① $2NaMnO_4(s) \rightarrow Mn_2O_7(s) + Na_2O(s)$

$Fe_2(CO_3)_3(aq) + 6NaOH(aq) \rightarrow 2FeO(OH)(s) + 3Na_2CO_3(aq) + 2H_2O(l)$

$2C_9H_{15}O_{(l)} + 25O_2(g) \rightarrow 18CO_2(g) + 15H_2O(g)$

② $\frac{42.86\ mol \mid 6.022\times10^{23}\ atom}{mol} = 2.58\times10^{25}$ atoms

③ Because they have different MW (g/mol) → 1 mol of CO_2 and 1 mol of CO are the same number of molecules, but CO_2 has more mass per molecule than CO because it has an extra atom.

④ $\frac{1.86\times10^{20}\ CO_2 \mid 1\ mol \mid 44.01\ g}{\mid 6.022\times10^{23} \mid mol} = 0.0136\ g\ CO_2$

⑤ $\frac{90.1853\ g\ O \mid mol \mid 1\ mol\ NaMnO_4 \mid 141.94\ g}{\mid 16\ g \mid 4\ mol\ O \mid mol} = 200\ g\ NaMnO_4$

⑥ C: $\frac{74.03 \mid mol}{\mid 12.01\ g} = 6.16$ mol C ÷ 0.616 = 10

H: $\frac{7.471 \mid mol}{\mid 1.01\ g} = 7.397$ mol H ÷ 0.616 = 12

N: $\frac{8.636 \mid mol}{\mid 14.01\ g} = 0.616$ mol N ÷ 0.616 = 1

O: $\frac{9.863 \mid mol}{\mid 16\ g} = 0.616$ mol O ÷ 0.616 = 1

E.F. = $C_{10}H_{12}N_1O_1$

E.F.W. = 162.23

$\frac{324.46}{162.23} = 2$

M.F. $C_{20}H_{24}N_2O_2$

⑦ $C_{20}H_{24}N_2O_2 + 27O_2(g) \rightarrow 20CO_2(g) + 12H_2O(g) + 2NO_2$

a) $\frac{100\ g \mid mol \mid 2\ mol\ NO_2 \mid 46.01\ g}{\mid 324.46\ g \mid 1\ mol\ Q \mid mol} = 28.36\ g\ NO_2$

b) $250\text{ g } H_2O \times \frac{\text{mol}}{18.02\text{ g}} \times \frac{1\text{ mol Q}}{12\text{ mol } H_2O} \times \frac{324.46\text{ g}}{1\text{ mol}} = 375.12\text{ g Quinine}$

$250\text{ g } H_2O \times \frac{1\text{ mol}}{18\text{ g}} \times \frac{27\text{ mol } O_2}{12\text{ mol } H_2O} \times \frac{32\text{ g}}{1\text{ mol}} = 1000\text{ g } O_2$

c) $250\text{ g } O_2 \times \frac{\text{mol}}{32\text{ g}} \times \frac{20\text{ mol } CO_2}{27\text{ mol } O_2} \times \frac{44.01\text{ g}}{\text{mol}} = 254.69\text{ g } CO_2$

$250\text{ g Q} \times \frac{\text{mol}}{324.46\text{ g}} \times \frac{20\text{ mol } CO_2}{1\text{ mol Q}} \times \frac{44.01\text{ g}}{1\text{ mol}} = 678.2\text{ g } CO_2$

O_2 is Limiting → $305.63\text{ g } CO_2$ = Theoretical Yield

$\%\text{ Yield} = \frac{250\text{ g}}{254.69\text{ g}} \times 100 = 98.16\%$

d. $50\text{ g } O_2 \times \frac{\text{mol}}{32\text{ g}} \times \frac{20\text{ mol } CO_2}{27\text{ mol } O_2} \times \frac{44.01\text{ g}}{\text{mol}} = 50.94\text{ g } CO_2$

$25\text{ g Q} \times \frac{\text{mol}}{324.46\text{ g}} \times \frac{20\text{ mol } CO_2}{1\text{ mol Q}} \times \frac{44.01\text{ g}}{1\text{ mol}} = 67.82\text{ g } CO_2$

O_2 = L.R. → Ø O_2 left

$50\text{ g } O_2 \times \frac{\text{mol}}{32\text{ g}} \times \frac{12\text{ } H_2O}{27 O_2} \times \frac{18.02\text{ g}}{1\text{ mol}} = 12.51\text{ g } H_2O$

$50\text{ g } O_2 \times \frac{\text{mol}}{32\text{ g}} \times \frac{2\text{ } NO_2}{27 O_2} \times \frac{46.01\text{ g}}{1\text{ mol}} = 5.33\text{ g } NO_2$

$12.51\text{ g } H_2O \times \frac{1\text{ mol}}{18.02\text{ g}} \times \frac{1\text{ Q}}{12\text{ } H_2O} \times \frac{324.46\text{ g}}{\text{mol}} = 18.77\text{ g Quinine used}$

$25 - 18.77 = 6.23\text{ g Quinine left}$

8. $\frac{1.8\,L}{} \Big| \frac{3.25\text{ mol }NH_4Cl}{1\,L} = 5.85\text{ mol }NH_4Cl \Big| \frac{53.5\text{ g}}{\text{mol}} = 312.98\text{ g }NH_4Cl$

Measure out 312.98 g of NH_4Cl. Add water to a total volume of 1.8 L

9. $\frac{154\text{ mmol }K_3PO_4}{L} \Big| \frac{3\text{ mmol }K^+}{1\text{ mmol }K_3PO_4} = \frac{462\text{ mmol }K^+}{L} = $ **462 mM** or **0.462 M**

10. $\frac{550\text{ mL}}{} \Big| \frac{10^{-3}\,L}{1\text{ mL}} \Big| \frac{1.5\text{ mol NaCl}}{L} = 0.825\text{ mol NaCl}$

New volume is 550 mL + 354 mL = $\frac{904\text{ mL}}{} \Big| \frac{10^{-3}\,L}{1\text{ mL}} = 0.904\,L$

$\frac{0.825\text{ mol NaCl}}{0.904\,L} = $ **0.913 M**

11. $FeCl_2(aq) + 2NaOH(aq) \longrightarrow Fe(OH)_2(s) + 2NaCl(aq)$

$FeCl_2$: $\frac{900\text{ mL}}{} \Big| \frac{10^{-3}\,L}{1\text{ mL}} \Big| \frac{0.25\text{ mol }FeCl_2}{L} \Big| \frac{1\text{ mol }Fe(OH)_2}{1\text{ mol }FeCl_2} = 0.225\text{ mol }Fe(OH)_2$

NaOH: $\frac{350\text{ mL}}{} \Big| \frac{10^{-3}\,L}{1\text{ mL}} \Big| \frac{302\text{ mmol NaOH}}{L} \Big| \frac{1\text{ mmol }Fe(OH)_2}{2\text{ mmol NaOH}} \Big| \frac{10^{-3}\text{ mol}}{1\text{ mmol}} = 0.05285\text{ mol }Fe(OH)_2$

NaOH = limiting

$\frac{0.05285\text{ mol }Fe(OH)_2}{} \Big| \frac{89.87\text{ g}}{\text{mol}} = $ **4.75 g $Fe(OH)_2$**

b. Na^+ is a spectator ion, so only need to consider dilution

$\frac{0.35\,L}{} \Big| \frac{302\text{ mmol NaOH}}{L} \Big| \frac{1\text{ mmol }Na^+}{1\text{ mmol NaOH}} = 105.7\text{ mmol }Na^+$

New V = 0.35 L + 0.9 L = 1.25 L

$\frac{105.7\text{ mmol }Na^+}{1.25\,L} = $ **84.56 mM**