

Question number	Answer	Notes	Marks
1 (a)	A (argon)		1
(b)	CO ₂ / H ₂ O do not allow as part of an equation	IGNORE names even if correct	1
(c) (i)	M1 (the copper) <u>reacts/combines</u> with oxygen / oxidised M2 to form copper(II) oxide	IGNORE bonds with oxygen IGNORE burns / combusts REJECT refs to rust ACCEPT copper oxide REJECT any other oxidation state	2
(ii)	the volume of a gas changes with temperature / gas expands when hot/heated	ACCEPT reverse argument IGNORE refs to density	1
(iii)	<u>all</u> the oxygen has reacted / the oxygen has been used up / no oxygen (left to react)	DO NOT ACCEPT refs to 'not enough oxygen'	1
(d)	M1 (150 – 125) or 25 (cm ³) M2 (25/150) x 100 = 16.7 (%) OR M1 100 x (125/150) = 83.3 (cm ³) M2 100 – 83.3 = 16.7 (%) M2 is cq on M1	ACCEPT 17 / 16.67 / 16.6̇ ACCEPT 83 / 83.33/ 83.3̇ REJECT 16.6 for M2 correct answer (with no working) scores 2	2

Question number	Answer	Accept	Reject	Marks
2 (a)	D			1
(b)	M1 before heating – colourless (solution/liquid) IGNORE clear/transparent/looks like water	no colour	white solution/liquid any colour other than white	1
	M2 after heating – milky/chalky/cloudy/white (precipitate)/turbid IGNORE references to goes clear OWTTE			1
(c)	M1 (sulfur dioxide/it) dissolves in/reacts with (rain) water	$\text{SO}_2 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{SO}_3$ OR $\text{SO}_2 + \text{H}_2\text{O} + \frac{1}{2}\text{O}_2 \rightarrow \text{H}_2\text{SO}_4$ for both M1 and M2		1
	M2 to form an acidic solution/an acid/sulfurous acid /acid rain IGNORE references to any other products whether correct or not	sulfuric acid		1
	M3 which reacts with/corrodes the marble/calcium carbonate IGNORE erodes / weathers / melts / eats into	<u>chemical</u> weathering dissolves correct equation for reaction with either sulfurous or sulfuric acid SO_2 reacts with marble for M3 only		
			Total	6

Question number	Answer	Notes	Marks
3 (a)	water	accept H_2O accept water vapour if both name and formula given mark name only	1
(b)	carbon dioxide	accept CO_2 if both name and formula given mark name only	1
(c)	M1 (the copper / it) reacts with oxygen / oxidises M2 to form copper(II) oxide (which is black)	accept 'combines with/joins with/burns in oxygen' ignore 'air' accept 'copper oxide' reject 'copper(I) oxide'	2

Question number	Expected Answer	Accept	Reject	Marks
4 (a)(i)	nitrogen <u>and</u> oxygen IGNORE formulae whether right or wrong			1
(ii)	argon IGNORE formula whether right or wrong			1
(b)	Any one from: <ul style="list-style-type: none"> • manufacture of ammonia/in the Haber process • food packaging/preservative • aircraft tyres • (in) light bulbs • coolant/refrigerant/freezing agent • treatment of warts 			1
(c)	Any one from: <ul style="list-style-type: none"> • sulfur dioxide • nitrogen monoxide • nitrogen dioxide • dinitrogen tetr(a)oxide • oxide(s) of nitrogen <p>If both a name and a formula are given, IGNORE the formula</p> <p>IGNORE carbon dioxide</p>	nitrogen oxide a correct formula	any other gas	1

(d)	<p>(i) iron + oxygen (+ water) → (hydrated) iron (III) oxide M1 lhs M2 rhs</p> <p>(ii) M1 volume of oxygen = $80 - 63 / 17 \text{ (cm}^3\text{)}$ M2 percentage = $\left(\frac{21}{80} \times 100 \right) / 21$ OR $\frac{M1}{80} \times 100$ correctly evaluated 21 with no working scores 1 78.75/78.8/78.7 with no working scores 1 $\frac{21}{80} \times 100 = 79$ scores 1 79 with no working scores 0</p>	<p>ferric oxide/iron oxide correct chemical equation M1 all formulae correct M2 balanced</p> <p>21.25 / 21.3/21.2</p>	<p>any other oxidation state</p>	<p>2</p> <p>1</p> <p>1</p>
(e)	<p>(whether it/the height / the measurement is) the same as before I IGNORE references to iron had stopped rusting</p>	<p>no change</p>		<p>1</p>
			<p>Total</p>	<p>9</p>

Question number	Answer	Notes	Marks
5 (a)	<p>M1 (Fe) (Ti) (O) <u>36.8</u> <u>31.6</u> <u>31.6</u> 56 48 16</p> <p>M2 0.66 0.66 1.98</p> <p>M3 1 1 3</p> <p>OR</p> <p>M1 calculation of M_r of $\text{FeTiO}_3 = 152$</p> <p>M2 expression for % of <u>each</u> element e.g. Fe: $56 \div 152 \times 100\%$</p> <p>M3 evaluation to show these equal 36.8% Fe, 31.6% Ti, 31.6% O</p>	<p>Division by atomic number scores 0</p> <p>ACCEPT any number of sig figs except one ALLOW 0.65, 0.65, 1.97</p>	3
(b)	<p>M1 (element oxidised) – carbon / C</p> <p>M2 (reason) – (it has) gained/combined with oxygen / forms carbon dioxide</p> <p>M2 dep on M1</p>	<p>IGNORE refs to electron loss</p> <p>ACCEPT oxidation state/number increases</p> <p>ACCEPT oxidation state/number changes from 0 to (+)4</p>	2
(c) (i)	<p>$\text{TiCl}_4 + 2\text{Mg} \rightarrow \text{Ti} + 2\text{MgCl}_2$</p> <p>M1 all formulae correct</p> <p>M2 balanced</p>	<p>ACCEPT multiples and halves</p> <p>IGNORE state symbols even if incorrect</p>	2 1
(ii)	<p>titanium / Ti / magnesium / Mg reacts with oxygen</p> <p>OR</p> <p>titanium / Ti / magnesium / Mg reacts with nitrogen</p>	<p>IGNORE refs to oxidation</p> <p>ACCEPT forms an oxide</p> <p>ACCEPT forms a nitride</p>	
(iii)	<p><u>magnesium chloride</u> will dissolve more quickly / to help the <u>magnesium chloride</u> to dissolve / more of the <u>magnesium chloride</u> is in contact with the water</p>	<p>IGNORE to speed up the reaction</p> <p>IGNORE refs to increasing surface area</p>	1

(d) (i)	M1 positive ions/cations/nuclei and delocalised electrons M2 attract (one another) M2 dep on M1	IGNORE metal ions ALLOW sea of electrons IGNORE free electrons any refs to ionic bonding, covalent bonding or IMFs scores zero	2
(ii)	(delocalised) electrons can flow/move (through structure)/are mobile (when voltage/pd is applied)	IGNORE carry charge	1

Question number	Answer	Notes	Marks
6 (a)	nitrogen / N ₂	accept N	1
(b)	oxygen AND water	accept steam	1
(c)	incomplete combustion (of the octane / fuel)	accept '(burns in a) limited supply / shortage of oxygen/air' reject 'no oxygen'	1
(d) (i)	N ₂ + 2O ₂ → 2 NO ₂	accept halves and multiples accept as two correct equations via NO	1
(ii)	(It produces) acid rain OR (it causes) breathing problems / asthma	accept 'photochemical smog' ignore refs to greenhouse gas / global warming / climate change ignore refs to pollution	1