

5.3 questions ms

1.	(a)	gains electrons (1)	1	[1]	
2.	(a)	(i) Fe^{2+}	1		
		(ii) F_2O	1		
		(iii) Fe^{2+}	1		
		Cl^-	1		
	<i>Use list principle if more than two answers</i>				
	(b)	(i)	e.m.f. = $E(\text{rhs}) - E(\text{lhs})$	1	
			= $1.52 - 0.77 = 0.75$ <i>(0.75 scores first mark also)</i>	1	
		(ii)	$\text{Fe}^{2+} \rightarrow \text{Fe}^{3+} + \text{e}^-$	1	
		(iii)	Decrease <i>(Increase is CE, no further marks)</i>	1	
		Equilibrium (or reaction) shifts to R <i>(or L if refers to half equation in table)</i> <i>(or in favour of more Fe^{3+})</i> <i>(or more Fe^{3+} formed)</i> <i>(or more electrons formed)</i>		1	
Electrode potential (for $\text{Fe}^{3+}/\text{Fe}^{2+}$) less positive (or decreases)		1	[10]		
3.	(a)	Fe^{2+} or Fe(II)	1		
		(b)	(i) 6 or (VI)	1	
	(ii) 3 or (III)		1		
	(c)	(i) 0.5	1		
		(ii)	$2\text{Mn}^{2+} + 8\text{H}_2\text{O} + 5\text{S}_2\text{O}_8^{2-} \rightarrow 10\text{SO}_4^{2-} + 2\text{MnO}_4^- + 16\text{H}^+$ Both SO_4^{2-} and MnO_4^- on right Balanced	1 1	[13]
	4.	(a)	(i) 0.60 V	1	
(ii) $\text{H}_2\text{O} + \text{H}_2\text{SO}_3 \rightarrow \text{SO}_4^{2-} + 4\text{H}^+ + 2\text{e}^-$			1		

(b)	(i)	$2\text{IO}_3^- + 2\text{H}^+ 5\text{H}_2\text{O}_2 \rightarrow 5\text{O}_2 + \text{I}_2 + 6\text{H}_2\text{O}$	Species	1
			Balanced	1
	(ii)	The concentration of the ions change or are no longer standard or the e.m.f is determined when no current flows		1
	(iii)	Unchanged		1
	(iv)	Increased		1
		Equilibrium IO_3^-/I_2 displaced to the right		1
		Electrons more readily accepted or more reduction occurs or electrode becomes more positive (Q o L)		1
(c)		VO_2^+		1
		5 or V		1
		$\text{V}^{2+} + 2\text{H}_2\text{O} \rightarrow \text{VO}_2^+ + 4\text{H}^+ 3\text{e}^-$		1

[12]

5.	(a)	Oxidising agents take/remove/accept/gain electrons (1)		
		<i>Not 'electron pair'</i>		1
(b)	(i)	<u>$\text{Cl}_2(\text{g})$ at 100 kPa / 1 bar / 1atm (1)</u> <u>$[\text{Cl}^-] = 1$ molar / 1M (1)</u> <i>Allow 1M HCl</i> Temperature = 298K / 25°C (1) Do not use list principle for other incorrect species		
	(ii)	Lower $[\text{Cl}^-]$ or reduce temperature Increase pressure or concentration of Cl_2 (1) <i>CE if change incorrect</i> Equilibrium displace to right (1) or if reduced temperature given, reaction exothermic Allow a correct explanation when no change given		5
(c)	(i)	Cl^- (1)		
	(ii)	Fe^{3+} ; (1) NO_3^- (1) <i>Penalise by list principle</i> <i>Note: H^+ is incorrect</i>		
	(iii)	V^{2+} , (1) Fe^{2+} (1) <i>Penalise by list principle</i>		5

[11]

6.	(a)	(Standard) hydrogen (electrode) (1)		1
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- (b) (i) To allow transfer of electrons / provide a reaction surface (1)
 (ii) 298 K (1)
Both $\text{Fe}^{3+}(\text{aq})$ and $\text{Fe}^{2+}(\text{aq})$ have a concentration of 1 mol dm^{-3} (1) (QoL)
 OR $[\text{H}^+] = 1 \text{ mol dm}^{-3}$
NOT zero current or 100 kPa

3

- (c) +1.34 V (1)
 $2 \text{MnO}_4^- + 5 \text{H}_2\text{SO}_3 \rightarrow 2 \text{Mn}^{2+} + 5 \text{SO}_4^{2-} + 3 \text{H}_2\text{O} + 4 \text{H}^+$
 Correct species / order (1)
 Balanced and cancelled (1)
Allow one for $2 \text{MnO}_4^- + 5 \text{H}_2\text{SO}_3 \rightarrow 2 \text{Mn}^{2+} + 5 \text{SO}_4^{2-}$

3

- (d) (i) $\text{Ce}^{4+}(\text{aq})$ (1)
 (ii) $\text{VO}_2^+(\text{aq})$ (1); Cl_2 (1)
Penalise additional answers to zero

3

- (e) $\text{Pt} | \text{Fe}^{2+}(\text{aq}), \text{Fe}^{3+}(\text{aq}) || \text{Ce}^{4+}(\text{aq}), \text{Ce}^{3+}(\text{aq}) | \text{Pt}$
 Correct species (1)
 Correct order (1)
Deduct one mark for each error

2

[12]

7. (a) Cell e.m.f.: 1.93 (v) CE if negative value given (1)
 Half equation: $\text{Mg} \rightarrow \text{Mg}^{2+} + 2 \text{e}^-$ (1)
 or \rightleftharpoons
Ignore state symbols
Mark on after an AE

2

- (b) Change in e.m.f.: increases (1)
Mark on even if incorrect

Explanation: Equilibrium displaced to Mg^{2+} or to the left (1)
cell reaction or overall reaction goes to the right
Electrode is more negative or E decreases
or gives more electron
or forms more Mg^{2+} ions
Mark separately

3

(c) Cell e.m.f. : -0.84 (V) (1)

Explanation: Fe is giving electrons **or** forming Fe^{2+}
or reaction goes in the reverse direction (1)

Mark on after AE

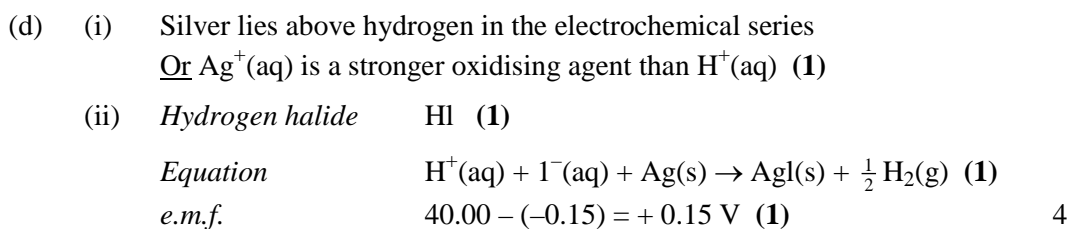
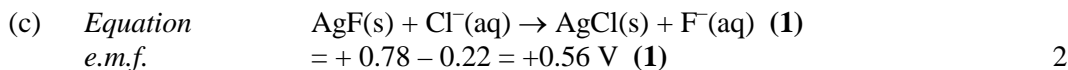
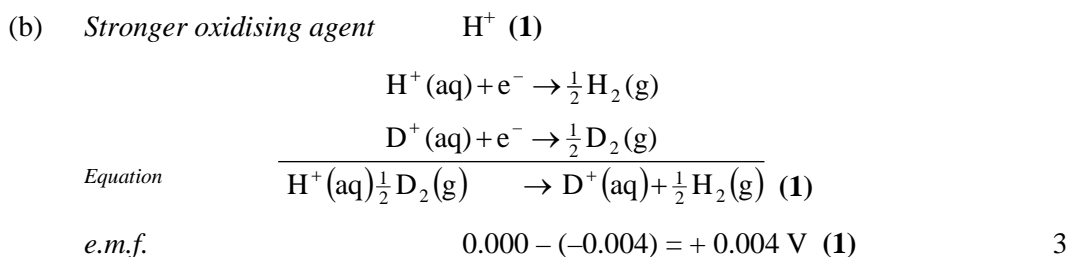
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**N.B. In (a) and (c) mark on if no value given,
but CE in both (a) and (c) if e.m.f. = 0**

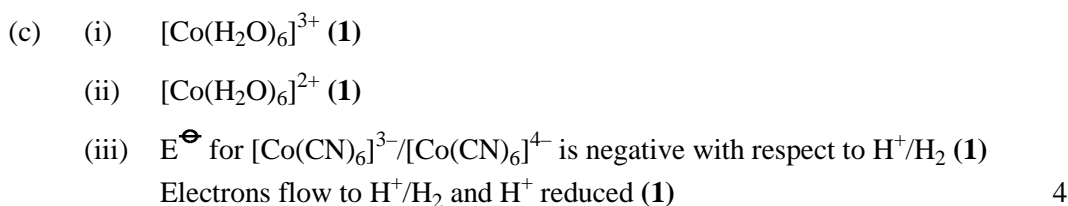
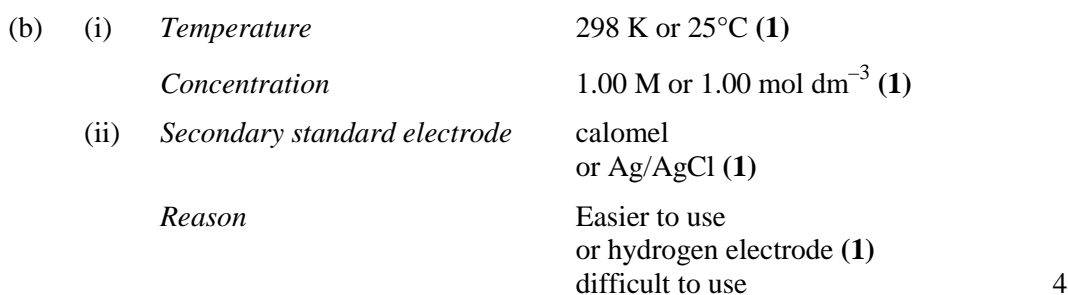
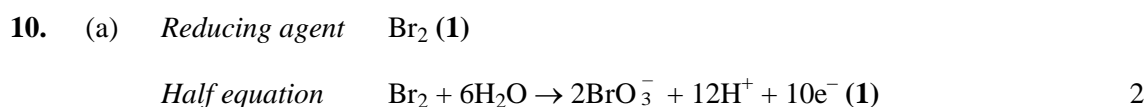
[7]

8. (a) (i) (standard) hydrogen (electrode) / hydrogen half cell **not**
hydrogen cell (1)
reference electrode / electrode to which others are compared (1) 2
- (ii) $0.00(\text{V}) / 0 / \text{zero}$ (1) 1
- (b) (i) $\text{emf} = -0.14 - (-0.25)$
 $= +0.11 \text{ V} / \text{allow } 0.11\text{V}$ **not** -0.11V (1) 1
- (ii) electrode D / $\text{Sn}^{2+} / \text{Sn} / \text{tin} / \text{right hand electrode}$ (1) 1
- (iii) $\text{Ni} + \text{Sn}^{2+} \rightarrow \text{Ni}^{2+} + \text{Sn}$ (ignore state symbols) (1) 1
- (c) (i) $\text{e.m.f} = -0.44 - (-0.14) = -0.30$ (V) / emf for cell is $-$ ve
comparison of standard electrode potentials (1)
 $+ve$ e.m.f for feasible reaction / tin is a weaker reducing agent
 \therefore would not occur (1)
if correct ΔG argument used, allow both marks 2
- (ii) manganese will decrease in size / disappear / eaten away / dissolves /
solution turns (pale) pink (1)
effervescence / bubbles (of colourless gas) / fizzing **not** gas
given off (1)
reaction likely to occur is $\text{Mn} + (2)\text{H}^+ \rightarrow \text{Mn}^{2+} + \text{H}_2$ (1)
or the same ideas expressed in words
 $+ve$ e.m.f. / $+1.18 \text{ V} / \text{Mn}$ is strong reducing agent / has
large $-ve E^{\ominus}$ (1)
(**not** just Mn is more reactive) 4
9. (a) oxidising agent accepts electrons (1) 1

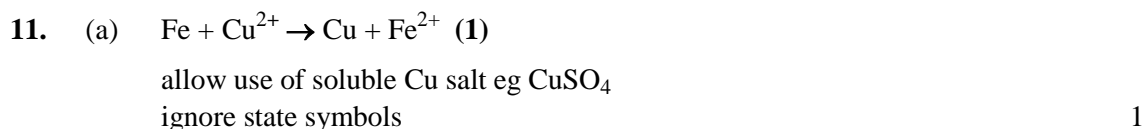
[12]



[10]



[10]



- (b) (i) $\text{Fe(s)} \mid \text{Fe}^{2+}(\text{aq}) \parallel \text{Cu}^{2+}(\text{aq}) \mid \text{Cu(s)}$
 junctions correct **(1)**
 ignore state symbols
 allow alternative symbols for salt bridge
 allow if junctions are correct but order is wrong providing
 metals on each side of salt bridge are the same ie $\text{Fe} \mid \text{Fe}^{2+}$ not $\text{Fe} \mid \text{Cu}^{2+}$
 order of species correct **(1)**
 do not give this mark if cell reversed 2
- (ii) e.m.f. = $+0.34 - (-0.44)$
 = $+0.78 \text{ V}$ **(1)**
 must have + sign
 allow -0.78 (V) if reverse cell given in (i) 1
- (c) (i) e.m.f for cell must be positive for reaction to occur / be feasible / **(1)**
 spontaneous **or** ΔG must be negative)
 $\text{Cu(s)} + 2\text{H}^+ \rightarrow \text{products}$
 e.m.f = $-0.34 \therefore$ won't happen /
 sensible comparison of the magnitude of E^\ominus for the electrodes
 eg 'Cu electrode more positive than hydrogen electrode \therefore won't work' **(1)**
 $\text{Cu(s)} + \text{NO}_3^- + 4\text{H}^+ \rightarrow \text{products}$
 e.m.f = $+0.96 - 0.34 = +0.62 \therefore$ can occur /
 similar sensible comparison **(1)** 3
- (ii) $3\text{Cu} + 2\text{NO}_3^- + 8\text{H}^+ \rightarrow 3\text{Cu}^{2+} + 2\text{NO} + 4\text{H}_2\text{O}$
 species **(1)**
 balanced – this mark dependent on first mark **(1)** 2
- (d) (i) $2\text{Fe} + \text{O}_2 + 2\text{H}_2\text{O} \rightarrow 2\text{Fe}^{2+} + 4\text{OH}^-$ **or** 2Fe(OH)_2 **(1)**
 ignore state symbols 1
- (ii) anode (only give this mark if explanation attempted) **(1)**
 Fe loses e^- (\therefore negative pole) / oxidation occurs **(1)**
 this mark dependent on anode for first mark 2
- (iii) e.m.f. = $+0.06 \text{ V}$ or reference to E^\ominus for electrodes **(1)**
 reasoned argument **(1)**
 eg positive \therefore should occur / difference so small that reaction unlikely 2

[14]

12. (a) *Name* hydrogen electrode (1)
Conditions 1 M H⁺(aq) or 1 M HCl(aq) or 0.5 M H₂SO₄(aq) (1)
 298 K (1)
 Hydrogen gas at 1 bar or 100 kPa (1) 4

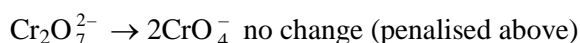
- (b) (i) E^{\ominus} value 1.21 v (1)
Equation S₂O₈²⁻ + 2Ag → 2SO₄²⁻ + 2Ag⁺ [2]
 (ii) *Change, if any, in electrode potential* Less positive or decrease (1)
Explanation Equilibrium displaced to the left (1)
 More electrons released (1) 6

[10]

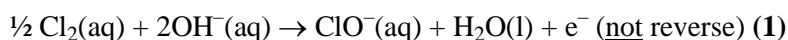
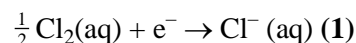
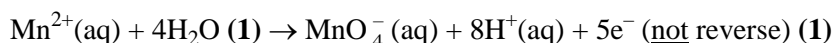
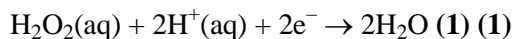
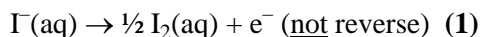
13. (i) Oxidising agents

Cu²⁺(aq) (1), H₂O₂(aq) (1), Cl₂(aq) (1) (3)
 if Cr₂O₇²⁻ (aq) is included, deduct one mark

- (ii) 2I⁻ → I₂ I(-1) → I(0) (1)



- (iii) Cu²⁺(aq) + I⁻(aq) + e⁻ → Cu⁺(s) (1)



Penalise missing or incorrect state symbols once only

(12 MAX)

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[11]