1.

$MnO_4^- + 5Fe^{2+} + 8H^+ \rightarrow Mn^{2+} + 5Fe^{3+} + 4H_2O$

v = 29.0 mL v = 25.0 mL
c = ? c = 0.105 molL^{-1}

$n(MnO_4^-) = 1/5\ n(Fe^{2+}) = 1/5\ (c \times v)$
$= 1/5\ (0.105 \times 0.0250)$
$= 5.25 \times 10^{-4}$ mol
$\mathbf{c(MnO_4^-)} = n/v = \frac{5.25 \times 10^{-4}}{0.0290}$
$= 0.0181$ molL^{-1}
$= \mathbf{1.81 \times 10^{-2}\ molL^{-1}}$

2.

$2MnO_4^- + 5H_2C_2O_4 + 6H^+ \rightarrow 2Mn^{2+} + 10CO_2 + 8H_2O$

v = 31.2 mL v = 25.0 mL

c = 0.0201 molL^{-1} c = ?

$n(H_2C_2O_4) = 5/2\ n(MnO_4^-)$
$= 5/2\ (v \times v)$
$= 5/2\ (0.0201 \times 0.0312) = 0.0015678$
$\mathbf{c(H_2C_2O_4)} = n/v = \frac{0.0015678}{0.0250}$
$= 0.0627$ molL^{-1} = $\mathbf{6.27 \times 10^{-2}\ molL^{-1}}$

3.

$Cr_2O_7^{2-} + 6Fe^{2+} + 14H^+ \rightleftharpoons 2Cr^{3+} + 6Fe^{3+} + 7H_2O$

c = 0.0214 molL^{-1} v = 20.0 mL

v = 20.5 mL c = ?
$n(Cr_2O_7^{2-}) = cV = 0.0214 \times 0.0205 = 4.387 \times 10^{-4}$ mol
$n(Fe^{2+}) = 6\ n(Cr_2O_7^{2-}) = 2.632 \times 10^{-4}$ mol
$c(Fe^{2+}) = \frac{n}{v(L)} = \frac{2.632 \times 10^{-4}}{0.0200} = 0.1316$ molL^{-1}
$\mathbf{c(Fe_2SO_4)} = 1/2\ c(Fe^{2+}) = \mathbf{6.58 \times 10^{-2}\ molL^{-1}}$

4.

MnO_4^- + $8H^+$ + Se^- → Mn^{2+} + $4H_2O$ ×2

$2C\ell^-$ → $C\ell_2$ + $2e^-$ ×5

$2MnO_4^-$ + $16H^+$ + $10C\ell^-$ → $2Mn^{2+}$ + $8H_2O$ + $5C\ell_2$

$c = 0.0432\ molL^{-1}$ $v = 25.0\ mL$

$v = ?$ $c(C\ell^{-1}) = 2\ c(SnC\ell_2) = 2(0.108\ molL^{-1}) = 0.216\ molL^{-1}$

$n(MnO_4^-) = 2/10\ n(C\ell^-)$

$= 2/10\ (c \times v)$

$= 2/10\ (0.216)(0.0250) = 0.00108\ mol$

$v(MnO_4^-)$ $= \frac{n}{c} = \frac{0.00108}{0.0432} = 2.50 \times 10^{-2}\ L =$ **25.0 mL**

5.

MnO_4^- + $8H^+$ + $5e^-$ → Mn^{2+} + $4H_2O$

Fe^{2+} → Fe^{3+} + e^- ×5

MnO_4^- + $8H^+$ + $5Fe^{2+}$ → $5Fe^{3+}$ + Mn^{2+} + $4H_2O$

$c = 0.0200\ molL^{-1}$

$n[(NH_4)_2Fe(SO_4)_2.6H_2O] = m/M = \frac{1.03}{392.13} = 0.00263$

$M[(NH_4)_2Fe(SO_4)_2.6H_2O]$

$(14 + 4(1.008))2 = 36.064$

55.85

$(32.06 + 64)2 = 192.12$

$6(2.016 + 16) = 108.096$

$= 392.13$

$n(Fe^{2+}) = 0.00263\ mol$

$n(MnO_4^-) = 1/5\ n(Fe^{2+})$

$= 0.000525\ mol$

$v(MnO_4^-)$ $= n/c = \frac{0.000520}{0.0200} = 0.0263\ L$ **(26.3 mL)**

6. MnO_4^- + $8H^+$ + $5e^-$ → Mn^{2+} + $4H_2O$ ×2

$H_2C_2O_4$ → $2CO_2$ + $2H^+$ + $2e^-$ ×5

$2MnO_4^-$ + $5H_2C_2O_4$ + $6H^+$ → $2Mn^{+2}$ + $10CO_2$ + $8H_2O$

v = 25 mL m?
c = 0.0192 $molL^{-1}$

$n(H_2C_2O_4)$ = 5/2 $n(MnO_4^-)$
= 5/2 (c × v)
= 5/2 (0.0192 × 0.0250)
= 0.0012 mol

$m(H_2C_2O_4)$ = n × M $M(H_2C_2O_4\ 2H_2O)$ = 2+ 24+ 64 + 36
= 126
= (0.0012)(126)
$m(H_2C_2O_4)$ = 0.151 g

7. $2MnO_4^-$ + $5H_2C_2O_4$ + 6H → $2Mn^{2+}$ + $10CO_2$ + $8H_2O$

v= 20.0 mL v=35.0 mL v= 5.60 x 10^2 mL
at STP = 0.560 L

$n(CO_2)$ = v/22.4 L = 0.560/ 22.4 = 0.025 mol

(a) $n(H_2C_2O_4)$ = 5/10 $n(CO_2)$= 0.0125 mol
$c(H_2C_2O_4)$ = n/v = $\frac{0.0125}{0.0350}$ **= 0.357 $molL^{-1}$**

(b) $n(MnO_4^-)$ = 2/10 $n(CO_2)$ = 2/10 (0.0250) = 0.00500 mol
$c(MnO_4^-)$ = n/v = $\frac{0.00500}{0.0200}$ **= 0.250 $molL^{-1}$**

8. $H_2O \rightleftharpoons O_2 + 2H^+ + 2e$ ×5

$MnO_4^- + 8H^+ + 5e \rightleftharpoons Mn^{2+} + 4H_2O$ ×2

$5H_2O_2 + 2MnO_4^- + 6H^+ \rightleftharpoons 5O_2 + 2Mn^{2+} + 8H_2O$

1 mL , 3% c= 0.0205 molL^{-1}
Density ρ = 1.00 g mL^{-1} v= ?

ρ = m/v = m(H_2O_2) = 0.0300 g mL^{-1} in / mL of 3%

n(H_2O_2) = m/M = $\frac{0.0300}{34}$ = 8.82 × 10^{-4} mol

n(MnO_4^-) = 2/5 n(H_2O_2) = 2/5 (8.82 × 10^{-4}) = 3.53 × 10^{-4} mol

v(MnO_4^-) = n/c = $\frac{3.53 \times 10^{-4}}{0.0205}$ = 0.0172 L (**17.2 mL**)

9. $Fe(g) + 2H^+ \rightarrow Fe^{2+} + H_2(g)$ $Cr_2O_7^{2-}$
v = 18.1 mL
c = 0.209 molL^{-1}

(beaker) → (beaker) → (beaker)
1.63 g Fe v = 250 mL v = 20 mL
% Iron in wire?

$Fe^{2+} \rightleftharpoons Fe^{3+} + e^-$ × 6

$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightleftharpoons 2Cr^{3+} + 7H_2O$

$6Fe^{2+} + Cr_2O_7^{2-} + 14H^+ \rightleftharpoons 6Fe^{3+} + 2Cr^{3+} + 7H_2O$

n($Cr_2O_7^{2-}$) = c × v = (0.209)(0.0181) = 3.78 × 10^{-4} mol

n(Fe^{2+} in 20 mL) = 6 xi($Cr_2O_7^{2-}$) = 2.27 × 10^{-3} mol

c(Fe^{2+} in 20 mL) = n/v = 0.1135 molL^{-1}

n(Fe^{2+} in 250 mL) = c × v = (0.1135)(0.250)
= 0.02837 mol
= n(Fe) in the wire

m(Fe) in wire = n x M = 0.02837 × 55.85 = 1.5846 g

% mass iron in wire = $\frac{m(Fe)}{m(wire)} \times 100$

= $\frac{1.5846}{1.63} \times 100$ = **97.2%**

10. Cr mineral → $Cr_2O_7^{2-}$ 1.27 g % Cr?

Fe^{2+} v = 37.5 mL c = 0.400molL^{-1}

$Fe^{2+} \rightleftharpoons Fe^{3+} + e^-$ ×6

$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightleftharpoons 2Cr^{3+} + 7H_2O$

$6Fe^{2+} + Cr_2O_7^{2-} + 14H^+ \rightleftharpoons 6Fe^{3+} + 2Cr^{3+} + 7H_2O$

$n(Fe^{2+}) = c \times v = (0.400)(0.0375) = 0.0150$ mol

$n(Cr_2O_7^{2-}) = 1/6\ n(Fe^{2+}) = 0.00250$ mol

$n(Cr) = 2n(Cr_2O_7^{2-}) = 0.00500$ mol

$m(Cr) = n \times M = (0.00500)(52) = 0.260$ g

% mass Cr in mineral

$$= \frac{\text{man Cr}}{\text{man mineral sample}} \times 100\%$$

$$= \frac{0.260}{1.27} \times 100$$

= 20.5%

11. Impure Na_2SO_3 0.752 g

$Cr_2O_7^{2-}$ c = 0.0993 molL^{-1} v = 17.2 mL

$SO_3^{2-} + H_2O \rightleftharpoons SO_4^{2-} + 2e^- + 2H^+$ ×3

$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightleftharpoons 2Cr^{3+} + 7H_2O$

$3SO_3^{2-} + Cr_2O_7^{2-} + 8H^+ \rightleftharpoons 3SO_4^{2-} + 2Cr^{3+} + 4H_2O$

$n(Cr_2O_7^{2-}) = c \times v = (0.0993)(0.0172) = 0.00171$ mol

$n(SO_3^{2-}) = 3n(Cr_2O_7^{2-}) = 0.00512$ mol

$n(Na_2SO_3) = n \times M = (0.00512)(126) = 0.646$ g

M = 2(23) + 32 + 48 = 126

% purity of the sodium sulfite

$$= \frac{m}{m\ \text{sample}} \times 100$$

$$= \frac{0.646}{0.752} \times 100$$

= 85.9 %

12. 3.08 g Iron ore Fe_2O_3 → H_2SO_4 → 250 mL → 25 mL

MnO_4^- v = 28.7 mL c = 0.0260 $molL^{-1}$

$MnO_4^- + 5Fe^{2+} + 8H^+ \rightleftharpoons Mn^{2+} + 5Fe^{3+} + 4H_2O$

$n(MnO_4^-) = c \times v = (0.0260)(0.0287) = 0.000746$ mol

$n(Fe^{2+}) = 5n(MnO_4^-) = 0.00373$ mol

$c(Fe^{2+}) = \frac{n}{v} = \frac{0.00373}{0.0250} = 0.149\ molL^{-1}$

$n(Fe^{2+})$ in 250 mL = n(Fe) in Iron ore Fe_2O_3
$= c \times v\ (250) = 0.0373$ mol

$n(Fe_2O_3) = 1/2\ n(Fe) = 0.0186$ mol

$m(Fe_2O_3) = n \times M\ (160) = 2.976$ g

M= 2(56) + 48 = 160

% Fe_2O_3 in the iron ore
$= \frac{m(Fe_2O_3)}{m\ (ore)} \times 100 = \frac{2.976}{3.08} \times 100 =$ **96.6 %**

13. FeO & Fe_2O_3

A 1: $MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_20$
$Fe^{2+} \rightarrow Fe^{3+} + e^-$
$MnO_4^- + 8H^+ + 5Fe^{2+} \rightarrow 5Fe^{3+} + 4H_20$

A 1: c ($KMnO_4$) = 6.30 gL^{-1}
v ($KMnO_4$) = 15.0 mL

A 2: $Fe^{3+} + e^- \rightarrow Fe^{2+}$
$Zn \rightarrow Zn^{2+} + 2e^-$
$2Fe^{3+} + Zn \rightarrow 2Fe^{2+} + Zn^{2+}$ then MnO_4- treatment

A 2: v ($KMnO_4$) = 25.1 mL
M ($KMnO_4$) = 158 g/mol
M (FeO) = 71.8 g/mol
M (Fe_2O_3) = 159.6 g/mol

Aliquot 1: c ($KMnO_4$) $= \frac{6.30\ (gL^{-1})}{M\ (gmol^{-1})} = \frac{6.30}{158} = 0.3987\ mol\ L^{-1}$

n (MnO_4^-) = cV = $0.3987 \times 0.0150 = 5.981 \times 10^{-4}$mol

Eqn. $n(Fe^{2+}) = 5 \times n(MnO_4^-) = 5\ (5.981 \times 10^{-4}) = 2.99 \times 10^{-3}$ mol

n(FeO) = $n(Fe^{2+}) = 2.99 \times 10^{-3}$ mol

m(FeO) in aliquot 1 = nM = $2.99 \times 10^{-3} \times 71.8 = 0.2147$ g

m(FeO) in original sample = 2 × 0.2147 = 0.429 g

Mass of FeO = 0.429 g

Aliquot 2: $n(MnO_4^-)$ = cV = $\frac{6.30}{158}$ x 0.0251 mol = 0.00100 mol

Eqn. $n(Fe^{2+})$ = 5 × $n(MnO_4^-)$ = 5 (0.00100) = 5.00×10^{-3} mol

This represents ALL Fe^{2+} & Fe^{3+} that was changed to Fe^{2+}
$n(Fe^{3+})$ present = total n(Fe) – $n(Fe^{2+})$ determined from aliquot 1
= $5.00 \times 10^{-3} - 2.99 \times 10^{-3}$
= 2.01×10^{-3} mol

$4Fe^{3+} + 6O^{2-} \rightarrow 2Fe_2O_3$
$n(Fe_2O_3)$ = 2/4 $n(Fe^{3+})$ = 1.005×10^{-3} mol

$m(Fe_2O_3)$ in aliquot = $1.005 \times 10^{-3} \times 159.6$ = 1.60×10^{-1} g

$m(Fe_2O_3)$ in original sample = $2 \times 1.60 \times 10^{-1}$ = 0.321 g

Mass of Fe_2O_3 = 0.321 g

14. v(Bleach) = 10.0 mL then made up to 100.0 mL

1. $C\ell O^- + 2I^- + 2H^+ \rightarrow I_2 + C\ell^- + H_2O$
2. $2S_2O_3^{2-} + I_2 \rightarrow S_4O_6^{2-} + 2I^-$

v(aliquot) = 25.0 mL

$c(Na_2S_2O_3)$= 0.845 M

$^{V}Na_2S_2O_3$= 17.9 mL

ρ(Bleach) = 1.00 $g.mL^{-1}$

$M(NaOC\ell)$ = 74.5 g/mol

$n(S_2O_3^{2-})$ = cV = 0.845 × 0.0179 mol

Eqn.2. $n(I_2)$ = 1/2 $n(S_2O_3^{2-})$ = 1/2 × 0.845 × 0.0179

Eqn.1. $n(C\ell O^-) = n(I_2) = \frac{0.845 \times 0.0179}{2}$ in 25.0 mL

$n(C\ell O^-)$ in original 10 mL = $\frac{100}{25} \times \frac{0.845 \times 0.0179}{2}$ mol

$m(NaOC\ell)$ = nM

Since = 1.00 g/mL, 10 mL sample weighs 10.0 g

$$\% \text{ purity} = \frac{100 \text{ x } 0.845 \times 0.0179 \text{ x } 74.5}{2 \text{ x } 25} \times \frac{100}{10}$$

= 22.54

Percentage purity of bleach = 22.5%