Question number	Answer	Notes	Marks
1 (a)	**A** (argon)		1
(b)	CO_2 / H_2O 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	IGNORE bonds with oxygen IGNORE burns / combusts REJECT refs to rust	2
	M2 to form copper(II) oxide	ACCEPT copper oxide REJECT any other oxidation state	
(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)		2
	M2 (25/150) x 100 = 16.7 (%)	ACCEPT 17 / 16.67 / $16.\dot{6}$	
	OR		
	M1 100 x (125/150) = 83.3 (cm^3)	ACCEPT 83 / 83.33/ $83.\dot{3}$	
	M2 100 – 83.3 = 16.7 (%)	REJECT 16.6 for **M2**	
	M2 is cq on **M1**	correct answer (with no working) scores 2	

Question number	Answer	Accept	Reject	Marks
2 (a)	D			1
(b)	**M1** before heating – colourless (solution/liquid) **IGNORE** clear/transparent/looks like water **M2** after heating – milky/chalky/cloudy/white (precipitate)/turbid **IGNORE** references to goes clear OWTTE	no colour	white solution/liquid any colour other than white	1 1
(c)	**M1** (sulfur dioxide/it) dissolves in/reacts with (rain) water **M2** to form an acidic solution/an acid/sulfurous acid /acid rain **IGNORE** references to any other products whether correct or not **M3** which reacts with/corrodes the marble/calcium carbonate **IGNORE** erodes / weathers / melts / eats into	$SO_2 + H_2O \rightarrow H_2SO_3$ OR $SO_2 + H_2O + ½O_2 \rightarrow H_2SO_4$ for both **M1** and **M2** sulfuric acid <u>chemical</u> weathering dissolves correct equation for reaction with either sulfurous or sulfuric acid SO_2 reacts with marble for M3 only		1 1 1
			Total	**6**

Question number	Answer	Notes	Marks
3 (a)	wa er	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: • 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: • sulfur dioxide • nitrogen monoxide • nitrogen dioxide • dinitrogen tetr(a)oxide • oxide(s) of nitrogen If both a name and a formula are given, **IGNORE** the formula **IGNORE** carbon dioxide	nitrogen oxide a correct formula	any other gas	1

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

Question number	Answer	Notes	Marks
5 (a)	M1 (Fe) 36.8/56 (Ti) 31.6/48 (O) 31.6/16 M2 0.66 0.66 1.98 M3 1 1 3 OR M1 calculation of M_r of $FeTiO_3$=152 M2 expression for % of each element e.g. Fe: 56 ÷ 152 x 100% M3 evaluation to show these equal 36.8% Fe, 31.6% Ti, 31.6% O	Division by atomic number scores 0 ACCEPT any number of sig figs except one ALLOW 0.65, 0.65, 1.97	3
(b)	M1 (element oxidised) – carbon / C M2 (reason) – (it has) gained/ combined with oxygen / forms carbon dioxide M2 dep on M1	IGNORE refs to electron loss ACCEPT oxidation state/ number increases ACCEPT oxidation state/ number changes from 0 to (+)4	2
(c) (i)	$TiCl_4 + 2Mg \rightarrow Ti + 2MgCl_2$ M1 all formulae correct M2 balanced	ACCEPT multiples and halves IGNORE state symbols even if incorrect	2 1
(ii)	titanium / Ti / magnesium / Mg reacts with oxygen OR titanium / Ti / magnesium / Mg reacts with nitrogen	IGNORE refs to oxidation ACCEPT forms an oxide ACCEPT forms a nitride	
(iii)	magnesium chloride will dissolve more quickly / to help the magnesium chloride to dissolve / more of the magnesium chloride is in contact with the water	IGNORE to speed up the reaction IGNORE refs to increasing surface area	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)	$N_2 + 2O_2 \rightarrow 2\ NO_2$	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