper and funnel • to remove excess magnesium oxide • heat solution in an evaporating basin • to crystallisation point • leave to crystallise • pat dry with filter paper credit may be given for diagrams		
Total			**8**

4.4.1.1 Metal oxides

Answer 49 · Mark scheme

June 2018 | 8462/1H | Original Q1

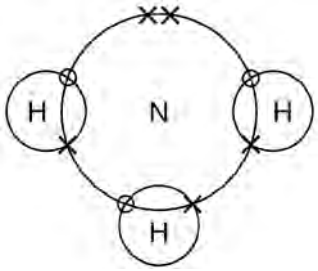


4.4.1.1 Metal oxides

Answer 50 · Mark scheme

June 2019 | 8462/1H | Original Q5

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1		 scores **2** marks allow dots, crosses, circles or $e^{(-)}$ for electrons		AO1 4.2.1.4
	1 bonding pair of electrons in each overlap		1	
	2 non-bonding electrons on nitrogen	do **not** accept non-bonding electrons on hydrogen ignore inner shell electrons drawn on nitrogen	1	
05.2	does not show the shape **or** only two-dimensional	allow is not three-dimensional	1	AO1 4.2.1.4
05.3	(ammonia has) small molecules	allow (ammonia has) a simple molecular (structure)	1	AO1 4.2.2.1 4.2.2.4
	(ammonia has) weak intermolecular forces	allow (ammonia has) weak intermolecular bonds do **not** accept weak covalent bonds	1	
	(so) little energy is needed to overcome the intermolecular forces	allow (so) little energy is needed to break the intermolecular bonds allow (so) little energy is needed to separate the molecules do **not** accept references to breaking covalent bonds	1	

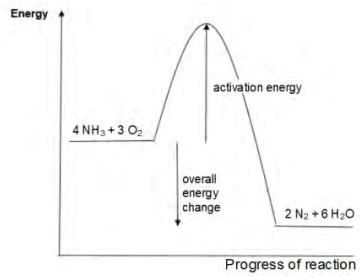
4.4.1.1 Metal oxides

Answer 50 · Mark scheme

June 2019 | 8462/1H | Original Q5

05.4	Cr_2O_3		1	AO2 4.1.3.2
05.5	(for bonds broken) ((12 x 391) + (3 x 498) =) 6186 (for bonds made) ((2 x 945) + (12 x 464) =) 7458 (overall energy change = 6186-7458 =) (-)1272 (kJ)	an answer of (-)1272 (kJ) scores **3** marks allow correct calculation using incorrectly calculated values from step 1 and/or step 2	1 1 1	AO2 4.5.1.3

Question 5 continued

05.6	7458 (kJ) (released in making bonds) is greater than 6186 (kJ) (used in breaking bonds) **or** the products have 1272 (kJ) less energy than the reactants	allow ecf from question **05.5** allow the (overall) energy change is -1272 (kJ)	1	AO2 4.5.1.3
	(so) energy is released (to the surroundings)	dependent on MP1 being awarded allow (so) heat is released (to the surroundings) if no values given, allow **1** mark for more energy released in making bonds than used in breaking bonds	1	
05.7		 scores **2** marks allow discontinuous lines ignore arrow heads		AO1 4.5.1.2
	activation energy labelled		1	
	(overall) energy change labelled		1	
Total			**14**	

4.4.1.1 Metal oxides

Answer 51 · Mark scheme

June 2019 | 8462/1H | Original Q7

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	mixture has a lower melting point (than aluminium oxide) (so) less energy needed	allow cryolite lowers melting point (of aluminium oxide) ignore boiling point do **not** accept cryolite is a catalyst ignore cost	1 1	AO1 4.4.3.3
07.2	aluminium ions gain electrons		1	AO1 4.4.1.4 4.4.3.3
07.3	$2O^{2-} \rightarrow O_2 + 4e^-$	allow multiples allow **1** mark for an unbalanced equation containing correct species	2	AO2 4.1.1.1 4.4.3.1 4.4.3.3
07.4	the electrode reacts with oxygen the electrode is carbon / graphite (so) carbon dioxide is produced	 allow (so) the electrode / carbon / graphite is used up allow (so) the electrode / carbon / graphite is burned away ignore (so) the electrode / carbon / graphite is worn away ignore (so) the electrode / carbon / graphite is corroded	1 1 1	AO1 4.4.3.3

Answer 51 · Mark scheme

Question 7 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.5		an answer of 941 (kg) scores **4** marks		AO2 4.3.2.2
	(M_r of Al_2O_3 =) 102		1	
	$\left(\frac{2\,000\,000}{102} =\right)$ 19 608 (mol Al_2O_3)	allow correct calculation using incorrectly calculated value of M_r of Al_2O_3	1	
	$\left(19\,608 \times \frac{3}{2} =\right)$ 29 412 (mol O_2)	allow correct calculation using incorrectly calculated value of moles of Al_2O_3	1	
	$\left(\frac{29\,412 \times 32}{1000} =\right)$ 941 (kg)	allow 941.1764706 (kg) correctly rounded to at least 2 significant figures allow correct answer using incorrectly calculated value of moles of O_2	1	
	alternative approach: (2 M_r of Al_2O_3 =) 204 (1) 204 (kg of Al_2O_3) gives 96 (kg of O_2) (1) (2000 kg of Al_2O_3 gives) $\frac{2000}{204}$ × 96 (kg of O_2) **or** $\frac{2000000}{204}$ × 96 (g of O_2) (1) = 941 (kg) (1)			

4.4.1.1 Metal oxides

Answer 51 · Mark scheme

07.6	hydrogen (gas) would be produced (instead of sodium) (because) sodium is more reactive than hydrogen		1 1	AO3 4.4.1.2 4.4.3.3 4.4.3.4
07.7	$\left(\frac{150\,000}{71} =\right)$ 2113 (mol of Cl_2) **or** (volume of 1 g of $Cl_2 = \frac{24}{71} =$) 0.34 (dm^3) ($\frac{150\,000}{71}$ x 24) = 50700 (dm^3)	an answer of 50700 (dm^3) scores **2** marks an answer of 50.7 (dm^3) scores **1** mark allow 50704.22535 (dm^3) correctly rounded to at least 2 significant figures allow correct calculation using their calculated number of moles and/or calculated volume of 1 g	1 1	AO2 4.3.5
Total			**16**	

4.4.1.1 Metal oxides

Answer 52 · Mark scheme

June 2019 | 8462/1H | Original Q8

Question 8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.1	to make sure all of the oxide (of copper) has reacted **or** to make sure all water (produced) is removed	ignore to ensure complete reaction unqualified ignore to make sure all of the hydrogen has reacted	1	AO3 4.3.2.3
08.2	to prevent hydrogen escaping (into the air) (because) hydrogen is explosive	 ignore hydrogen is flammable	1 1	AO3 4.3.2.3
08.3	(mass of copper) 8.66 (g) (mass of water) 2.45 (g)		1 1	AO2 4.3.2.3

4.4.1.1 Metal oxides

Answer 52 · Mark scheme

June 2019 | 8462/1H | Original Q8

08.4	moles Cu = 0.04 **or** $\frac{2.54}{63.5}$ = 0.04 moles H_2O = 0.04 **or** $\frac{0.72}{18}$ = 0.04 ratio = 1:1 so equation 2 is correct **alternative approach A** (calculating mass of water from copper) moles Cu= 0.04 **or** $\frac{2.54}{63.5}$ = 0.04(1) 0.02 x 18 = 0.36 (g of water for equation 1) (1) 0.04 x 18 = 0.72 (g of water) so equation 2 is correct (1) **alternative approach B** (calculating mass of copper from water) moles H_2O=0.04 **or** $\frac{0.72}{18}$=0.04 (1) 0.08 x 63.5 = 5.08 (g of copper for equation 1) (1) 0.04 x 63.5 = 2.54 (g of copper) so equation 2 is correct (1)	**alternative approach C** (mass ratio) (copper : water for equation 1) 127 : 18 = 7.06 : 1 (1) (copper : water for equation 2) 63.5 : 18 = 3.53 : 1 (1) 2.54 : 0.72 = 3.53 : 1 = 63.5 : 18 so equation 2 is correct (1)	1 1 1	AO2 4.3.2.1 4.3.2.3
Total			**8**	

4.4.1.1 Metal oxides

Answer 53 · Mark scheme

November 2020 | 8462/1H | Original Q1

Question 1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	poly(ethene) water		1 1	AO2 4.2.1.4 4.2.2.4 4.2.2.5

4.4.1.1 Metal oxides

Question 1 continued

Question	Answers	Mark	AO/ Spec. Ref
01.2	**Level 2:** Scientifically relevant features are identified; the way(s) in which they are similar/different is made clear and (where appropriate) the magnitude of the similarity/difference is noted.	4–6	AO1 4.2.1.2 4.2.1.3 4.2.1.4
	Level 1: Relevant features are identified and differences noted.	1–3	
	No relevant content	0	
	Indicative content • (both) carbon dioxide and silicon dioxide are made up of atoms • (but) magnesium oxide is made up of ions • (both) silicon dioxide and magnesium oxide are giant structures • (but) carbon dioxide is small molecules • with weak intermolecular forces • all three compounds have strong bonds • (both) carbon dioxide and silicon dioxide are formed from two non-metals • (so) bonds formed are covalent • (so) electron (pairs) are shared (between atoms) • (but) magnesium oxide is formed from a metal and a non-metal • (so) bonds in magnesium oxide are ionic • (so) electrons are transferred • from magnesium to oxygen • two electrons are transferred • bonds in silicon dioxide are single bonds • (where) each silicon forms four bonds • (and) each oxygen forms two bonds • (but) in carbon dioxide the bonds are double bonds • (where) carbon forms two double bonds • (and) oxygen forms one double bond ignore properties e.g. melting point, electrical conductivity		

Total			8

4.4.1.1 Metal oxides

Answer 54 · Mark scheme

November 2020 | 8462/1H | Original Q6

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	the (minimum) energy needed for particles to react **or** the (minimum) energy needed for a reaction to occur	allow the (minimum) energy needed to start a reaction	1	AO1 4.5.1.2
06.2	(M_r of Fe_2O_3 =) 160		1	AO2 4.3.1.2 4.3.2.1 4.3.2.2 4.3.2.4
	(moles $Fe_2O_3 = \frac{3000}{160}$ =) 18.75 (mol)	allow correct use of incorrectly calculated M_r	1	
	(moles Al $= \frac{1000}{27}$ =) 37.0 (mol)	allow 37.037037 (mol) correctly rounded to at least 2 significant figures if both MP2 and MP3 are not awarded allow **1** mark for 0.01875 mol Fe_2O_3 **and** 0.037 mol Al	1	
	(aluminium is limiting because) 37.0 mol is less than the (2 x 18.75 =) 37.5 mol (aluminium needed) **or** iron oxide is in excess because 18.75 mol is more than the ($\frac{37.0}{2}$ =) 18.5 mol (iron oxide needed)	allow correct use of incorrect number of moles from steps 2 and/or 3	1	

Answer 54 · Mark scheme

Question 6 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2 ctd	**alternative approaches:** **approach 1:** **(finding required mass of aluminium by moles method)** (M_r of Fe_2O_3 =) 160 (1) (moles $Fe_2O_3 = \frac{3000}{160}$ =) 18.75 (mol) (1) (moles Al needed =18.75 × 2 =) 37.5 (mol) **and** (mass Al needed = 37.5 × 27 =) 1012.5 (g) **or** 1.0125 kg (1) (so) 1.00 kg of aluminium is not enough (1) **approach 2:** **(finding required mass of aluminium by proportion method)** (M_r of Fe_2O_3 =) 160 (1) (3.00 kg Fe_2O_3 needs) $\frac{3.00}{160}$ × 2 × 27 (kg Al) (1) (=) 1.0125 (kg) (1) (so) 1.00 kg of aluminium is not enough (1)	 allow correct use of incorrectly calculated M_r allow correct use of incorrectly calculated moles of iron oxide allow correct use of incorrectly calculated moles of aluminium needed dependent on calculated mass of aluminium needed being greater than 1.00 (kg) allow correct use of incorrectly calculated M_r dependent on calculated mass of aluminium needed being greater than 1.00 (kg)		AO2 4.3.1.2 4.3.2.1 4.3.2.2 4.3.2.4

Answer 54 · Mark scheme

November 2020 | 8462/1H | Original Q6

Question 6 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2 ctd	**alternative approaches:** **approach 3:** **(finding required mass of iron oxide by moles method)** M_r of Fe_2O_3 =) 160 (1) (moles Al $= \frac{1000}{27}$ =) 37.0 (mol) (1) (moles Fe_2O_3 needed) $= \frac{37.0}{2}$) = 18.5 (mol) **and** (mass Fe_2O_3 needed = 18.5 × 160 =) 2960 (g) **or** 2.96 (kg) (1) (so) 3.00 kg of iron oxide is an excess (1) **approach 4:** **(finding required mass of iron oxide by proportion method)** (M_r of Fe_2O_3 =) 160 (1) (1.00 kg Al needs) $\frac{1.00}{2 \times 27} \times 160$ (kg Fe_2O_3) (1) (=) 2.96 (kg) (1) (so) 3.00 kg of iron oxide is an excess (1)	allow 37.037037 (mol) correctly rounded to at least 2 significant figures allow correct use of incorrectly calculated moles of aluminium allow correct use of incorrectly calculated moles of iron oxide needed allow correct use of incorrectly calculated M_r dependent on calculated mass of iron oxide needed being less than 3.00 (kg) allow correct use of incorrectly calculated M_r dependent on calculated mass of iron oxide needed being less than 3.00 (kg)		AO2 4.3.1.2 4.3.2.1 4.3.2.2 4.3.2.4

4.4.1.1 Metal oxides

Answer 54 · Mark scheme

November 2020 | 8462/1H | Original Q6

Question 6 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.3	$Mg(s) + Zn^{2+}(aq) \rightarrow Mg^{2+}(aq) + Zn(s)$	allow multiples allow **1** mark for $Mg^{2+} + Zn$ with missing or incorrect state symbols	2	AO2 4.1.1.1 4.2.2.2 4.4.1.4
06.4	magnesium (atoms) are oxidised because they lose electrons (and) zinc (ions) are reduced because they gain electrons	 if no other marks awarded allow **1** mark for magnesium (atoms) lose electrons and zinc (ions) gain electrons	1 1	AO2 4.4.1.4
Total			**9**	

4.4.1.1 Metal oxides

Answer 55 · Mark scheme

November 2021 | 8462/1H | Original Q3

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	(3 × M_r H_2O = 3 × (2 + 16) =) 54 (A_r **R** = 150 – 54 =) 96 **alternative approach**: (M_r **R**O_3 = 150 – 6 =) 144 (1) (A_r **R** = 144 – (3 × 16) =) 96 (1)	 ignore units ignore units	1 1	AO2 4.3.1.1 4.3.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.2	**(R** =) molybdenum / Mo	allow ecf from question **03.1**	1	AO3 4.1.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.3	(total M_r of reactants) = 163 (% atom economy =) $\frac{119}{163}$ (×100) = 73 (%)	 allow correct use of an incorrectly calculated value of total M_r allow 73.00613 (%) correctly rounded to at least 2 significant figures	1 1 1	AO2 4.3.1.2 4.3.3.2

Question 3 continued

Question	Answers	Mark	AO/ Spec. Ref
03.4	**Level 2:** Some logically linked reasons are given. There may also be a simple judgement.	3-4	AO3 4.4.1.3
	Level 1: Relevant points are made. They are not logically linked.	1–2	
	No relevant content	0	
	Indicative content • carbon and iron are the cheapest reactants • hydrogen is the most expensive reactant • separating solid products is expensive • separating solid products is time consuming • in method 1, tungsten needs to be separated from tungsten carbide • in method 1, some tungsten is lost as tungsten carbide • in method 1, the carbon dioxide produced will escape • in method 2, the water vapour produced will escape • in method 2, no separation of solids is needed • in method 3, tungsten needs to be separated from iron oxide		

Total			**10**

4.4.1.1 Metal oxides

Answer 56 · Mark scheme

November 2021 | 8462/1H | Original Q4

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	any **two** from: • (potassium) floats • (potassium) melts • (potassium) moves around • potassium becomes smaller • (lilac) flame • effervescence	 allow potassium disappears allow fizzing	2	AO1 4.1.2.5 4.4.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.2	$2K + 2H_2O \rightarrow 2KOH + H_2$	allow multiples allow **1** mark for KOH **and** H_2	2	AO1 AO2 4.1.1.1 4.1.2.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.3	reactivity increases (going down the group) (because) the outer electron / shell is further from the nucleus (so) there is less attraction between the nucleus and the outer electron / shell (so) the atom loses an electron more easily	 allow (because) there are more shells allow (because) the atoms get larger allow (so) there is more shielding from the nucleus do **not** accept incorrect attractions	1 1 1 1	AO1 4.1.2.5 4.4.1.2

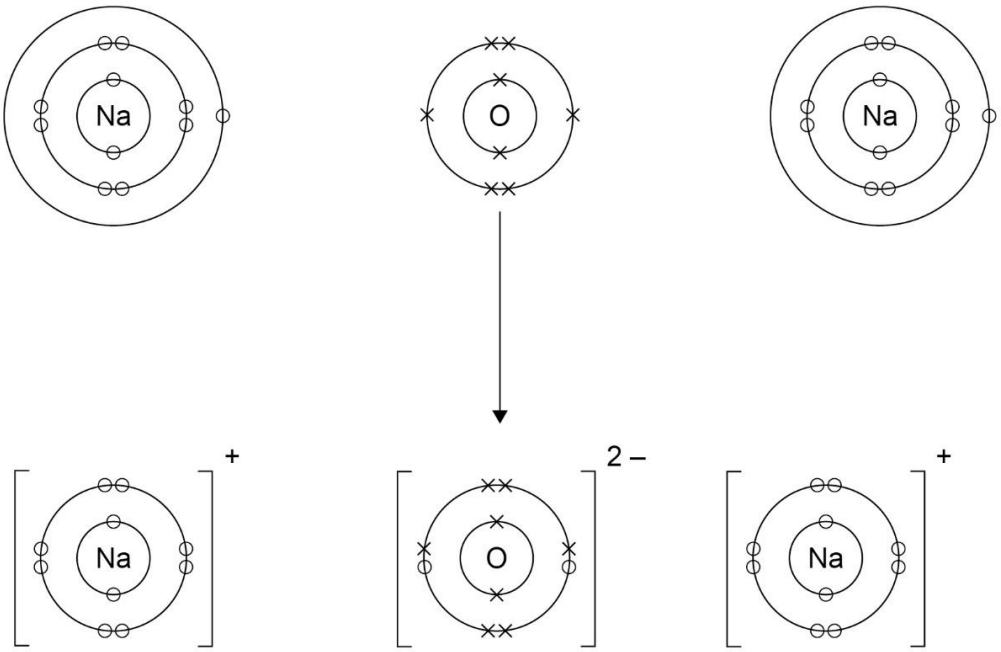
4.4.1.1 Metal oxides

Answer 56 · Mark scheme

November 2021 | 8462/1H | Original Q4

Question 4 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.4	(dot and cross diagram to show) sodium atom **and** oxygen atom	allow use of outer shells only	1	AO2 4.2.1.1 4.2.1.2
	two sodium atoms to one oxygen atom	allow two sodium ions to one oxide ion	1	
	(to produce) sodium ion with a + charge		1	
	(to produce) oxide ion with a 2– charge		1	



scores **4** marks

Question 4 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.5	(oxygen) gains electrons		1	AO1 4.4.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.6	giant structure	allow (giant ionic) lattice	1	AO1 4.2.1.3 4.2.2.1
	(with) strong (electrostatic) forces of attraction between (oppositely charged) ions		1	4.2.2.3
	(so) large amounts of energy are needed to break the bonds / forces	allow (so) large amounts of energy are needed to separate the ions	1	

Total			**16**

4.4.1.1 Metal oxides

Answer 57 · Mark scheme

November 2021 | 8462/1H | Original Q5

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	potassium chloride	allow KCl	1	AO1 4.4.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.2	$H^+ + OH^- \rightarrow H_2O$	ignore state symbols	1	AO1 4.1.1.1 4.4.2.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.3	copper carbonate and copper oxide only		1	AO1 4.4.1.2 4.4.2.2 4.4.2.3 RPA1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.4	(Step 2) to speed up the reaction (Step 5) to make sure all the (hydrochloric) acid reacts (Step 6) to remove the excess magnesium oxide	 ignore to remove impurities	1 1 1	AO1 4.4.2.3 RPA1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.5	using a (boiling) water bath **or** using an electric heater		1	AO1 4.4.2.3 RPA1

4.4.1.1 Metal oxides

Answer 57 · Mark scheme

November 2021 | 8462/1H | Original Q5

Question 5 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.6	(moles Fe = $\frac{14}{56}$ =) 0.25 (mol)		1	AO2 4.3.2.1 4.3.2.2 4.3.5
	(moles Cl_2 = $\frac{3}{2}$ × 0.25 =) 0.375 (mol)	allow correct use of an incorrectly calculated number of moles of Fe	1	
	(volume Cl_2 = 24 × 0.375) = 9.0 (dm^3)	allow correct use of an incorrectly calculated number of moles of Cl_2	1	

Total			**10**

4.4.1.1 Metal oxides

Answer 58 · Mark scheme

Question 1

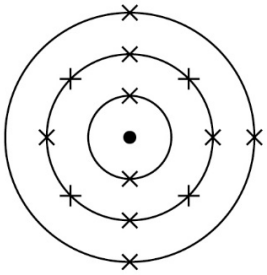
Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	D		1	AO3 4.1.2.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.2	B		1	AO3 4.1.3.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.3	any **two** from: (Group 1 elements) • have lower melting / boiling points • have lower densities • are less strong • are softer	allow converse statements for transition elements allow (Group 1 elements are) more malleable / ductile allow (Group 1 elements) are not useful as catalysts ignore transition elements form coloured compounds ignore transition elements form ions with different charges ignore references to chemical properties	2	AO1 4.1.3.1 4.1.3.2

4.4.1.1 Metal oxides

Answer 58 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.4		allow any combination of x, •, o, $e^{(-)}$ for electrons	1	AO2 4.1.1.7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.5	delocalised electrons	allow free electrons	1	AO1 4.2.1.5 4.2.2.8
	(the electrons) carry (electrical) charge	ignore current / electricity for charge	1	
	(the electrons move) through the metal / aluminium / structure	ignore throughout for through	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.6	ionic		1	AO1 4.2.1.1

4.4.1.1 Metal oxides

Answer 58 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.7	magnesium (atom) loses electrons		1	AO2 4.2.1.1 4.2.1.2
	oxygen (atom) gains electrons		1	
	two electrons (are transferred)		1	
	magnesium ions **and** oxide ions are formed	allow Mg^{2+} (ions) **and** O^{2-} (ions) are formed allow magnesium forms positive ions and oxygen forms negative ions allow (both) form a complete outer shell	1	

Total Question 1		**13**

4.4.1.1 Metal oxides

Answer 59 · Mark scheme

June 2022 | 8462/1H | Original Q7

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	silicon is less reactive than carbon	ignore references to hydrogen allow converse allow silicon is below carbon (in the reactivity series)	1	AO3 4.4.1.3
	(because) carbon displaces silicon (from silicon dioxide)	ignore (because) carbon reduces silicon dioxide	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.2	more energy is needed (to obtain aluminium) (because) aluminium is obtained (from aluminium oxide) by electrolysis	ignore references to electricity	1 1	AO3 4.4.1.3 4.4.3.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.3	both products are solid		1	AO3 4.4.1.3

4.4.1.1 Metal oxides

Answer 59 · Mark scheme

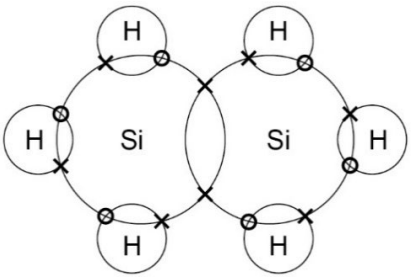
June 2022 | 8462/1H | Original Q7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.4	(M_r of SiO_2 = 28 + (2 × 16)) = 60		1	AO2 4.3.1.2 4.3.2.1 4.3.2.2
	(conversion 1.2 kg =) 1200 (g)		1	
	(number of moles of SiO_2 = $\frac{1200}{60}$) = 20	allow correct use of an incorrectly converted or unconverted mass of SiO_2 allow correct use of an incorrectly calculated M_r of SiO_2	1	
	(number of moles of Mg = 20 × 2) = 40	allow correct use of an incorrectly calculated number of moles of SiO_2	1	
	(mass of Mg = 40 × 24) = 960 (g)	allow correct use of an incorrectly calculated number of moles of Mg	1	
	alternative approach:			
	(M_r of SiO_2 = 28 + (2 × 16)) = 60 (1)			
	48 g Mg reacts with 60 g SiO_2 (1)	allow correct use of an incorrectly calculated M_r of SiO_2		
	(conversion 1.2 kg =) 1200 (g) (1)			
	48 × $\frac{1200}{60}$ (g Mg reacts with 1200 g SiO_2) (1)	allow correct use of an incorrectly calculated mass of Mg and / or incorrectly converted or unconverted mass of SiO_2		
	= 960 (g) (1)			

4.4.1.1 Metal oxides

Answer 59 · Mark scheme

June 2022 | 8462/1H | Original Q7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.5		allow any combination of x, •, o, $e^{(-)}$ for electrons	1	AO2 4.2.1.4

4.4.1.1 Metal oxides

Answer 59 · Mark scheme

June 2022 | 8462/1H | Original Q7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.6	(volume of oxygen for 30 cm^3 Si_2H_6 = 3.5 × 30) = 105 (cm^3)		1	AO2 4.3.2.4 4.3.5
	(volume of excess oxygen = 150 – 105) = 45 (cm^3)	allow correct use of an incorrectly calculated volume of oxygen for 30 cm^3 Si_2H_6	1	
	(volume of water (vapour) = 3 × 30) = 90 (cm^3)		1	
	(volume of gases = 45 + 90) = 135 (cm^3)	allow correct use of incorrectly calculated volumes of excess oxygen and / or water vapour	1	
	allowed alternative approach: (moles Si_2H_6 = $\frac{0.03}{24}$ =) 0.00125 (1)			
	(moles water vapour formed = 3 × 0.00125 =) 0.00375 **and** (moles oxygen used = 3.5 × 0.00125 =) 0.004375 (1)	allow correct use of an incorrectly calculated number of moles of Si_2H_6		
	(moles excess oxygen = $\frac{0.15}{24}$ - 0.004375 =) 0.001875 (1)	allow correct use of an incorrectly calculated number of moles of oxygen used		
	(volume of gases = 24 × (0.00375 + 0.001875) = 0.135 dm^3 =) 135 (cm^3) (1)	allow correct use of an incorrectly calculated number of moles of excess oxygen and / or moles of water vapour formed		

Total Question 7		15

4.4.1.1 Metal oxides

Answer 60 · Mark scheme

June 2023 | 8462/1H | Original Q7

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	$Al^{3+} + 3e^- \rightarrow Al$	allow multiples	1	AO2 4.1.1.1 4.4.3.3 4.4.3.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.2	sodium is more reactive than aluminium		1	AO3 4.4.3.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.3		allow hydroxide ions for OH^- throughout		AO1 4.4.3.4
	water (molecules) break down		1	
	(to) produce (H^+ and) OH^- (ions)		1	
	(OH^- (ions) are attracted / move to the positive electrode		1	
	(OH^- (ions) are discharged / oxidised to give oxygen (molecules)	allow (OH^- (ions) lose electrons to give oxygen (molecules)	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.4		allow (inverted) burettes for measuring cylinders allow gas syringes for measuring cylinders		AO3 4.4.3.4
	(change) use measuring cylinders (instead of test tubes)		1	
	(reason) because there is a scale (on the measuring cylinders)	allow measuring cylinder(s) measure volume	1	

4.4.1.1 Metal oxides

Answer 60 · Mark scheme

June 2023 | 8462/1H | Original Q7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.5	10 cm^3		1	AO2 4.3.5

Total Question 7	**9**

4.4.1.1 Metal oxides

Answer 61 · Mark scheme

June 2023 | 8462/1H | Original Q9

Question 9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.1	(substance reduced) Fe_2O_3 (reason) (Fe_2O_3) loses oxygen	allow iron oxide MP2 is dependent upon MP1 being awarded ignore Fe^{3+} gains electrons	1 1	AO2 4.4.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.2	$\frac{3}{2}$ × 12g		1	AO2 4.3.1.1 4.3.2.1 4.3.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.3	**A** loses electrons and $\mathbf{B}^+$ gains electrons		1	AO2 4.4.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.4	**D**		1	AO3 4.4.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.5	(metal) **C** (explanation) aluminium forms ions with a charge 3+ (so) 3 nitrate ions are needed for 1 aluminium ion	 allow aluminium forms Al^{3+} (ions) allow (so) 3 nitrate ions are needed to balance the 3+ charge on 1 aluminium (ion)	1 1 1	AO3 4.4.1.2 4.4.3.3

4.4.1.1 Metal oxides

Answer 61 · Mark scheme

June 2023 | 8462/1H | Original Q9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.6	(percentage atom economy =) $\frac{A_rX}{A_rX + 54} \times 100 = 77.3$		1	AO2 4.3.3.2
	100 A_r**X** = 77.3 (A_r**X** + 54)	allow A_r**X** = 0.773 (A_r**X** + 54) allow correct use of an incorrectly determined value of the M_r of the non-useful reactant atoms	1	
	22.7 A_r**X** = 4174.2	allow 0.227 A_r**X** = 41.742	1	
	A_r**X** = 184	allow 183.8854626 correctly rounded to at least three significant figures	1	
	alternative approach 1: ($3M_r$ H_2O = (3 × 16) + (6 × 1) =) 54 **and** (percentage = 100 – 77.3 =) 22.7% (1)			
	(total M_r of reactants =) $\frac{100}{22.7} \times 54$ (1)	allow correct use of an incorrectly determined value for $3M_r$ H_2O and/or percentage of unwanted products		
	= 238 (1)			
	(A_r**X** = 238 – 54) **or** $\left(A_r\mathbf{X} = 238 \times \frac{77.3}{100}\right)$ = 184 (1)	allow correct use of an incorrectly determined value of total M_r of reactants and/or value for $3M_r$ H_2O allow 183.8854626 correctly rounded to at least three significant figures		

	alternative approach 2: ($3M_r$ H_2O = (3 × 16) + (6 × 1) =) 54 **and** (percentage = 100 – 77.3 =) 22.7% (1) $\left(\frac{1}{22.7} \times 54 =\right)$ 2.3788546 (1) 2.3788546 × 77.3 (1) = 184 (1)	allow correct use of an incorrectly determined value for $3M_r$ H_2O and/or percentage of unwanted products allow correct use of an incorrectly determined value for 1% of the total M_r of reactants allow 183.8854626 correctly rounded to at least three significant figures		

Total Question 9	**12**

4.4.1.1 Metal oxides

Answer 62 · Mark scheme

June 2024 | 8462/2H | Original Q7

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1		ignore (hydrochloric / nitric / sulfuric) acid		AO1 4.8.3.5
	(test) add barium chloride (solution)	allow add barium nitrate (solution)	1	
	(result) white precipitate		1	
		MP2 is dependent upon MP1 being awarded		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.2	the yield is smaller at higher temperatures because the reaction is exothermic		1	AO2 4.6.2.6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.3		allow converse		AO2 4.6.2.7
	there are more moles / molecules (of gas) on the left	ignore particles	1	
	(so the position of) equilibrium shifts to the right		1	

4.4.1.1 Metal oxides

Answer 62 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.4	any **two** from: • the yield is already high • more energy required • risk of explosion is increased • higher income from increased yield is outweighed by the extra expenditure • increased cost of safety precautions	allow requires stronger vessels allow requires thicker walls	2	AO3 4.6.2.7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.5	vanadium (V)		1	AO3 4.1.3.2

Total Question 7	**8**

4.4.1.1 Metal oxides

Answer 63 · Mark scheme

June 2025 | 8462/1H | Original Q3

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	(substance reduced) SnO_2	allow tin oxide	1	AO2 4.4.1.1 4.4.1.3
	(reason) (SnO_2) loses oxygen	allow (tin oxide) loses oxygen MP2 is dependent upon MP1 being awarded	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.2	carbon is more reactive than tin	allow tin is less reactive than carbon	1	AO3 4.4.1.2 4.4.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.3	(total M_r = 128 + 12 =) 140	allow (total M_r = 112 + 12 + 16 =) 140	1	AO2 4.3.3.2
	(% atom economy =) $\frac{112}{140} \times 100$	allow correct use of an incorrectly determined total M_r	1	
	= 80 (%)		1	

4.4.1.1 Metal oxides

Answer 63 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.4		allow the converse for potassium allow the transition metal for tungsten allow the Group 1 metal for potassium ignore references to atomic structure		
	any **two** from: tungsten • has a higher melting / boiling point • is denser • is harder • is stronger • is less reactive • has ions with different charges • forms coloured compounds • can be a catalyst	 allow is less malleable / ductile allow specific reactions showing difference in reactivity	2	AO1 4.1.2.5 4.1.3.1 4.1.3.2

4.4.1.1 Metal oxides

Answer 63 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.5	(sum of relative formula masses on left hand side =) 232 + (3 × 2) = 238 (is equal to sum of relative formula masses on right hand side =) 184 + (3 × 18) = 238	allow (sum of relative formula masses on left hand side =) 232 + 6 = 238 allow (is equal to sum of relative formula masses on right hand side =) 184 + 54 = 238 if no other mark awarded, allow **1** mark for 232 + (3 × 2) = 184 + (3 × 18) **or** 232 + 6 = 184 + 54 **or** allow **1** mark for both sides = 238	1 1	AO2 4.3.1.1 4.3.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.6	for sustainable development **or** for economic reasons	allow to minimise use of limited resources allow to minimise use of energy allow to minimise waste ignore references to yield	1	AO1 4.3.3.2

Total Question 3	11

4.4.1.1 Metal oxides

Answer 64 · Mark scheme

June 2025 | 8462/1H | Original Q6

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	strong electrostatic forces	allow strong forces of attraction ignore strong ionic bonds	1	AO1 4.2.1.3 4.2.2.3
	between oppositely charged ions	allow between (positive) aluminium ions and (negative) oxide ions allow between Al^{3+} (ions) and O^{2-} (ions)	1	
	(which) act in all directions (in the giant structure)		1	
	(so) need a lot of energy to break (the many strong bonds)		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2	cryolite	allow Na_3AlF_6	1	AO1 4.4.3.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.3	the mixture has a lower melting point than aluminium oxide	allow to lower the melting point (of the mixture) allow to lower the energy demand (of the process)	1	AO1 4.4.3.3

4.4.1.1 Metal oxides

Answer 64 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.4	$2\,O^{2-} \rightarrow O_2 + 4\,e^-$	allow multiples allow **1** mark for $O^{2-} \rightarrow O_2 + e^-$ with no / incorrect balancing numbers	2	AO2 4.1.1.1 4.4.3.2 4.4.3.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.5	the (positive) electrode is made of carbon / graphite		1	AO1 4.4.3.3
	(so) the carbon / graphite reacts with oxygen (produced in the electrolysis)		1	
	(which) produces carbon dioxide		1	

Total Question 6	**11**

4.4.1.1 Metal oxides

Version 1.0: 0707

ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Secondary Education

Science B 4462 / Chemistry 4421

CHY1H Unit Chemistry 1

Mark Scheme

2007 examination - June series

4.4.1.1 Metal oxides

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation meeting attended by all examiners and is the scheme which was used by them in this examination. The standardisation meeting ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for the standardisation meeting each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed at the meeting and legislated for. If, after this meeting, examiners encounter unusual answers which have not been discussed at the meeting they are required to refer these to the Principal Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of candidates' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

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Dr Michael Cresswell, Director General.

4.4.1.1 Metal oxides

MARK SCHEME

Information to Examiners

1. General

The mark scheme for each question shows:

- the marks available for each part of the question
- the total marks available for the question
- the typical answer or answers which are expected
- extra information to help the Examiner make his or her judgement and help to delineate what is acceptable or not worthy of credit or, in discursive answers, to give an overview of the area in which a mark or marks may be awarded.

The extra information is aligned to the appropriate answer in the left-hand part of the mark scheme and should only be applied to that item in the mark scheme.

At the beginning of a part of a question a reminder may be given, for example: where consequential marking needs to be considered in a calculation; or the answer may be on the diagram or at a different place on the script.

In general the right hand side of the mark scheme is there to provide those extra details which confuse the main part of the mark scheme yet may be helpful in ensuring that marking is straightforward and consistent.

2. Emboldening

2.1 In a list of acceptable answers where more than one mark is available 'any **two** from' is used, with the number of marks emboldened. Each of the following lines is a potential mark.

2.2 A bold **and** is used to indicate that both parts of the answer are required to award the mark.

2.3 Alternative answers acceptable for a mark are indicated by the use of **or**. (Different terms in the mark scheme are shown by a / ; eg allow smooth / free movement.)

3. Marking points

3.1 Marking of lists

This applies to questions requiring a set number of responses, but for which candidates have provided extra responses. The general principle to be followed in such a situation is that 'right + wrong = wrong'.

Each error/contradiction negates each correct response. So, if the number of error/contradictions equals or exceeds the number of marks available for the question, no marks can be awarded.

However, responses considered to be neutral (indicated as * in example 1) are not penalised.

4.4.1.1 Metal oxides

Example 1: What is the pH of an acidic solution? (1 mark)

Candidate	Response	Marks awarded
1	4,8	0
2	green, 5	0
3	red*, 5	1
4	red*, 8	0

Example 2: Name two planets in the solar system. (2 marks)

Candidate	Response	Marks awarded
1	Pluto, Mars, Moon	1
2	Pluto, Sun, Mars, Moon	0

3.2 Use of chemical symbols / formulae

If a candidate writes a chemical symbol / formula instead of a required chemical name, full credit can be given if the symbol / formula is correct and if, in the context of the question, such action is appropriate.

3.3 Marking procedure for calculations

Full marks can be given for a correct numerical answer, as shown in the column 'answers', without any working shown.

However if the answer is incorrect, mark(s) can be gained by correct substitution / working and this is shown in the 'extra information' column;

3.4 Interpretation of 'it'

Answers using the word 'it' should be given credit only if it is clear that the 'it' refers to the correct subject.

3.5 Errors carried forward

Any error in the answers to a structured question should be penalised once only.

Papers should be constructed in such a way that the number of times errors can be carried forward are kept to a minimum. Allowances for errors carried forward are most likely to be restricted to calculation questions and should be shown by the abbreviation e.c.f. in the marking scheme.

3.6 Phonetic spelling

The phonetic spelling of correct scientific terminology should be credited **unless** there is a possible confusion with another technical term.

3.7 Brackets

(…..) are used to indicate information which is not essential for the mark to be awarded but is included to help the examiner identify the sense of the answer required.

3.8 Unexpected Correct Answers not in the Mark Scheme

The Examiner should use professional judgement to award credit where a candidate has given an unexpected correct answer which is not covered by the mark scheme. The Examiner should consult with the Team Leader to confirm the judgement. The Team Leader should pass this answer on to the Principal Examiner with a view to informing all examiners.

4.4.1.1 Metal oxides

CHY1H Question 1

	answers	extra information	mark
(a)	any **two** from: • nitrogen • carbon dioxide • water (vapour) / steam	 accept formulae N / N_2 accept formula CO_2 ignore CO accept formula H_2O	2
(b)	any **three** from: <u>limestone</u> • abundant / local • natural material **or** no 'processing' needed • relatively easy to cut • appearance better <u>concrete</u> • <u>raw materials</u> are abundant • can be reinforced (by steel rods) / strong(er) / supported (by steel rods) • concrete mixture can be poured / moulded / constructed on site • less reactive with acid rain / weathering / erosion	no mark for 'limestone' or 'concrete' on first line – mark advantages only ignore ideas of speed of production or easier to use accept 'can build higher' ignore density / extraction / quarrying / pollution / cost	3
total			5

4.4.1.1 Metal oxides

CHY1H Question 2

	answers	extra information	mark
(a)(i)	$Cu_2S + 2O_2 \rightarrow 2CuO + SO_2$	accept fractions and multiples	1
(ii)	any **two** from: • sulfur dioxide • causes acid rain • consequence of acid rain eg kills fish / plants	 accept sulphur dioxide / sulphur oxide / SO_2 ignore other comments eg global warming / ozone / global dimming / greenhouse effect	2
(b)	any **two** from: • heat (copper oxide with carbon) • oxygen is removed by carbon **or** carbon monoxide / carbon dioxide is produced **or** carbon displaces copper • because carbon is more reactive than copper	 accept copper (oxide) loses oxygen **or** carbon gains oxygen accept carbon oxide accept a correct word or balanced symbol equation allow a correct comparison of reactivity	2
(c)(i)	electrolysis	accept electroplating	1
(ii)	(electrical) wiring / appliances / coins / pipes / cladding for buildings / jewellery / making alloys **or** named alloys		1

Continued on next page

4.4.1.1 Metal oxides

Question 2 continued

	answers	extra information	mark
(d)	any **three** explanations from: <u>for recycling</u> • less acid rain (pollution) • copper reserves last longer / conserved **or** do not run out • energy for extraction (saved) **or** less energy required • less mining / quarrying • less waste (copper) / electrical appliances dumped **or** less landfill <u>against recycling</u> • collection problems • transport problems • difficult to separate copper from appliances • energy used to melt the collected copper	ignore electrolysis / pollution ignore ideas about less machinery / plant ignore idea of cost	3
total			10

4.4.1.1 Metal oxides

CHY1H Question 3

	answers	extra information	mark
(a)(i)	core		1
(ii)	plate (boundaries)	accept parts of the crust ignore crust alone	1
	sudden movement / colliding **or** normally move a few centimetres per year	accept movement but ignore movement apart accept continental drift	1
	convection currents / driven by heat from radioactive processes / decay	idea of source of energy for the movement	1
	the idea of uncertainty with an explanation eg scientists do not know (with any certainty) • what happens under the crust • where the forces / pressure are building up • we cannot measure the forces • when the forces reach their limit	ignore references to volcanoes	1
(b)(i)	78		1

Continued on next page

4.4.1.1 Metal oxides

Question 3 continued

	answers	extra information	mark
(ii)	marks awarded for any 2 gases from the following 3 gases	max **3** marks from CO_2	
	any **four** from: carbon dioxide has decreased: • used by plants / bacteria (stromatolites) • during photosynthesis (must be linked to CO_2 decrease) • 'locked up' in (sedimentary) rocks / carbonates / fossil fuels • dissolved in oceans **and / or** oxygen has increased because: • released by plants / bacteria (stromatolites) • during photosynthesis (must be linked to O_2 increase) **and / or** nitrogen has increased because • ammonia reacted with oxygen (to release nitrogen) • nitrogen is released by bacteria	ignore references to respiration	4
total			10

4.4.1.1 Metal oxides

CHY1H Question 4

	answers	extra information	mark
(a)	permitted additive / (added) chemicals **or** names / types of additives	accept the chemical name ignore food additive alone	1
(b)(i)	water and oil do not mix / are immiscible **or** don't dissolve each other	ignore density ignore emulsifier alone	1
(ii)	any **two** from: • emulsifier • forms an emulsion • holds the two components together • by lowering the surface tension	 accept description of an emulsion accept stops them separating / they mix allow bonds / binds for holds accept a description of how an emulsifier works for **two** marks eg 'tadpole' diagram or dispersal of oil drops	2
(c)(i)	(because they contain) a double (carbon carbon) bond	accept unsaturated ignore poly or mono	1
(ii)	results suggest sunflower oil is best **or** 'the one that took the least time' because (sunflower oil) has the highest amount of unsaturation / most double bonds / least saturated	 ignore uses up I_2 most quickly second mark is dependent on first	1 1

Continued on next page

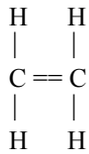
4.4.1.1 Metal oxides

Question 4 continued

	answers	extra information	mark
(d)(i)	any **one** from: • have a higher melting point than (vegetable) oil • are solid at (room temperature) / hardened / harder	 accept useful as spreads **or** doesn't soak into bread ignore hard / soft(er)	1
(ii)	any **two** from: • hydrogen added • to carbon carbon double bond / to saturate • (nickel) catalyst / temperature 60 - 150°C	 do **not** accept 'water' wrong catalyst doesn't get this mark ignore high / warm temperature	2
total			10

4.4.1.1 Metal oxides

CHY1H Question 5

	answers	extra information	mark
(a)(i)	by (fractional) distillation **or** fractionation	accept a description of the distillation process (heat and how separation works) eg heat **and** condense accept boil / vapourise etc for heat	1
(ii)	CO_2 H_2O	note the order of these products must be correct wrong way round = **1** mark	1 1
(b)(i)	(hexane) has been broken down (into smaller hydrocarbons / molecules)	accept (thermal) decomposition / cracked / split / broken up owtte	1
(ii)		accept $CH_2=CH_2$	1
(iii)	water / hydrogen oxide / steam	accept H_2O	1

Continued on next page

4.4.1.1 Metal oxides

Question 5 continued

	answers	extra information	mark
(c)	candidates must include both sugar cane and crude oil in their evaluation **and** both an advantage and a disadvantage to gain full marks. if they do not then the maximum mark is three any **four** from: <u>advantages of using sugar</u> • country has no wealth to buy (large quantities of) crude oil • country has limited technological development **or** underdeveloped / third world country • able / suitable climate to grow sugar cane • enough land to grow sugar cane / land cannot be used to grow food / deforestation • sugar is a renewable source **or** crude oil is a non-renewable resource / finite resource / limited resources • CO_2 / carbon neutral <u>advantages of using alkanes:</u> • economic costs are low • continuous process • country has large oil resources • country has oil refineries / cracking plants • very pure product • faster process	not 'expensive' alone	4
total			10

Version 1.0: 0108

ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Secondary Education

Additional Science 4463 / Chemistry 4421

CHY2H Unit 2 Chemistry

Mark Scheme

2008 examination – January series

4.4.1.1 Metal oxides

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation meeting attended by all examiners and is the scheme which was used by them in this examination. The standardisation meeting ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for the standardisation meeting each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed at the meeting and legislated for. If, after this meeting, examiners encounter unusual answers which have not been discussed at the meeting they are required to refer these to the Principal Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of candidates' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

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4.4.1.1 Metal oxides

MARK SCHEME

Information to Examiners

1. General

The mark scheme for each question shows:

- the marks available for each part of the question
- the total marks available for the question
- the typical answer or answers which are expected
- extra information to help the Examiner make his or her judgement and help to delineate what is acceptable or not worthy of credit or, in discursive answers, to give an overview of the area in which a mark or marks may be awarded.

The extra information is aligned to the appropriate answer in the left-hand part of the mark scheme and should only be applied to that item in the mark scheme.

At the beginning of a part of a question a reminder may be given, for example: where consequential marking needs to be considered in a calculation; or the answer may be on the diagram or at a different place on the script.

In general the right hand side of the mark scheme is there to provide those extra details which confuse the main part of the mark scheme yet may be helpful in ensuring that marking is straightforward and consistent.

2. Emboldening

2.1 In a list of acceptable answers where more than one mark is available 'any **two** from' is used, with the number of marks emboldened. Each of the following lines is a potential mark.

2.2 A bold **and** is used to indicate that both parts of the answer are required to award the mark.

2.3 Alternative answers acceptable for a mark are indicated by the use of **or**. (Different terms in the mark scheme are shown by a / ; eg allow smooth / free movement.)

3. Marking points

3.1 Marking of lists

This applies to questions requiring a set number of responses, but for which candidates have provided extra responses. The general principle to be followed in such a situation is that 'right + wrong = wrong'.

Each error/contradiction negates each correct response. So, if the number of error/contradictions equals or exceeds the number of marks available for the question, no marks can be awarded.

However, responses considered to be neutral (indicated as * in example 1) are not penalised.

Example 1: What is the pH of an acidic solution? (1 mark)

Candidate	Response	Marks awarded
1	4,8	0
2	green, 5	0
3	red*, 5	1
4	red*, 8	0

Example 2: Name two planets in the solar system. (2 marks)

Candidate	Response	Marks awarded
1	Pluto, Mars, Moon	1
2	Pluto, Sun, Mars, Moon	0

3.2 Use of chemical symbols / formulae

If a candidate writes a chemical symbol / formula instead of a required chemical name, full credit can be given if the symbol / formula is correct and if, in the context of the question, such action is appropriate.

3.3 Marking procedure for calculations

Full marks can be given for a correct numerical answer, as shown in the column 'answers', without any working shown.

However if the answer is incorrect, mark(s) can be gained by correct substitution / working and this is shown in the 'extra information' column;

3.4 Interpretation of 'it'

Answers using the word 'it' should be given credit only if it is clear that the 'it' refers to the correct subject.

3.5 Errors carried forward

Any error in the answers to a structured question should be penalised once only.

Papers should be constructed in such a way that the number of times errors can be carried forward are kept to a minimum. Allowances for errors carried forward are most likely to be restricted to calculation questions and should be shown by the abbreviation e.c.f. in the marking scheme.

3.6 Phonetic spelling

The phonetic spelling of correct scientific terminology should be credited **unless** there is a possible confusion with another technical term.

3.7 Brackets

(…..) are used to indicate information which is not essential for the mark to be awarded but is included to help the examiner identify the sense of the answer required.

3.8 Unexpected Correct Answers not in the Mark Scheme

The Examiner should use professional judgement to award credit where a candidate has given an unexpected correct answer which is not covered by the mark scheme. The Examiner should consult with the Team Leader to confirm the judgement. The Team Leader should pass this answer on to the Principal Examiner with a view to informing all examiners.

4.4.1.1 Metal oxides

CHY2H

Question 1

question	answers	extra information	mark
(a)	sensible line of best fit which goes through or close to all the points **except** the anomalous point	allow wobbly / short double lines ± ½ square	1
(b)	loss of gas / loss of CO_2	idea of gas produced / formed	1
(c)	7		1
(d)(i)	steeper line from around the same starting point and left of the points levelling off at 99	allow crosses if they are fully correct for **1** mark accept short level line at 99 ± ½ square	1 1
(d)(ii)	any **three** from: • particles / molecules / atoms/ ions have more energy • move faster • collide <u>more</u> often **or** <u>more</u> chance of collisions **or** bump into each other <u>more</u> • collide with <u>more</u> force / energy **or** <u>more</u> particles have the activation energy **or** <u>more</u> collisions result in reaction **or** <u>more</u> collisions are successful	 allow given / gain / get energy ignore move about more ignore vibrate more / faster ignore collide quicker / faster	3
total			8

4.4.1.1 Metal oxides

CHY2H

Question 2

question	answers	extra information	mark
(a)	any **one** from: • they are made of layers • atoms / ions / particles / layers (of atoms) can slide over each other	 do **not** accept line / rows / lattice	1
(b)	any **one** from: • smaller / tiny **or** very small • correct size range 1 to 100 nanometres • a few hundred atoms in size	 do **not** allow small alone if they state smaller and give a size outside range ignore size if it is less than 20,000	1
(c)	harder plus **one** from: • so does not wear as quickly / erode as quickly • less vulnerable to damage owtte • because they have a high surface area to volume ratio **or** stronger (1) plus **one** from: (1) • less likely to break / do not break • not as vulnerable to damage owtte • do not bend out of shape • because they have a high surface area to volume ratio	 ignore corrode harder to wear down = **1** mark accept withstand pressure harder and stronger alone gains **1** mark	1 1
total			4

4.4.1.1 Metal oxides

CHY2H

Question 3

question	answers	extra information	mark
(a)	N_2O		1
(b)	13.8 to 14	gains full marks without working if answer incorrect 13 gains **1** mark **or** 14/101 × 100 gains **1** mark	2
total			3

4.4.1.1 Metal oxides

CHY2H

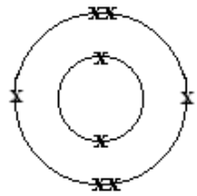
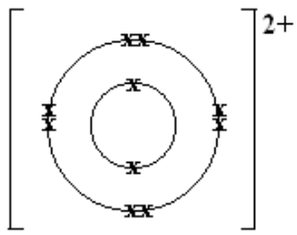
Question 4

question	answers	extra information	mark
(a)	electric current / electricity		1
	plus **one** from:		1
	• is passed through ionic compound / substance / electrolyte	must be linked to electricity allow liquid compound / substance	
	• passed through molten/aqueous compound / substance	do **not** allow solution / liquid alone	
	• causing decomposition	accept split up / breakdown / breaking up owtte ignore separated accept elements are formed ignore new substances form	
(b)	hydrogen	accept H_2 do **not** accept H / H^2	1
(c)	one electron from each atom	accept each carbon is bonded to three other carbon atoms leaving one (unbonded) electron owtte	1
	is delocalised / free (to move)	must be linked to electrons answers of delocalised / free electrons only, gains **1** mark accept each carbon is bonded to three other carbon atoms leaving delocalised / free electrons = **2** marks **maximum 1** mark if graphite described as a metal / giant ionic lattice	1
total			5

4.4.1.1 Metal oxides

CHY2H

Question 5

question	answers	extra information	mark
(a)	any **one** from: • gives out heat / energy • transfers energy from a substance to the surroundings • ΔH / energy change / enthalpy change is negative	accept releases / gives off owtte ignore references to light	1
(b)	$2Mg + O_2 \rightarrow 2MgO$	accept correct multiples / fractions	1
(c)		electrons do not need to be paired accept dots / circles / e instead of crosses do **not** allow 2.6 without diagram	1
(d)		electrons do not need to be paired allow without brackets must have the charge accept dots / circles / e instead of crosses ignore extra empty outer shells ignore nucleus do **not** allow $[2.8]^{2+}$ without diagram	1

continued…

4.4.1.1 Metal oxides

CHY2H

Question 5 continued…

question	answers	extra information	mark
(e)	oppositely charged (ions / atoms)	allow positive and negative(ions / atoms)	1
	(they) attract	must be in correct context accept held by electrostatic forces ignore ionic bonding **maximum 1** if they refer to intermolecular forces / attractions / covalent bonds	1
(f)	magnesium chloride	accept $MgCl_2$ (if correctly written)	1
total			7

4.4.1.1 Metal oxides

CHY2H

Question 6

question	answers	extra information	mark
(a)	**Compound A** any **one** from: • sodium bromide • potassium bromide • ammonium bromide • hydrogen bromide • any metal bromide except silver and lead. **Compound B** silver nitrate	accept correct formulae accept silver sulfate	1 1
(b)	the silver compound will decompose / silver ions be reduced to silver (owtte)	accept film would darken owtte accept any idea of light changing silver bromide / silver ions / silver nitrate / silver sulfate allow 'forms a black solid' / it would turn black	1
(c)	precipitation	accept descriptions of precipitation reactions accept double decomposition accept precipitate do **not** allow displacement	1
(d)	electrons are gained	 the second mark **must** be linked to electrons accept it / silver / silver ions gains electrons for **both** marks ignore references to oxygen	1 1
total			6

4.4.1.1 Metal oxides

CHY2H

Question 7

question	answers	extra information	mark
(a)	1213.8 to 1214.3 correct answer not given then check working 1) moles of N_2 = $\frac{1000}{28}$ = 35.7 mol 2) moles of NH_3 = 2 × (answer from (1)) = 71.4 mol 3) mass of NH_3 = (answer from 2) × 17 = 71.4 × 17 = 1214 g **or** • 28g of N_2 → 34g of NH_3 • 1g of N_2 → $\frac{34}{28}$ = 1.214g NH_3 • 1000 g of N_2 → 1000 × 1.214 = 1214g **or** • $1000 \times \frac{34}{28}$ **or** **other correct methods**	gains **3** marks without working **1** mark for each correct step do **not** penalise rounding errors in this part **1** mark for each correct step do **not** penalise rounding errors in this part allow error carried forward eg gains **2** marks if correct answer not given $1000 \times \frac{28}{34}$ gains **1** mark, **2** marks if correctly calculated (823.5g) $1000 \times \frac{28}{17}$ gains **1** mark if calculated correctly (1647.05g) look for the key ideas in the methods above	3

continued…

4.4.1.1 Metal oxides

CHY2H

Question 7 continued…

question	answers	extra information	mark
(b)	25 / 25.035 **or** ecf from (a)	gains **2** marks even when there is no working incorrect answer then 304/(their answer from (a)) × 100 gains **1** mark	2
	or using figures from part (b)		
	27.6 / 28	gains **2** marks even when there is no working accept 27 for **1** mark if answers incorrect then304/1100 × 100 gains **1** mark	
(c)(i)	increase yield		1
	reaction is exothermic		1
	or		
	allow decreased yield because rate of reaction is slower / fewer collisions for **2** marks	**must** get both points for **2** marks	
(c)(ii)	increase yield		1
	plus **one** from: • more (gaseous) reactant molecules than (gaseous) product molecules (owtte) • increased rate of reaction / more collisions	accept greater volume on the left than the right owtte	1

continued…

4.4.1.1 Metal oxides

CHY2H

Question 7 continued…

question	answers	extra information	mark
(d)	any **one** from: **economic** • large town provides workforce • workers do not have to travel far to the factory. (owtte) • transport infrastructure already in place for large town. (owtte) • factory brings prosperity to town (owtte) • factory provides employment • reduced tourism • reduction in local house prices • any other sensible economic factor linked to town		1
	any **one** from: **safety** • escape of dangerous / harmful chemicals / gases (owtte) • danger of increased traffic • risk of explosion.(owtte) /danger of high pressure • consequences of an accident could be severe if the town is close • any other sensible safety idea	do **not** allow polluting gases unqualified	1

continued…

4.4.1.1 Metal oxides

CHY2H

Question 7(d) continued…

question	answers	extra information	mark
	any **one** from: **environmental** • factory might be unsightly (owtte) • screening of factory (owtte) • loss of habitats (owtte) • plant trees/ hedges etc on and around plant site • pollution of water / air / soil could harm plants / animals **or** noise pollution • CO_2 is produced by burning fuels / heating • CO_2 causes global warming / any effect of global warming • eye sore • any other sensible environmental factor	must be explained	1
total			12

4.4.1.1 Metal oxides

GCSE

Additional Science / Chemistry

CH2HP
Final Mark scheme

4408 / 4402
June 2017

Version/Stage: v1.0

4.4.1.1 Metal oxides

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Information to Examiners

1. General

The mark scheme for each question shows:

- the marks available for each part of the question
- the total marks available for the question
- the typical answer or answers which are expected
- extra information to help the Examiner make his or her judgement and help to delineate what is acceptable or not worthy of credit or, in discursive answers, to give an overview of the area in which a mark or marks may be awarded
- the Assessment Objectives and specification content that each question is intended to cover.

The extra information is aligned to the appropriate answer in the left-hand part of the mark scheme and should only be applied to that item in the mark scheme.
At the beginning of a part of a question a reminder may be given, for example: where consequential marking needs to be considered in a calculation; or the answer may be on the diagram or at a different place on the script.
In general the right-hand side of the mark scheme is there to provide those extra details which confuse the main part of the mark scheme yet may be helpful in ensuring that marking is straightforward and consistent.

2. Emboldening and underlining

2.1 In a list of acceptable answers where more than one mark is available 'any **two** from' is used, with the number of marks emboldened. Each of the following bullet points is a potential mark.

2.2 A bold **and** is used to indicate that both parts of the answer are required to award the mark.

2.3 Alternative answers acceptable for a mark are indicated by the use of **or**.
Different terms in the mark scheme are shown by a / ; eg allow smooth/free movement.

2.4 Any wording that is underlined is essential for the marking point to be awarded.

3. Marking points

3.1 Marking of lists

This applies to questions requiring a set number of responses, but for which students have provided extra responses. The general principle to be followed in such a situation is that 'right + wrong = wrong'.

Each error/contradiction negates each correct response. So, if the number of error/contradictions equals or exceeds the number of marks available for the question, no marks can be awarded.

However, responses considered to be neutral (indicated as * in example 1) are not penalised.

Example 1: What is the pH of an acidic solution?

[1 mark]

Student	Response	Marks awarded
1	green, 5	0
2	red*, 5	1
3	red*, 8	0

4.4.1.1 Metal oxides

Example 2: Name two planets in the solar system.

[2 marks]

Student	Response	Marks awarded
1	Pluto, Mars, Moon	1
2	Pluto, Sun, Mars, Moon	0

3.2 Use of chemical symbols/formulae

If a student writes a chemical symbol/formula instead of a required chemical name, full credit can be given if the symbol/formula is correct and if, in the context of the question, such action is appropriate.

3.3 Marking procedure for calculations

Full marks can be given for a correct numerical answer, without any working shown. However, if the answer is incorrect, mark(s) can be gained by correct substitution/working and this is shown in the 'extra information' column or by each stage of a longer calculation.

3.4 Interpretation of 'it'

Answers using the word 'it' should be given credit only if it is clear that the 'it' refers to the correct subject.

3.5 Errors carried forward

Any error in the answers to a structured question should be penalised once only. Papers should be constructed in such a way that the number of times errors can be carried forward are kept to a minimum. Allowances for errors carried forward are most likely to be restricted to calculation questions and should be shown by the abbreviation 'ecf' in the marking scheme.

3.6 Phonetic spelling

The phonetic spelling of correct scientific terminology should be credited **unless** there is a possible confusion with another technical term.

3.7 Brackets

(…..) are used to indicate information which is not essential for the mark to be awarded but is included to help the examiner identify the sense of the answer required.

3.8 Accept/allow

Accept is used to indicate an equivalent answer to that given on the left-hand side of the mark scheme. Allow is used to denote lower-level responses that just gain credit.

3.9 Ignore/Insufficient/Do not allow

Ignore or insufficient is used when the information given is irrelevant to the question or not enough to gain a marking point. Any further correct amplification could gain the marking point.
Do **not** allow means that this is a wrong answer which, even if the correct answer is given, will still mean that the mark is not awarded.

4 Quality of Written Communication and levels marking

In Question 2 students are required to produce extended written material in English, and will be assessed on the quality of their written communication as well as the standard of the scientific response.

Students will be required to:
- use good English
- organise information clearly
- use specialist vocabulary where appropriate.

The following general criteria should be used to assign marks to a level:

Level 1: Basic

- Knowledge of basic information.
- Simple understanding.
- The answer is poorly organised, with almost no specialist terms and their use demonstrating a general lack of understanding of their meaning, little or no detail.
- The spelling, punctuation and grammar are very weak.

Level 2: Clear

- Knowledge of accurate information.
- Clear understanding.
- The answer has some structure and organisation, use of specialist terms has been attempted but not always accurately, some detail is given.
- There is reasonable accuracy in spelling, punctuation and grammar, although there may still be some errors.

Level 3: Detailed

- Knowledge of accurate information appropriately contextualised.
- Detailed understanding, supported by relevant evidence and examples.
- Answer is coherent and in an organised, logical sequence, containing a wide range of appropriate or relevant specialist terms used accurately.
- The answer shows almost faultless spelling, punctuation and grammar.

4.4.1.1 Metal oxides

Question	Answers	Extra information	Mark	AO / Spec. Ref.
1(a)(i)	a smooth curve through or close to all points except (30,12)		1	**AO2** 2.4
1(a)(ii)	correct reading from the curve in 1(a)(i) (cm^3)	allow a tolerance of +/- 0.5 cm^3	1	**AO2** 2.4
1(a)(iii)	45-50 (seconds)		1	**AO3** 2.4
1(a)(iv)	line becomes less steep because gas is produced more slowly	ignore line levels out or plateaus allow examples with figures, eg 12 cm^3 gas from 0 to 20s but 1.5 cm^3 gas in last 20s ignore reaction has stopped or no more gas produced	1 1	**AO3** 2.4
1(a)(v)	0.6 (cm^3 per second)	allow 0.55 to 0.65	1	**AO2** 2.4
1(b)(i)	 temperature volume (of hydrogen peroxide)	concentration of hydrogen peroxide = max **1** ignore amount (of hydrogen peroxide)	 1 1	**AO3** 2.4
1(b)(ii)	 rate increases because more particles (in the same volume) so frequency of collisions increases	incorrect reference to energy = max **2** accept particles closer together allow greater chance of collisions ignore more collisions	 1 1 1	**AO1** 2.4.1e

4.4.1.1 Metal oxides

1(c)	(increasing the amount of catalyst) increases rate same final volume of gas	accept steeper graph or graph levels off earlier	1 1	**AO2** 2.4.1g
Total			**13**	

4.4.1.1 Metal oxides

<table>
<tr><th>Question</th><th>Answers</th><th>Extra information</th><th>Mark</th><th>AO / Spec. Ref.</th></tr>
<tr><td>2</td><td></td><td></td><td>6</td><td rowspan="6">AO1
2.1.1h
2.2.4b,c
2.2.5a,b</td></tr>
<tr><td colspan="4">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 on page 5 and apply a ‘best-fit’ approach to the marking.</td></tr>
<tr><td>0 marks</td><td>Level 1
(1–2 marks)</td><td>Level 2
(3–4 marks)</td><td>Level 3
(5–6 marks)</td></tr>
<tr><td>no relevant information given</td><td>a statement about the structure or a property of a metal
or
a statement about the structure or a property of a polymer</td><td>a statement about the structure or a property of a metal
and
a statement about the structure or a property of a polymer</td><td>a statement about the structure or a property of a metal
and
a statement about the structure or a property of a polymer
and
at least one statement linking structure and property</td></tr>
<tr><td colspan="4">Statements shown as HT only are credited on both FT and HT.
However, HT only means that these statements are not expected in a FT answer.</td></tr>
<tr><td colspan="4">Examples of chemistry points made in response
Metal:
Properties
shiny
hardness
(tensile) strength
melting point/boiling point
density
malleable/flexible
ductile
conduct electricity or thermal energy</td></tr>
</table>

Structure • metals contain atoms /((positive) ions HT only) • (the atoms/(positive) ions/particles are) closely packed / in a regular pattern / in a giant structure/in layers / in a lattice • strong bonds/(electrostatic attractions HT only) • (metal has delocalised electrons HT only) **Polymer:** **Properties** • flexible • melting/boiling point • density • can be shaped/moulded • poor conductor of electricity or thermal energy **Structure** • polymer consists of chains • polymer chains may be tangled • polymer has no cross links. • (polymer has weak intermolecular forces HT only) **Level 3:** **Examples of linked statements:** • metal can be bent and shaped because the layers can slide • some metals are soft because layers can slide • some metals are hard because they have strong bonds and/ or (the atoms/(positive) ions/particles) are closely packed / in a regular pattern / in a giant structure/ in a lattice • metal has high melting/boiling point because they have strong bonds and/ or (the atoms/(positive) ions/particles) are closely packed / in a regular pattern / in a giant structure / in a lattice • metal is strong because of strong bonds • some metals are dense because the atoms are closely packed • (metal can conduct thermal energy and electricity because metal has delocalised electrons HT only) • thermosoftening polymer melts when heated because it has no cross-links (or has weak intermolecular forces HT only) • thermosoftening polymer is flexible because the chains can move over each other	

Total			**6**

4.4.1.1 Metal oxides

Question	Answers	Extra Information	Mark	AO / Spec. Ref
3(a)(i)	2 bonding pairs 4 unbonded electrons on each atom	accept dots, crosses, e, - or any combination ignore any electrons on any inner shells if no other mark awarded allow **1** mark for 1 bonding pair and 6 unbonded electrons on each atom	1 1	**AO2** 2.1.1g
3(a)(ii)	covalent	allow convalent and covelant ignore single or double ignore shared, shared bond or sharing	1	**AO1** 2.1.1g
3(a)(iii)	weak intermolecular forces require little energy to overcome	reference to weak covalent or weak ionic bonds = **0** accept weak intermolecular bonds MP2 dependent on MP1 if no other mark awarded allow 1 mark for simple/small molecules	1 1	**AO1** **AO2** 2.2.1a,b

3(b)(i)	**2** Mg + O_2 → **2** MgO	accept multiples	1	**AO2** 2.2.2
3(b)(ii)		reference to incorrect particles **or** incorrect bonding **or** incorrect structure = max **2**		**AO1** **AO2** 2.1.1a,b,c,f
	magnesium loses (electrons) **and** oxygen gains (electrons)		1	
	two (electrons transferred)		1	
	noble gas structure **or** 8 electrons in outer shells **or** (electrostatic) attraction between ions **or** forms ionic bonds	accept full outer shell (of electrons)	1	
3(b)(iii)	particles 1-100 nm in size	accept contain a few hundred atoms/ions accept have a high surface area to volume ratio ignore reference to (very) small particles do **not** accept smaller than an atom/ion	1	**AO1** 2.2.6a

4.4.1.1 Metal oxides

3(c)	has a high melting point	allow will not melt allow a lot of energy needed to melt ignore boiling point reference to incorrect particles or incorrect bonding or incorrect structure = max **1** from MP2 and MP3	1	**AO1** **AO2** 2.2.3a
	because all atoms linked to other atoms	allow giant structure/lattice ignore many bonds	1	
	by covalent bonds	allow strong bonds allow a lot of energy needed to break bonds accept giant covalent structure for MP2 and MP3	1	
Total			**13**	

4.4.1.1 Metal oxides

Question	Answers	Extra Information	Mark	AO / Spec. Ref
4(a)	add copper oxide and (sulfuric) acid		1	**AO1** **AO2** 2.6.1b,c
	excess (copper oxide)		1	
	filter (to remove excess)	ignore impurities	1	
	heat /boil / evaporate / leave (to crystallise)	do **not** accept to dryness	1	
4(b)	(M_r CuO =) 79.5		1	**AO2** 2.3.3c
	24.95/249.5 **or** 0.1 **OR** 79.5/249.5 **or** 0.3186…	allow ecf for M_r CuO from step 1 allow correct rounding to min 2SF	1	
	(24.95/249.5 x 79.5=) 7.95	allow ecf for M_r CuO from step 1 allow ecf from step 2 of incorrect calculation/ rounding of correct ratio allow correct rounding to min 2SF correct answer with or without working gains 3 marks	1	
4(c)(i)	as wealth decreases, ethene production decreases (with the exception of country C or D)	accept converse	1	**AO2** **AO3** 2.6
	sulfuric acid production is not linked to wealth		1	

4.4.1.1 Metal oxides

4(c)(ii)	use of products of ethene has increased	allow use of polymers / plastics / ethanol / poly(ethene) has increased ignore use of ethene as a (bio)fuel ignore cost	1	**AO3** 2.2.5
Total			**10**	

4.4.1.1 Metal oxides

Question	Answers	Extra Information	Mark	AO / Spec. Ref
5(a)(i)	draw line on paper put (dots of) inks on line place (bottom of) paper in solvent / water any **one** from: line drawn in pencil allow dots of ink to dry line above solvent lid		1 1 1 1	**AO1** 2.3.2b
5(a)(ii)	any **two** from: • A has 3 colours **and** B has 4 colours • 2 colours are the same • **A** has 1 colour not in **B and B** has 2 colours not in **A**	accept 3 colours are different if no other mark awarded allow **one** more colour in ink **B** than in ink **A** (or converse)	2	**AO3** 2.3.2b
5(b)(i)	substances carried by gas through column / tube / coil (packed with solid) (different substances move through the column) at different speeds	 accept (different) substances come out at different times or have different retention times	1 1 1	**AO1** 2.3.2c
5(b)(ii)	(relative) molecular mass	allow (relative) formula mass allow RFM, RMM, M_r	1	**AO1** 2.3.2c
Total			**10**	

4.4.1.1 Metal oxides

Question	Answers	Extra Information	Mark	AO / Spec. Ref
6(a)(i)	tick (✓) by: the initial temperature reading was too low		1	**AO3** 2.5
6(a)(ii)	the reaction is exothermic	allow energy is given out	1	**AO3** 2.5.1b
6(b)(i)	(positive/hydrogen) ions gain electrons hydrogen is below sodium in the reactivity series so hydrogen / H_2 is produced	accept (positive/hydrogen) ions are reduced accept reference to high reactivity of sodium If no other mark awarded allow hydrogen (and sodium) ions **or** positive ions are attracted to negative electrode for **1** mark	1 1 1	**AO1** **AO2** 2.7.1c,f,i
6(b)(ii)	**2** (Cl^-) → **Cl_2 + 2e^-**	must be completely correct allow multiples	1	**AO1** 2.7.1g
6(b)(iii)	solution is alkaline because sodium hydroxide / NaOH is produced **or** sodium hydroxide / NaOH is left over	accept hydroxide (ions) / OH^- is produced **or** hydroxide (ions) / OH^- is left over	1 1	**AO1** **AO2** 2.7.1i; 2.6.2d
Total			**8**	

4.4.1.1 Metal oxides

Answer 49 · Examiner comments

June 2018 | 8462/1H | Original Q1

Question 1 (standard demand)

01.1 This question was well answered, with 70% of students able to give a different type of substance. Many suggested a base, but as metal oxides are themselves bases, this was not another type of substance and was ignored. Named examples of correct types of substance were accepted.

01.2 38% of students could write the correct formula for calcium nitrate. Many didn't know what to do with the nitrate ion even if they worked out the ratio as 1:2.

01.3 This question discriminated well, with marks across the range being spread fairly equally. Whilst there were many excellent answers, a lot of students concentrated on the crystallisation phase, without saying how the magnesium sulfate solution would be produced.

Some started by adding magnesium sulfate to an acid. A few students mixed unspecified quantities of magnesium oxide and sulfuric acid in an evaporating basin and then evaporated to dryness, sometimes stating that the acid was being evaporated off. Even when an oxide is correctly added in excess and the excess filtered off, evaporation to dryness will not yield crystals.

4.4.1.1 Metal oxides

Answer 50 · Examiner comments

June 2019 | 8462/1H | Original Q5

Question 5 (standard, standard / high and high demand)

05.1 Approximately three-quarters of students were able to complete the dot and cross diagram correctly.

The mark for the bonding electrons was scored more often than the mark for the non-bonding electrons.

05.2 Only a small proportion of students were able to give a limitation of a dot and cross diagram.

The most common correct response was that the molecule was not shown in 3 dimensions.

Common responses seen that were not credited included:

- only shows the outer electrons
- does not show the structure
- does not show the intermolecular forces.

05.3 Students found this question difficult.

The mark for indicating the presence of weak intermolecular forces was most often awarded. However, some students referred to 'intermolecular forces' incorrectly, for example, weak intermolecular forces between the atoms / bonds.

A common misconception was that covalent bonds are weak and that it is these bonds that are broken when ammonia boils.

Ammonia consisting of small molecules was the mark least often awarded.

05.4 Students found identification of a metal oxide most likely to be used as a catalyst difficult.

The correct answer, the transition metal oxide, Cr_2O_3, was the most common choice of catalyst but the other 3 options were all chosen in significant numbers, especially MgO.

05.5 Approximately two-thirds of students correctly calculated the overall energy change.

The most common error was to incorrectly determine, or not determine, the number of each type of bond from the given equation.

05.6 Students found this question challenging. In particular, students did not always use values from their previous calculation as instructed in the question. A common non-scoring response was simply to define an exothermic reaction.

Few students compared their calculated values for bond breaking and bond making as was intended. Some referred in general terms to these processes but often used incorrect terms, for example, more energy was <u>needed</u> for making bonds than used for breaking bonds.

4.4.1.1 Metal oxides

Answer 50 · Examiner comments

June 2019 | 8462/1H | Original Q5

05.7 The completion of the energy profile was often done well with almost two-thirds of students scoring both marks.

Some students were imprecise with the positioning of their lines.

Other common errors included:

- Not drawing a line for activation energy, just labelling the peak.
- Drawing a line from the peak to the products line for ‘overall energy change’.

4.4.1.1 Metal oxides

Answer 51 · Examiner comments

June 2019 | 8462/1H | Original Q7

Question 7 (standard, standard / high and high demand)

07.1 The explanation for the use of cryolite in the extraction of aluminium does not appear to be well known. Almost two-thirds of students scored 0 marks.

A common misconception was that cryolite acts as a catalyst.

Common responses seen that were not credited included:

- to melt the aluminium oxide so that it conducts electricity
- so that the ions can move freely
- to reduce costs.

07.2 Almost 60% of students correctly identified that aluminium ions gain electrons as the process occurring at the negative electrode.

07.3 Students found the completion of the half-equation difficult. Almost 70% scored 0 marks.

Common errors included:

- including Al / Al_2O_3
- representing the oxide ion as O^- or O_2^-
- 2 electrons rather than 4 electrons being produced.

07.4 However, only approximately a quarter of students were able to state why the positive electrode needs to be replaced and hence score all 3 marks.

4.4.1.1 Metal oxides

Answer 51 · Examiner comments

June 2019 | 8462/1H | Original Q7

07.5 Most students scored at least 1 mark. Approximately 40% scored all 4 marks.

The most frequently scored mark was for M_r (Al_2O_3) = 102 (or '204' from the alternative approach in the mark scheme).

A common error was M_r (Al_2O_3) = 156 but students were still able to score marks for using this incorrect value in subsequent steps.

A valid variation on the reacting mass method was to calculate the percentage by mass of oxygen in Al_2O_3 and then use this to calculate the mass of oxygen in 2000 kg of Al_2O_3

It was not always clear which approach was being used. A common incorrect final answer was 1412 (kg) where students had applied the 2 : 3 mole ratio (from the main approach) as well as the 96 / 204 mass ratio (from the alternative approach).

07.6 Students found this question difficult. Almost two-thirds of students scored 0 marks.

Even when students realised that reactivity was the key idea, they sometimes compared the reactivity of the wrong species, for example, sodium and chlorine or Na^+ ions and H^+ ions

A common misconception was that sodium chloride solution does not conduct electricity.

07.7 Approximately two-thirds of students scored at least 1 mark for this calculation.

However, the most common final answer was 50.7 dm^3. The error here was the omission of the unit conversion, kg to g.

4.4.1.1 Metal oxides

Answer 52 · Examiner comments — June 2019 | 8462/1H | Original Q8

Question 8 (standard / high and high demand)

08.1 Only approximately a quarter of students scored this mark. They usually did so by identifying the need to ensure that the oxide of copper had completely reacted.

Common responses seen that were not credited included:

- to ensure complete reaction (unqualified)
- to ensure reliable / valid / accurate results.

08.2 Students found this question difficult. Approximately 80% of students scored 0 marks.

The idea that hydrogen is explosive was the most common correct response.

A common misconception was that, unless burned off, the hydrogen would affect the masses of the tubes and contents.

Common responses seen that were not credited included:

- Hydrogen is flammable.
- Hydrogen would react with the drying agent.

Answer 52 · Examiner comments — June 2019 | 8462/1H | Original Q8

08.3 Students found the processing of the data quite difficult. Approximately a third of students scored both marks with a similar proportion scoring 1 mark.

Common responses seen that were not credited included:

- 1.09 g (which represents the mass of oxygen)
- 2.45 g (the mass of water) recorded as the mass of copper.

08.4 Students found this question difficult. Only approximately a quarter of students scored full marks with approximately a half scoring 0 marks.

For those who scored marks, it was usually by the main approach in the mark scheme. Here, the mark for linking the mole ratio to equation 2 was the least frequently scored.

All approaches in the mark scheme were represented and students scored best when their working was set out clearly.

The most common incorrect approach was to calculate the M_r of all the reactants and products in both equations and then simply refer to conservation of mass.

4.4.1.1 Metal oxides

Answer 53 · Examiner comments November 2020 | 8462/1H | Original Q1

Question 1 (standard demand)

01.1 Few students scored both marks. Diamond and sodium chloride were both commonly seen incorrect responses.

01.2 Many students were unable to reach the higher marks because they did not make direct comparisons. Instead, they gave separate descriptions of the three compounds. Many also referred to the properties of the compounds, which were not required. The phrase 'intermolecular forces' was used indiscriminately to describe interactions between ions or in giant covalent structures, as well as between molecules.

Answer 54 · Examiner comments November 2020 | 8462/1H | Original Q6

Question 6 (standard, standard / high and high demand)

06.1 Most students were able to express the idea that activation energy is the minimum energy required to start a reaction. One common error was to say that it is the energy needed to make particles collide.

06.2 A variety of approaches was seen. The majority of students calculated the number of moles of both aluminium and of iron oxide and then attempted with varying degrees of success to explain why the number of moles of aluminium was insufficient for the iron oxide. Common errors were to omit to convert the mass from kilograms to grams, and/or using 54 as the 'M_r' of aluminium. Of those who did correctly calculate the number of moles of each reactant, some had difficulty in expressing clearly the idea of 2 moles of aluminium being needed to react with 1 mole of iron oxide, and therefore 37.0 moles of aluminium is less than the 37.5 moles required, or that 18.75 moles of iron oxide is more than the 18.5 moles required. Other students started with the mass of one reagent and calculated the required mass of the other, either by the moles method or by proportion. These students found it easier to express why there was insufficient aluminium or excess iron oxide.

06.3 Few students scored both marks. Aqueous zinc was often seen as a response. Many students did not understand the idea of an ionic equation and tried to include the sulfate ion.

06.4 Only a third of students scored both marks, but a lot of students were confused about which species gained electrons and which lost them. Definitions of oxidation and reduction in terms of gain and loss of oxygen were not appropriate here and were not credited.

4.4.1.1 Metal oxides

Answer 55 · Examiner comments

November 2021 | 8462/1H | Original Q3

Question 3 (standard demand)

03.1 This was well answered by many students. A common error was to not multiply the relative formula mass of hydrogen by three, leading to an answer of 100.

03.2 This was well answered. Credit was given to those who applied an incorrect response to question **03.1** correctly. Some students gave an answer which corresponded to their answer to question **03.1** used as atomic number rather than relative atomic mass.

03.3 This was well answered, although a common error was to omit the carbon in calculating the total M_r of the reactants.

03.4 The best answers gave the pros and cons of each method and then gave a judgement. One misconception was that the iron oxide in method 3 could be sold. Many concentrated only on cost, and the number of by-products, rather than what those products were and how difficult or costly further separation would be. Few students used the information provided, that solid products have to be separated. A few very good students commented on the low atom economy that method 1 would give because of some tungsten being lost as tungsten carbide.

4.4.1.1 Metal oxides

Answer 56 · Examiner comments November 2021 | 8462/1H | Original Q4

Question 4 (standard, standard / high and high demand)

04.1 Many students remembered that effervescence would be seen, but there were many vague descriptions such as 'vigorous reaction' which did not gain credit. Students often gave the same observation twice, eg, 'effervescence' and 'bubbles'. Many students incorrectly mentioned a colour change, perhaps remembering a demonstration where an indicator had been added. Very few mentioned the potassium melting.

04.2 Very few students could write the formulae for the correct products. Those who could were usually able to balance the equation. Many students approached the question from the wrong direction, trying to balance the equation by inventing fictitious products.

04.3 This was not well answered, with only a small number of students scoring full marks. Many incorrectly tried to link reactivity to melting and boiling point. Many referred to the distance and / or attraction between the nucleus and electrons in general, rather than the outer electrons. Others failed to mention the nucleus at all.

04.4 The electron arrangements of both atoms and ions were required for full marks, as well as the ratio of sodium ions to oxide ions and the correct charges on the ions. Few students scored all the marks as they did not draw the atoms of sodium and oxygen before reaction. Many tried to draw covalent structures. The ratio of 2 atoms of sodium to one of oxygen was well known. Students should be aware that electrons cannot be in two places at the same time and should not be drawn as if they are. Some students drew both ionic and covalent structures, thereby contradicting themselves and losing the marks for a correct ionic structure. A great deal of time and effort would be saved by drawing the outer electrons only, as in the specification.

04.6 Students found this question very difficult, with many referring incorrectly to intermolecular forces, even when mentioning ions. Many also referred to covalent bonds or forces between atoms. Of those who did refer correctly to the large amounts of energy required to break the strong attractions between ions, very few referred to the giant structure of the compound.

Answer 57 · Examiner comments November 2021 | 8462/1H | Original Q5

Question 5 (standard, standard / high and high demand)

05.2 This equation, which is given in the specification, was not well known.

05.4 Students found this question difficult. Most students do not know why the acid is heated, and many incorrectly referred to helping the magnesium oxide dissolve. Very few appeared to understand that excess magnesium oxide is needed to ensure that all of the acid reacts. Most students knew that filtration separates solids from liquids or solutions, but many did not refer specifically to removing the excess magnesium oxide.

05.5 Very few students knew that a water bath or an electric heater should be used, despite this being stated in the specification.

4.4.1.1 Metal oxides

Answer 57 · Examiner comments November 2021 | 8462/1H | Original Q5

05.6 Those who followed the method provided in the question were often successful in scoring at least one mark. It was common to see the number of moles of iron calculated by dividing the mass by 112 instead of 56. Those who calculated the number of moles of chlorine often insisted on converting this to a mass and then back again to calculate the volume of chlorine.

Answer 58 · Examiner comments June 2022 | 8462/1H | Original Q1

Question 1 (Standard demand)

01.1 Students found this question challenging. It was expected that the lack of electrical conductivity and the low melting point would have suggested a non-metal and therefore section **D**. However, fewer than half of students gave this response, with distractors **A** and **C** both proving very attractive to students.

01.2 Nearly two thirds of students recognised element **R** as a transition metal and therefore in area **B**.

01.3 Fewer than 20% of students scored two marks, although more than half scored at least one mark. Students were asked to compare physical properties of Group 1 elements with transition elements. Many students gave chemical properties such as reactivity instead of physical properties. Others referred to atomic structure. Some students described a property of either a Group 1 element or a transition element without reference to the other.

01.4 Nearly all students could draw the electronic structure correctly.

01.5 The great majority of students referred to delocalised electrons in their answer. Many also referred to the electrons carrying charge. However, few articulated the idea that the electrons themselves move through the metal in a particular direction. Many implied that the movement was random by the use of words such as ‘throughout’ rather than ‘through’. Some students incorrectly referred to electrons bumping into other atoms or electrons.

01.6 The great majority of students correctly identified the type of bonding.

4.4.1.1 Metal oxides

Answer 58 · Examiner comments June 2022 | 8462/1H | Original Q1

01.7 The majority of students gave excellent descriptions of the transfer of two electrons from a magnesium atom to an oxygen atom to produce magnesium ions and oxide ions,with more than 80% scoring at least three marks. A few students showed a lack of understanding by subsequently referring to electrons being shared.

Answer 59 · Examiner comments June 2022 | 8462/1H | Original Q7

Question 7 (Standard, standard/high and high demand)

07.1 This was well answered, with more than half of students scoring both marks. There was, however, some ambiguous use of the word 'it' such as 'it shows that it is below carbon because it displaces it'. If it was not clear what 'it' referred to, credit was not given.

07.2 Only 10% of students were awarded both marks, although nearly 60% scored at least one mark. Many students realised that aluminium is extracted by electrolysis, although some stated that aluminium would be extracted by the use of a more reactive metal. Although many mentioned the high energy cost of electrolysis, few compared electrolysis to the lower energy cost of heating coal to obtain carbon. Other students did state that extracting aluminium requires more energy than forming carbon, but did not explain why.

07.3 Many students realised that the products both being solids would make their physical separation difficult. Some appeared to misunderstandd what 'separate' means, and described the difficulty of decomposing magnesium oxide; this did not gain credit. Another common incorrect approach was to say that magnesium is high in the reactivity series. Whilst true, this was not relevant to the question set.

07.4 Those students who adopted a systematic approach, either using moles or reacting masses by proportion, had little difficulty in scoring most or all of the marks. In a multi-step calculation it is essential that each step is shown in the working so that marks for working can be awarded. The most common error was to use 48, instead of 24, for the M_r of Mg, giving an answer that was twice the correct value. Nearly all students carried out the unit conversion correctly. Some students calculated the correct final answer (960 g) but used an incorrect method. Such responses did not score full marks.

4.4.1.1 Metal oxides

Answer 59 · Examiner comments June 2022 | 8462/1H | Original Q7

07.5 This was well answered. However, there were many blank responses.

07.6 This was a high demand calculation, and students found it difficult to analyse the correct approach to take. The gas molar volume was not provided, because it was not needed. Indeed, with the water being formed as a gas, a value of 24 dm^3/mol was not correct. Even so, those students who adopted the approach of converting gas volumes to moles were given full credit if they succeeded. Few did, as a four-step calculation with simple numbers was turned into a seven-step calculation with a unit conversion by electing to follow this approach.

Students needed to use the equation to realise that the SiO_2 formed is a solid, not a gas. They were also told that the oxygen is in excess; that means that the Si_2H_6 is the limiting reactant, and that the gases after reaction would therefore be the water vapour and the remaining oxygen. All that was therefore necessary was to multiply the volume of Si_2H_6 by 3 to find the volume of water vapour formed, and by 7/2 to find the volume of oxygen used. Subtracting that volume from 150 cm^3 would then give the volume of excess oxygen, and adding the volumes of the two appropriate gases together gave the final answer. Only one sixth of students scored at least one mark, which was usually for calculating the volume of water vapour produced.

Answer 60 · Examiner comments June 2023 | 8462/1H | Original Q7

Question 7 (standard, standard/high and high demand)

07.1 Nearly all students could balance the ionic equation correctly.

07.2 About a fifth of students answered this high demand question correctly. Some students compared the reactivity of sodium with hydrogen instead of with aluminium. Imprecise language was sometimes a problem; it is elemental sodium which is more reactive, not sodium ions. Aluminium is released at the electrode, not discharged (it is the ion which is discharged, ie loses its charge). There is no displacement occurring.

07.3 The question discriminated well, but very few fully correct answers were seen, with just over a third of students scoring at least one mark. Students were asked to explain <u>how</u> oxygen is produced from water, not <u>why</u> oxygen is produced. Few students described the initial step outlined in the specification; that water molecules break down to form H^+ ions and OH^- ions. Many seem to think that oxide or 'oxygen' ions are responsible, rather than hydroxide ions. The attraction of the hydroxide ions to the positive electrode was reasonably well known, but few students then correctly described the oxidation or discharge of the hydroxide ions to form oxygen. As in the previous question, the term 'discharged' is widely misunderstood – the word means 'loses its charge', so to say that oxygen is discharged is not correct.

4.4.1.1 Metal oxides

Answer 60 · Examiner comments June 2023 | 8462/1H | Original Q7

07.4 Nearly two thirds of students scored at least one mark, but just over half of these also scored the second mark. The easiest change to the apparatus is to change the test tubes to measuring cylinders or inverted burettes. Many students suggested gas syringes; this was allowed, although it would be difficult to set up the apparatus in such a way that this would work. However, a 'gas cylinder' is not a measuring device. One popular misconception is that gas would escape from the apparatus so a lid should be used.

Most students realised that the reason was so that the gas volume could be measured rather than estimated, or that test tubes have no scale; any equivalent way of expressing this idea was allowed. Some students used imprecise language such as 'so the gas could be measured' without referring to volume or a scale.

07.5 The great majority of students gave the correct response, with 20 cm^3 being the most common incorrect choice.

4.4.1.1 Metal oxides

Answer 61 · Examiner comments

June 2023 | 8462/1H | Original Q9

Question 9 (standard, standard/high and high demand)

09.1 Students found this question difficult, with only a tenth of students scoring both marks and not many more scoring one. Most students gave incorrect responses for the substance reduced: usually iron, but sometimes carbon. Those who gave the correct substance were usually able to give the correct reason in terms of loss of oxygen. It seems that students are so well versed in the definitions of redox in terms of electrons (as in question 09.3) that they have forgotten the simpler definitions in terms of gain or loss of oxygen.

09.2 Fewer than a third of students gave the correct answer, with all three distractors being very popular. This suggests a large degree of guessing rather than using the equation to work out the mole ratio of C:Fe as 3/2 and then multiply by 12 grams.

09.3 Over three-quarters of students could correctly apply their knowledge of redox in terms of electrons. By far the most common incorrect response was **A** gains electrons and $\mathbf{B}^{+}$ loses electrons.

09.4 Fewer than one in seven students answered this high demand question correctly, with the great majority giving metal **A** as the answer. It was necessary to realise that the greatest tendency to form positive ions means the most reactive metal. It was then necessary to work out from the three reactions in the table that **A** is more reactive than **B**, **C** is more reactive than **A**, and **C** is less reactive than **D**, making **D** the most reactive.

09.5 This question discriminated well. Over half of students scored at least one mark, with just over one in ten scoring all three.

Many students tried to answer in terms of the reactivity series. This was not possible, as insufficient detail was provided to identify any of the four metals. The formula of the nitrate ion was provided but was not referenced by the majority of students. The key to answering the question was in the formulae of the nitrates; aluminium forms an ion of charge 3+, so each ion requires three nitrate ions to balance the charge. Even when students got the basic idea, they often did not express themselves clearly enough, using phrases such as ‘aluminium has a 3+ charge’ rather than referring to an aluminium ion.

09.6 Those who understood the concept of atom economy were able to complete this difficult calculation successfully; over a fifth of students scored all four marks and two fifths scored at least one.

There were two main approaches. One was to substitute values into the atom economy expression, followed by successive rearrangements of the expression to give the value of A_r of **X**. A neater solution, used by students who had a good understanding of atom economy, was to realise that the remaining 22.7% was the total M_r of the waste atoms, ie 54, and then scale either to 100% and subtract the 54, or scale straight to 77.3%. Many students misunderstood the M_r of XO_3, thinking it meant the A_r of **X** times 48. Some also misunderstood $3H_2$ or $3H_2O$, giving various values for what should have been a total of 54 for the M_r of the waste atoms. Nevertheless, correct manipulation after these errors allowed access to 3 marks.

4.4.1.1 Metal oxides

Answer 62 · Examiner comments June 2024 | 8462/2H | Original Q7

Question 7 (standard, standard / high and high demand)

07.1 Around 40% of students scored two marks for this question. However, many students were not able to name the correct reagent for the test. White precipitate was often given as the result of the test, but this answer was not creditworthy unless the correct reagent had been named. Sodium hydroxide and silver nitrate were the most common incorrect reagents. A significant number of students left the answer space blank.

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Answer 62 · Examiner comments June 2024 | 8462/2H | Original Q7

07.2 This multiple-choice question was well answered with two-thirds of students gaining the mark.

07.3 Around 30% of students scored both the marks on this question. Clear descriptions about the numbers of moles / molecules on each side of the equation and the resulting shift in the position of equilibrium at higher pressure were seen. A number of students failed to score the first marking point because they did not give a comparison of the number of moles or molecules of gas on each side of the equation. Answers that focused on changes in the rate of reaction or particle collisions were not creditworthy, nor were those which stated that the equilibrium shifted to the side with lower pressure.

07.4 This question was not well answered and only around 2% of students were awarded both marks. The most common creditworthy responses were based on the idea that a higher pressure is not used because the yield is already high or because more energy would be required to achieve a higher pressure. Many answers could not be given credit because they were not comparative. Higher risk of explosion or higher cost of safety precautions were creditworthy responses that focused on the consequences of using higher pressure compared to using a lower pressure.

07.5 This multiple-choice question was answered correctly by around a quarter of students who used their periodic table to locate and identify vanadium as a transition metal.

4.4.1.1 Metal oxides

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June 2025 | 8462/1H | Original Q3

Question 3 (standard demand)

03.1 This was answered less successfully, with the majority of students choosing tin as the substance reduced. Tin is the product of the reduction, not the substance which is reduced. Those who did choose the correct substance, SnO_2, were usually able to give a correct reason; one in seven students were awarded both marks. Some tried to answer in terms of electrons, despite the instruction to answer in terms of oxygen. These answers did not gain credit for the second marking point.

03.2 Nearly three quarters of students managed to state succinctly that carbon is more reactive than tin or that tin is less reactive than carbon. However, some answers were vague and used the word 'it' which is problematic as there are three substances named in the question. 'Carbon is more reactive' is insufficient as we do not know what the reactivity is being compared to.

03.3 More than two thirds of students achieved full marks. Some did not calculate a total M_r but used the M_r of CdO instead; these answers were not creditworthy. Others added up all the M_r of reactants and products instead of just the reactants; these gained partial credit.

03.4 The question asked for two differences in properties, so comparative language was necessary (potassium is softer rather than potassium is soft). Three fifths of students scored both marks, choosing from differences in physical properties and properties exhibited by transition metals only. The most common type of error was to describe differences in atomic structure rather than differences in the properties of the metals in bulk.

03.5 The vast majority of students interpreted the equation correctly and showed that the total M_r on both sides was 238.

03.6 More than two thirds of students gave an acceptable response. Most of those who were awarded the mark answered in terms of economic reasons such as lowering the cost of the operation. Fewer answered in terms of sustainable development; of those who did, most referred to a high atom economy producing less waste. Some students confuse a high atom economy with a high yield; references to yield were ignored.

4.4.1.1 Metal oxides

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Question 6 (standard, standard/high and high demand)

06.1 This was a high demand question which required the use of correct terminology. The question discriminated well, with three fifths of students gaining one mark but very few scoring all four. Many students referred correctly to strong electrostatic forces of attraction and to the large amount of energy needed to break these. Fewer referred correctly to the particles that those forces acted between, i.e. the oppositely charged ions; some referred incorrectly to the forces being between bonds. Some referred to

4.4.1.1 Metal oxides

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'oxygen ions' rather than oxide ions. There were very few who stated that the electrostatic forces act in all directions in the giant structure, despite the statement in the specification; this was the mark that most students did not score. Some students ruined their answer by the use of the word 'intermolecular', which is not appropriate as there are no molecules. Most students did recognise that a lot of energy was needed to break bonds but had contradicted this marking point earlier in their response by referring to the bonds as intermolecular forces. Some referred to 'more' energy being needed to break the bonds; this did not gain credit because the question did not require a comparison to anything else, and 'more' does not necessarily imply 'a lot'.

06.2 Only a half of students knew that cryolite was the correct substance. The most common incorrect answer was water.

06.3 Only one in five students scored the mark. Many students missed the point and referred to allowing ions to flow. The idea that the mixture has a lower melting point than pure aluminium oxide so that less energy is required was not well known. It is not correct to say that the melting point of aluminium oxide is lowered, as aluminium oxide has a fixed melting point. Some appear to think incorrectly that cryolite is a catalyst.

06.4 Students had difficulty with this high demand question, but it did discriminate well between the higher achieving students. One in five students scored both marks. Many could not write the formula of the oxide ion, and of those who could, some had the oxygen on the left and the oxide ion on the right. Those who could write the correct formulae could often balance the equation correctly, with the correct number of electrons on the right. An electron must be written with its charge in an ionic equation, as e^-, so that the charge balances as well as the atoms.

06.5 This question discriminated well, with half of students scoring at least one mark and more than a third scoring all three. Those who knew that the positive electrode is made of carbon often went on to score all three marks, although some merely referred to oxidation of the electrode rather than a specific reaction with the oxygen produced. There appeared to be much guesswork, with unspecified corrosion of an electrode made of an unspecified material being fairly common. Some thought that the deterioration of the electrode was due to its gaining electrons, and some thought that the electrode was made of iron and would rust.