

Question number	Answer	Marks	Guidance
1 (a)	By definition	1	allow 'set to this value'
1 (b)	1.23 V	1	Allow + or -
1 (c)	Pt H <sub>2</sub> (g) OH <sup>-</sup> (aq),H <sub>2</sub> O(l)  O <sub>2</sub> (g) H <sub>2</sub> O(l),OH <sup>-</sup> (aq) Pt  Correct but with Pt missing  Includes Pt with correct representation	1  1	H <sub>2</sub> O not essential, allow reverse order
1 (d)	Uses O <sub>2</sub> + 2H <sub>2</sub> O + 4e <sup>-</sup> → 4OH <sup>-</sup> And (2x) 2OH <sup>-</sup> + H <sub>2</sub> → 2H <sub>2</sub> O + 2e <sup>-</sup>  2H <sub>2</sub> + O <sub>2</sub> → 2H <sub>2</sub> O	1  1	
1 (e)	Increases the surface area (so reaction faster)	1	
1 (f)	Overall reaction is the same (2H <sub>2</sub> + O <sub>2</sub> → 2H <sub>2</sub> O)	1	Or shows e.m.f. is the same
1 (g)	Hydrogen and oxygen supplied continuously  <b>OR</b>  Can be operated without stopping to recharge	1	Or can be refuelled quickly Allow any one mark
1 (h)	Hydrogen may need to be made using an energy source that is not 'carbon neutral'	1	
2 (a)	Zn	1	This is always the species with the most negative E value (it is oxidised itself).
2 (b) (i)	Fe <sup>2+</sup>	1	
2 (b) (ii)	Cl <sub>2</sub>	1	
2 (c) (i)	The standard electrode potential: 1.25 V	1	Remember that: E <sub>cell</sub> = E <sub>right</sub> - E <sub>left</sub>
2 (c) (ii)	Tl <sup>3+</sup> + 2Fe <sup>2+</sup> → 2Fe <sup>3+</sup> + Tl <sup>+</sup>	2	One mark for a balanced equation and one for the correct direction.
3 (a)	Pt H <sub>2</sub>  H <sup>+</sup>   Fe <sup>2+</sup>  Fe  Note, allow one mark only for correct symbol in reverse: Fe Fe <sup>2+</sup>   H <sup>+</sup>  H <sub>2</sub>  Pt	2	Allow 1 for correct order of symbols but lose second mark for a wrong phase boundary(s) / Pt missing / extra Pt on RHS, additional phase boundary Allow dashed lines for salt bridge Ignore state symbols Ignore 2 if used before H <sup>+</sup>

3 (b)	Electron donor	1	Allow (species that) loses electrons Do not allow reference to electron pairs
3 (c)	Cl <sub>2</sub> / chlorine	1	If M1 blank or incorrect cannot score M2
	(Species on RHS / electron donor) has most positive / largest E <sub>o</sub> / has highest potential	1	Do not allow reference to e.m.f. or E(cell)
3 (d) (i)	Cl / chlorine	1	
3 (d) (ii)	Chlorine +1 to chlorine 0	1	CE if chlorine not identified in 5(d)(i) Allow chlorine +1 to chlorine -1 (in Cl <sup>-</sup> ) Allow oxidation state decreases by one OR two Allow oxidation state changes by -1 OR -2
3 (e)	4HOCl + 4H <sup>+</sup> + 4OH <sup>-</sup> → 2Cl <sub>2</sub> + O <sub>2</sub> + 6H <sub>2</sub> O OR 4HOCl → 2Cl <sub>2</sub> + O <sub>2</sub> + 2H <sub>2</sub> O	2	Allow one mark for any incorrect equation that shows HOCl → Cl <sub>2</sub> + O <sub>2</sub> Allow multiples Ignore state symbols Penalise one mark for uncancelled or uncombined species (e.g., H <sub>2</sub> O + H <sub>2</sub> O instead of 2H <sub>2</sub> O)
3 (f)	e.m.f. = 0.40 - (-1.25) = 1.65 V / +1.65 V	1	Allow -1.65 V