Question number	Answer	Notes	Marks
1 (a)	$CuO + 2HNO_3 \rightarrow Cu(NO_3)_2 + H_2O$	Ignore state symbols	1
(b) (i)	to increase the rate of <u>reaction</u>	ignore references to dissolving/solubillty	1
(b) (ii)	(copper(II) oxide/it) stops disappearing/ stays as a solid / forms as a solid (at the bottom of the beaker)	Accept stops dissolving / forms a suspension /forms a residue Accept when copper oxide remains/settles in the beaker Allow liquid goes cloudy/black ignore references to stops reacting ignore references to bubbling	1
(iii)	a drop of solution forms crystals when removed (and cooled)	Accept when crystals start to form/start to be seen Reject if all water evaporated	1
(iv)	(stage) 3	accept any reference to <u>first</u> filtration stage	1

<table>
<tr><th>Question number</th><th>Answer</th><th>Notes</th><th>Marks</th></tr>
<tr><td>2 a</td><td>M1 oxygen / air

M2 water (vapour) / moisture</td><td>ACCEPT O_2 but not O

ACCEPT H_2O
IGNORE steam</td><td>2</td></tr>
<tr><td>b</td><td>(hydrated) iron(III) oxide</td><td>ACCEPT iron oxide / ferric oxide
REJECT ferrous oxide and iron with other oxidation numbers
IGNORE iron trioxide

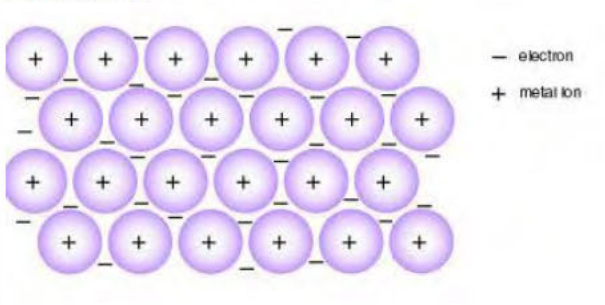
ACCEPT $Fe_2O_3(.xH_2O)$
IGNORE all other formulae

If both name and formula given mark name only</td><td>1</td></tr>
<tr><td>c</td><td><table><tr><td>M1 (galvanising)</td><td>bucket / car body / railway bridge</td></tr><tr><td>M2 (oiling)</td><td>bicycle chain / car engine</td></tr><tr><td>M3 (painting)</td><td>car body / railway bridge</td></tr></table></td><td>DO NOT AWARD M3 for car body/railway bridge if already scored for M1</td><td>3</td></tr>
<tr><td>d</td><td>M1 zinc corrodes/oxidises/reacts in preference to iron

M2 (because) zinc is more reactive than iron / zinc (atoms) lose electrons more readily (than do iron atoms)</td><td>REJECT zinc rusts
IGNORE reference to sacrificial protection
ACCEPT for M1 zinc atoms react with iron(II) ions

ACCEPT for M2 iron(II) ions are converted to iron atoms</td><td>2</td></tr>
</table>

Question number	Answer	Notes	Marks
3 a i	Ni/nickel has lost oxygen (atoms / ions) OR nickel <u>ions</u> gain electrons	Accept NiO/nickel oxide has lost oxygen Accept nickel(II) loses oxygen Ignore <u>it</u> loses oxygen / gains electrons Reject nickel oxide gains electrons Reject nickel loses oxygen molecules Reject any answer that does not refer to Ni or NiO	1
ii	M1 equilibrium (position) shifts to right M2 (forward) reaction is exothermic	Mark independently Ignore forward reaction favoured/occurs more readily/is faster / more product formed Accept heat / thermal energy given out Ignore just gives out energy Ignore because stage 3 is decomposition which is endothermic/takes in heat Ignore references to bond breaking and making and Le Chatelier's principle and different numbers of (gas) moles on each side and rate of reaction	2

Question number	Answer	Notes	Marks
3 b i	diagram showing: M1 minimum of 5 circles in regular pattern in 2 rows M2 +/2+ charges in each circle / appropriate key M3 some indication of electrons between ions / appropriate key	 Accept labelled as cations/positive ions not just ions Reject atoms / protons / nuclei eg e / e^- / – / (shaded) area labelled electrons Do not award M3 if electrons shown in circles more than half the size of the ions Ignore lines between circles Max 1 if negative ions shown Reject electrons shown in pairs between nickel particles for M3 Ignore intermolecular forces label Example:  	3

Question number	Answer	Notes	Marks
3 b ii	malleability (2 marks): M1 layers / sheets / planes / rows AND (positive) ions / atoms / particles M2 slide (over each other) conductivity (2 marks): M3 – delocalised electrons M4 – that flow (when a potential difference is applied)	 Reject molecules / protons / electrons M2 needs reference to either layers or equivalent OR ions/particles/atoms Allow OWTTE, eg slip / flow / shift / roll / move M2 DEP on mention of EITHER layers or equivalent OR mention of ions or equivalent Do not award M2 if protons / electrons / nuclei / molecules in place of ions, etc If reference to ionic bonding / covalent bonding / molecules / intermolecular forces, no M1 or M2 Accept sea of electrons Ignore free electrons Accept move / mobile in place of flow M4 DEP on mention of electrons Ignore reference to intermolecular forces for M3 and M4	4
			Total 10 marks

Question number				Answer	Notes	Marks
4	a	(i)	M1	Iron(III) oxide	Accept Iron oxide / ferric oxide Ignore formula whether right or wrong	1
		(ii)	M1	calcium carbonate	Ignore formula whether right or wrong	1
	b	(i)	M1	A		1
		(ii)	M1	E		1
		(iii)	M1	B		1
		(iv)	M1	C		1
	c		M1	slag	Accept calcium silicate Ignore formula	1
	d	(i)	M1	aluminium/it is more reactive than iron/carbon OR above iron/carbon in reactivity series OR cannot be reduced by/does not react with carbon (monoxide) OR cannot be displaced by carbon	Comparison with iron or carbon must be stated or implied, eg not just aluminium is (very/too) reactive Accept reverse argument for iron	1
		(ii)	M1	(cost of) electricity	Accept keeping electrolyte molten Accept high current Ignore energy Ignore references to electrode replacement	1

Question number				Answer	Notes	Marks
4	e		M1	electrode(s) / to conduct electricity	Accept cathode / anode	1
	f		M1	$Al^{3+} + 3e \rightarrow Al$	M1 for both aluminium formulae on correct sides of equation M2 for both oxygen formulae on correct sides of equation M3 for balancing both equations even if one or both reversed	3
			M2	$2O^{2-} \rightarrow O_2 + 4e$ / $2O^{2-} - 4e \rightarrow O_2$		
			M3			
					Accept in either order	
					Total 13 marks	

Question number	Expected answer	Accept	Reject	Marks
5 (a)(i)	Magnesium	Mg		1
(a)(ii)	It would react with the sulfuric acid / the clouds / the atmosphere / it will fizz	It is <u>too</u> reactive / <u>very</u> reactive / the <u>most</u> reactive Dissolve <u>in the (sulfuric) acid/ eq</u>	"reactive" by itself	1
(b)	it has low melting point / would melt / temperature on Venus is higher than the melting point of lead (ora) IGNORE heavy / dense	Lead would be a liquid Answer using data from table e.g. 328°C is lower than temp on Venus		1
(c)	Titanium Any two from: • it has a low density / is lightweight • it has a high melting point / wouldn't melt / temperature on Venus is lower than the melting point of titanium (ora) • does not react with sulfuric acid / the clouds / the atmosphere / it will not fizz	Ti The <u>probe</u> would be light Remains solid **Reason marks can be scored for copper (density mark would need to be compared to lead)**	Light on its own / light <u>in</u> weight on its own	1 1 1

Total 6 Marks

Question number				Answer	Notes	Marks
6	a	i		tungsten(VI) oxide / tungsten trioxide	Accept tungsten oxide Reject tungsten oxide with other oxidation numbers or prefixes such as mono- and di-	1
		ii		**(1)** (1) 3	Accept multiples and fractions	1
		iii		loss of oxygen (by it / tungsten / tungsten oxide)	Accept decrease in oxidation number of tungsten Accept tungsten <u>ions</u> gain electrons	1
	b		M1	Ca W O <u>13.9</u> <u>63.9</u> <u>22.2</u> 40 184 16 OR 0.348 0.347 1.39	Apply ECF 0/3 for use of any atomic numbers / division wrong way round / multiplication If division by 32 instead of 16 for O, then no M1, but M2 and M3 can score by ECF ($CaWO_2$) If any transcription error (eg 69.3 in place of 63.9), then no M1, but M2 and M3 can score by ECF	1
			M2	<u>0.348</u> <u>0.347</u> <u>1.39</u> 0.347 0.347 0.347 OR 1 : 1 : 4		1
			M3	$CaWO_4$	Accept elements in any order Correct final answer scores 3	1

Question number		Answer	Notes	Marks
6 c	i	$\frac{59.6 \times 184}{298}$	Award 1 for $n(WF_6) = 0.2$ mol and any sight of 0.2	1
M1	M2	36.8 (g)	No ECF from incorrect expression except for transcription error - eg using 289 instead of 29 ECF from incorrect number of moles	1
			Award 2 for correct final answer	
ii	M1	$\frac{47.5 \times 100}{52.0}$		1
	M2	91.3 (%)	Accept any answer in range 91 - 91.4 Do not penalise excessive numbers of dp	1
			Award 2 for correct final answer	
TOTAL				14