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	
			Use list principle if more than two answers		
	(b)	(i)	e.m.f. = E(rhs) – E(lhs)	1	
			= 1.52 – 0.77 = 0.75		
			(0.75 scores first mark also)	1	
		(ii)	$Fe^{2+} \rightarrow Fe^{3+} + e^-$	1	
		(iii)	Decrease	1	
			(Increase is CE, no further marks)		
			Equilibrium (or reaction) shifts to R	1	
			(or L if refers to half equation in table)		
			(or in favour of more Fe^{3+})		
			(or more Fe^{3+} formed)		
			(or more electrons formed)		
			Electrode potential (for Fe^{3+}/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)	$2Mn^{2+} + 8H_2O + 5S_2O_8^{2-} \rightarrow 10SO_4^{2-} + 2MnO_4^- + 16H^+$		
			Both SO_4^{2-} and MnO_4^- on right	1	
			Balanced	1	
					[13]
4.	(a)	(i)	0.60 V	1	
		(ii)	$H_2O + H_2SO_3 \rightarrow SO_4^{2} + 4H^+ + 2e^-$	1	

(b) (i) $2IO_3^- + 2H^+ 5H_2O_2 \rightarrow 5O_2 + I_2 + 6H_2O$ 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

$V^{2+} + 2H_2O \rightarrow VO_2^+ + 4H^+ \; 3e^-$ 1

[12]

5. (a) Oxidising agents take/remove/accept/gain electrons **(1)**

Not 'electron pair' 1

(b) (i) <u>Cl_2(g) at 100 kPa / 1 bar / 1atm</u> **(1)**

<u>[Cl^-] = 1 molar / 1M</u> **(1)**

Allow 1M HCl

Temperature = 298K / 25°C **(1)**

Do not use list principle for other incorrect species

(ii) Lower [Cl^-] or reduce temperature

Increase pressure or concentration of Cl_2 **(1)**

CE if change incorrect

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)**

Penalise by list principle

Note: H^+ is incorrect

(iii) V^{2+}, **(1)** Fe^{2+} **(1)**

Penalise by list principle 5

[11]

6. (a) (Standard) hydrogen (electrode) **(1)** 1

(b) (i) To allow transfer of electrons / provide a reaction surface **(1)**

(ii) 298 K **(1)**
<u>Both F^{3+} (aq) and Fe^{2+} (aq)</u> have a concentration of 1 mol dm^{-3} **(1)** (QoL)
OR $[H^+]$ = 1 mol dm^{-3}
NOT zero current or 100 kPa

3

(c) +1.34 V **(1)**
$2\ MnO_4^- + 5\ H_2SO_3 \rightarrow 2\ Mn^{2+} + 5\ SO_4^{2-} + 3\ H_2O + 4\ H^+$
Correct species / order **(1)**
Balanced and cancelled **(1)**
Allow one for $2\ MnO_4^- + 5\ H_2SO_3 \rightarrow 2\ Mn^{2+} + 5\ SO_4^{2-}$

3

(d) (i) Ce^{4+} (aq) **(1)**

(ii) VO_2^+ (aq) **(1)**; Cl_2 **(1)**
Penalise additional answers to zero

3

(e) Pt | Fe^{2+} (aq), Fe^{3+} (aq) || Ce^{4+}(aq), Ce^{3+} (aq) | 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: $Mg \rightarrow Mg^{2+} + 2\ e^-$ **(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

2

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(V) / 0 / zero **(1)** 1

(b) (i) emf = –0. 14 –(–0.25)
= + 0.11 V / allow 0.11V **not** – 0.11V **(1)** 1

(ii) electrode D / Sn^{2+} /Sn /tin / right hand electrode **(1)** 1

(iii) $Ni + Sn^{2+} \rightarrow Ni^{2+} + Sn$ (ignore state symbols) **(1)** 1

(c) (i) 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 $Mn + (2)H^+ \rightarrow Mn^{2+} + H_2$ **(1)**
or the same ideas expressed in words

+ve e.m.f. / +1.18 V / Mn is strong reducing agent / has large – ve $E^{(\ominus)}$ **(1)**
(**not** just Mn is more reactive) 4

[12]

9. (a) oxidising agent <u>accepts</u> electrons **(1)** 1

(b) *Stronger oxidising agent* H^+ **(1)**

$$H^+(aq) + e^- \rightarrow \tfrac{1}{2}H_2(g)$$
$$D^+(aq) + e^- \rightarrow \tfrac{1}{2}D_2(g)$$

Equation $H^+(aq)\tfrac{1}{2}D_2(g) \rightarrow D^+(aq) + \tfrac{1}{2}H_2(g)$ **(1)**

e.m.f. 0.000 – (–0.004) = + 0.004 V **(1)** 3

(c) *Equation* $AgF(s) + Cl^-(aq) \rightarrow AgCl(s) + F^-(aq)$ **(1)**
e.m.f. = + 0.78 – 0.22 = +0.56 V **(1)** 2

(d) (i) Silver lies above hydrogen in the electrochemical series
<u>Or</u> $Ag^+(aq)$ is a stronger oxidising agent than $H^+(aq)$ **(1)**

(ii) *Hydrogen halide* Hl **(1)**

Equation $H^+(aq) + 1^-(aq) + Ag(s) \rightarrow Agl(s) + \tfrac{1}{2}H_2(g)$ **(1)**
e.m.f. 40.00 – (–0.15) = + 0.15 V **(1)** 4

[10]

10. (a) *Reducing agent* Br_2 **(1)**

Half equation $Br_2 + 6H_2O \rightarrow 2BrO_3^- + 12H^+ + 10e^-$ **(1)** 2

(b) (i) *Temperature* 298 K or 25°C **(1)**

Concentration 1.00 M or 1.00 mol dm^{-3} **(1)**

(ii) *Secondary standard electrode* calomel
or Ag/AgCl **(1)**

Reason Easier to use
or hydrogen electrode **(1)**
difficult to use 4

(c) (i) $[Co(H_2O)_6]^{3+}$ **(1)**

(ii) $[Co(H_2O)_6]^{2+}$ **(1)**

(iii) $E^{\ominus}$ for $[Co(CN)_6]^{3-}/[Co(CN)_6]^{4-}$ is negative with respect to H^+/H_2 **(1)**
Electrons flow to H^+/H_2 and H^+ reduced **(1)** 4

[10]

11. (a) $Fe + Cu^{2+} \rightarrow Cu + Fe^{2+}$ **(1)**

allow use of soluble Cu salt eg $CuSO_4$
ignore state symbols 1

(b) (i) Fe(s) | Fe^{2+}(aq) ¦¦ Cu^{2+}(aq) | 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 Fe | Fe^{2+} not Fe | 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 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)

Cu(s) + $2H^+ \rightarrow$ products
e.m.f = – 0.34 ∴ won't happen /
sensible comparison of the magnitude of $E^{\ominus}$ for the electrodes
eg 'Cu electrode more positive than hydrogen electrode ∴ won't work' **(1)**

Cu(s) + NO_3^- + $4H^+ \rightarrow$ products
e.m.f = + 0.96 – 0.34 = +0.62 ∴ can occur /
similar sensible comparison **(1)** 3

(ii) $3Cu + 2\ NO_3^- + 8H^+ \rightarrow 3Cu^{2+} + 2NO + 4H_2O$

species **(1)**
balanced – this mark dependent on first mark **(1)** 2

(d) (i) $2Fe + O_2 + 2H_2O \rightarrow 2Fe^{2+} + 4OH^-$ **or** $2Fe(OH)_2$ **(1)**
ignore state symbols 1

(ii) anode (only give this mark if explanation attempted) **(1)**

Fe loses e^- (∴ negative pole) / oxidation occurs **(1)**
this mark dependent on anode for first mark 2

(iii) e.m.f. = + 0.06 V or reference to $E^{\ominus}$ for electrodes **(1)**

reasoned argument **(1)**
eg positive ∴ 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 H_2SO_4(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 $S_2O_8^{2-} + 2Ag \rightarrow 2SO_4^{2-} + 2Ag^+$ **[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) <u>Oxidising agents</u>

Cu^{2+}(aq) **(1)**, H_2O_2(aq) **(1)**, $C1_2$(aq) **(1)** **(3)**
if $Cr_2O_7^{2-}$ (aq) is included, deduct one mark

(ii) $2I^- \rightarrow I_2$ $I(-1) \rightarrow I(0)$ **(1)**

$Mn^{2+} \rightarrow MnO_4^-$ $Mn(II) \rightarrow Mn(VII)$ **(1)**

$Cr_2O_7^{2-} \rightarrow 2CrO_4^-$ no change (penalised above)

$Cl_2 \rightarrow ClO^-$ $Cl(0) \rightarrow Cl(1)$ **(1)**

(iii) Cu^2(aq) + I^-(aq) + $e^- \rightarrow Cu^+$(s) **(1)**

I^-(aq) $\rightarrow$ ½ I_2(aq) + e^- (<u>not</u> reverse) **(1)**

H_2O_2(aq) + $2H^+$(aq) + $2e^- \rightarrow 2H_2O$ **(1)** **(1)**

Mn^{2+}(aq) + $4H_2O$ **(1)** $\rightarrow MnO_4^-$(aq) + $8H^+$(aq) + $5e^-$ (<u>not</u> reverse) **(1)**

$\frac{1}{2}Cl_2$(aq) + $e^- \rightarrow Cl^-$ (aq) **(1)**

½ Cl_2(aq) + $2OH^-$(aq) $\rightarrow ClO^-$(aq) + H_2O(l) + e^- (<u>not</u> reverse) **(1)**

Penalise missing or incorrect state symbols <u>once</u> only

(12 MAX)

11

[11]