TOPIC 13 HW MS

1. (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 (QoL) 1

(c) VO_2^+ 1

5 or V 1

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

[12]

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

(b) (i) To allow transfer of electrons / provide a reaction surface **(1)**
(ii) 298 K **(1)**
Both Fe^{3+} (aq) and Fe^{2+} (aq) 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]

3. (a) Pt|H_2|H^+||Fe^{2+}|Fe
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
Note, allow one mark only for correct symbol in reverse:
Fe|Fe^{2+}||H^+|H_2|Pt
Allow dashed lines for salt bridge
Ignore state symbols
Ignore 2 if used before H^+

2

(b) Electron donor
Allow (species that) loses electrons
Do not allow reference to electron pairs

1

(c) Cl_2 / chlorine
If M1 blank or incorrect cannot score M2

1

(Species on RHS / electron donor) has most positive / largest $E^\ominus$ / has highest potential
Do not allow reference to e.m.f. or E(cell)

1

(d) (i) Cl / chlorine

1

(ii) Chlorine +1 to chlorine 0
CE if chlorine not identified in part (i)
Allow chlorine +1 to chlorine –1 (in Cl^-)
Allow oxidation state decreases by one OR two
Allow oxidation state changes by –1 OR –2

1

(e) $4HOCl + 4H^+ + 4OH^- \rightarrow 2Cl_2 + O_2 + 6H_2O$
OR
$4HOCl \rightarrow 2Cl_2 + O_2 + 2H_2O$
Allow one mark for any incorrect equation that shows
$HOCl \rightarrow Cl_2 + O_2$
Allow multiples
Ignore state symbols
Penalise one mark for uncancelled or uncombined species (eg $H_2O + H_2O$ instead of $2H_2O$)

2

(f) (i) e.m.f. = 0.40 – (–1.25) = <u>1.65</u> (V) / <u>+1.65</u> (V)

Allow –1.65 (V)

1

(ii) $2Zn + O_2 \rightarrow 2ZnO$

Allow multiples
Ignore state symbols
Do not allow uncancelled species
If more than one equation given, choose the best

1

(iii) **A** / stainless lid

If M1 incorrect or blank CE=0

1

<u>O_2</u> (electrode) has a more positive $E^\ominus$ / <u>oxygen</u> (electrode) requires / gains electrons from external circuit

Or reference to the overall equation and a link to electrons going into A
Allow oxygen is reduced and reduction occurs at the positive electrode

OR <u>Zinc</u> (electrode) has more negative $E^\ominus$

Do not allow reference to e.m.f. or E(cell)

1

(iv) (Cell) reaction(s) cannot be reversed / zinc oxide cannot be reduced to zinc by passing a current through it / zinc cannot be regenerated

Allow danger from production of gas / oxygen produced / hydrogen produced

1

[14]

4. (a) H_2O_2

Ignore state symbols

1

(b) $E^\ominus$ Cl_2/Cl^- > $E^\ominus$ O_2/H_2O

Allow potential for chlorine/Cl_2 greater than for oxygen/O_2
Allow 1.36 > 1.23 / E cell = 0.13

1

$Cl_2 + H_2O \rightarrow 2Cl^- + 1/2O_2 + 2H^+$

Allow multiples
Allow + HCl

1

(c) Activation energy is high / light/UV provides the activation energy / light breaks
chlorine molecule / Cl–Cl bond

If light used to break Cl–Cl bond award 1 mark and ignore product e.g. Cl^-

1

(d) <u>O</u> <u>(–1)</u> (in H_2O_2)

Must give oxidation state of O in H_2O_2= –1

1

Changes to <u>O(–2)</u> (in water)

Must give oxidation state of O in water = –2
CE = 0/2 if refers to oxidation state of H changing

1

(e) $E^\ominus$ H_2O_2/H_2O > $E^\ominus$ O_2/H_2O_2
Allow stated in words
Allow 1.77 > 0.68 / E cell = 1.09

1

$2H_2O_2 \rightarrow O_2 + 2H_2O$
Allow multiples
H^+ and e^- must be cancelled

1

[8]

5. (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
(Increase is CE, no further marks)

1

Equilibrium (or reaction) shifts to R
(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)

1

Electrode potential (for Fe^{3+}/Fe^{2+}) less positive (or decreases)

1

[10]

6. (a) (i) Co/Cobalt
If Co or Cobalt not given CE = 0
ignore case in symbol for Co

1

(+) 4

1

(+) 3
Allow 4 and 3 in either order

1

(ii) $Li \rightarrow Li^+ + e^-$
Ignore state symbols

Allow e without -ve sign
Do not allow equilibrium sign

1

(iii) Platinum is a conductor

1

(Platinum is) unreactive/inert

Ignore mention of surface area or catalyst
Allow 2 marks if two properties given on one answer line
Apply list principle to contradictions/wrong answers
Do not allow platinum resists corrosion

1

(iv) Li reacts with water/forms lithium hydroxide

Allow water breaks down (or is electrolysed) on re-charge

1

(b) (i) Pt|SO_3^{2-} (aq), SO_4^{2-} (aq)||ClO_3^- (aq), Cl^-(aq)|Pt

State symbols an ',' not necessary
Allow | in place of ',' NOT ',' in place of |
Ignore H^+ and H_2O
Deduct one mark for each mistake (e.g. Pt missed twice counts as two mistakes)
Allow reverse order for whole cell
Pt | Cl^-, ClO_3^- || SO_4^{2-}, SO_3^{2-} | Pt

2

(ii) $ClO_3^- + 3SO_3^{2-} \rightarrow Cl^- + 3SO_4^{2-}$

1

Oxidising agent ClO_3^-

1

Reducing agent SO_3^{2-}

1

[12]

7. (a) By definition

allow 'set to this value'

1

(b) 1.23 V

Allow + or –

1

(c) Pt|H_2(g)|OH^-(aq),H_2O(l)||O_2(g)|H_2O(l),OH^-(aq)|Pt

H_2O not essential, allow reverse order

Correct but with Pt missing

1

Includes Pt with correct representation

1

(d) Uses $O_2 + 2H_2O + 4e^- \rightarrow 4OH^-$

And (2×) $2OH^- + H_2 \rightarrow 2H_2O + 2e^-$

1

$2H_2 + O_2 \rightarrow 2H_2O$

1

(e) Increases the surface area (so reaction faster)

1

(f) Overall reaction is the same ($2H_2 + O_2 \rightarrow 2H_2O$)

Or shows e.m.f. is the same

1

(g) Hydrogen and oxygen supplied continuously

OR

Can be operated without stopping to recharge

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

[10]

8. D

[1]

9. D

[1]