

- M1.** (a) Hydrogen/H₂ 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) $\text{Li}^+ + \text{MnO}_2 + \text{e}^- \rightarrow \text{LiMnO}_2$
Ignore state symbols 1
- 0.13(V) 1
- (c) Fe³⁺ ions reduced to Fe²⁺
Can score from equation/scheme 1
- Because $E(\text{Fe}^{3+}/\text{Fe}^{2+}) > E(\text{H}^+/\text{H}_2)/E(\text{hydrogen})$
Allow emf/E_{cell} +ve/0.77V
Allow Fe³⁺ better oxidising agent than H⁺
Allow H₂ better reducing agent than Fe²⁺
Only award this explanation mark if previous mark given 1
- (d) Moles Cr₂O₇²⁻ = 23.7 × 0.01/1000 = 2.37 × 10⁻⁴ 1
- 1 mol Cr₂O₇²⁻ reacts with 6 mol Fe²⁺ so moles
 Fe²⁺ in 25 cm³ = 6 × 2.37 × 10⁻⁴ = 1.422 × 10⁻³ 1
- M1 × 6*
- Moles Fe²⁺ in 250 cm³ = 1.422 × 10⁻²
M2 × 10 or M4/10 1
- Original moles Fe²⁺ = 10.00/277.9 = 0.0360

Independent mark

1

$$\text{Moles Fe}^{2+} \text{ oxidised} = 0.0360 - 0.0142 = 0.0218$$

M4 – M3

1

$$\% \text{ oxidised} = (0.0218 \times 100)/0.0360 = 60.5\%$$

(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]

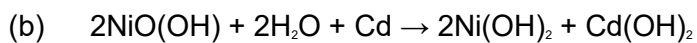
M2.D

[1]

M3. (a) 1.4 V

Allow + or –

1



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

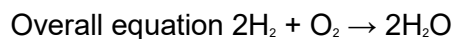
+3

Allow conseq on wrong species

1

[5]

- M4.**
- (a) (i) HgO 1
- (ii) $\text{Hg}^{2+} + 2\text{e}^- \rightarrow \text{Hg}$ 1
- (iii) $2\text{H}_2\text{O} + \text{SO}_2 \rightarrow \text{H}_2\text{SO}_4 + 2\text{e}^-$ etc 1
- (iv) $\text{Cl}_2 + 2\text{e}^- \rightarrow 2\text{Cl}^-$ 1
- (b) (i) Vanadium species: VO_2^+ 1
- Oxidation state: 5 1
- Half-equation: $\text{V}^{2+} + 2\text{H}_2\text{O} \rightarrow \text{VO}_2^+ + 4\text{H}^+ + 3\text{e}^-$ 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
- $\text{Fe}^{3+}/\text{Fe}^{2+}$ electrode becomes more positive 1
- (c) (i) $2\text{H}_2 \rightarrow 4\text{H}^+ + 4\text{e}^-$ 1
- $4\text{e}^- + \text{O}_2 + 2\text{H}_2\text{O} \rightarrow 4\text{OH}^-$ 1



- (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

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- M5.** (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)

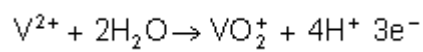
1

(c) VO_2^+

1

5 or V

1



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. = $E(\text{rhs}) - E(\text{lhs})$

1

$$= 1.52 - 0.77 = 0.75$$

(0.75 scores first mark also)

1

(ii) $\text{Fe}^{2+} \rightarrow \text{Fe}^{3+} + \text{e}^-$

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 $\text{Fe}^{3+}/\text{Fe}^{2+}$) less positive (or decreases) 1

[10]