M1. (a) Hydrogen/H_2 gas/bubbles

1

$1.0\ mol\ dm^{-3}$ HCl/H^+

1

At 298K and 100kPa

Allow 1 bar instead of 100 kPa
Do not allow 1 atm

1

Pt (electrode)

1

(b) $Li^+ + MnO_2 + e^- \rightarrow LiMnO_2$

Ignore state symbols

1

–0.13(V)

1

(c) Fe^{3+} ions reduced to Fe^{2+}

Can score from equation/scheme

1

Because $E(Fe^{3+}(/Fe^{2+})) > E(H^+/H_2)/E$(hydrogen)

Allow emf/E_{cell} +ve/0.77V
Allow Fe^{3+} better oxidising agent than H^+
Allow H_2 better reducing agent than Fe^{2+}
Only award this explanation mark if previous mark given

1

(d) Moles $Cr_2O_7^{2-}$ = 23.7 × 0.01/1000 = 2.37×10^{-4}

1

1 mol $Cr_2O_7^{2-}$ reacts with 6 mol Fe^{2+} so moles
Fe^{2+} in 25 cm^3 = 6 × 2.37 × 10^{-4} = 1.422 × 10^{-3}

1

M1 × 6

Moles Fe^{2+} in 250 cm^3 = 1.422 × 10^{-2}

M2 × 10 or M4/10

1

Original moles Fe^{2+} = 10.00/277.9 = 0.0360

Independent mark

1

Moles Fe^{2+} oxidised = 0.0360 – 0.0142 = 0.0218

M4 – M3

1

% oxidised = (0.0218 × 100)/0.0360 = 60.5%

(M5 × 100)/M4
Allow 60 to 61
Note Max 3 if mol ratio for M2 wrong
eg 1:5 gives 67.1%
1:1 gives 93.4%
Note also, 39.5% (39-40) scores M1, M2, M3 and M4 (4 marks)

1

[14]

M2. D

[1]

M3. (a) 1.4 V

Allow + or –

1

(b) $2NiO(OH) + 2H_2O + Cd \rightarrow 2Ni(OH)_2 + Cd(OH)_2$

Mark for species, Deduct a mark for additional species (eg OH^-) but allow balance mark

1

Balanced

If equation is reversed CE=0

1

(c) NiO(OH) or Ni(III) or nickel

1

+3

Allow conseq on wrong species

1

[5]

M4. (a) (i) HgO

1

(ii) $Hg^{2+} + 2e^- \rightarrow Hg$

1

(iii) $2H_2O + SO_2 \rightarrow H_2SO_4 + 2e^-$ etc

1

(iv) $Cl_2 + 2e^- \rightarrow 2Cl^-$

1

(b) (i) Vanadium species: VO_2^+

1

Oxidation state: 5

1

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

1

(ii) Cell e.m.f 0.06 V

1

Change in e.m.f , Increases

1

More Fe^{3+} ions to accept electrons

1

Fe^{3+}/Fe^{2+} electrode becomes more positive

1

(c) (i) $2H_2 \rightarrow 4H^+ + 4e^-$

1

$4e^- + O_2 + 2H_2O \rightarrow 4OH^-$

1

Overall equation $2H_2 + O_2 \rightarrow 2H_2O$

(ii) Unchanged 1

(d) Economic disadvantage; Use of CH_4 or cost of producing or high temp 1

Environmental disadvantage; Makes CO_2 1

(e) Cost of manufacture of solar cells 1

[17]

M5. (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]

M6. (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]