1. Assume 1L volume for each solution

$KNO_3(s) \rightarrow K^{1+}(aq) + NO_3^{1-}(aq)$

$$1\,L \times \frac{0.120\ mol\ KNO_3}{1\,L} \times \frac{1\ mol\ NO_3^{1-}}{1\ mol\ KNO_3} = 0.120\ mol\ NO_3^{1-}$$

$Fe(NO_3)_3(s) \rightarrow Fe^{3+}(aq) + 3NO_3^{1-}(aq)$

$$1\,L \times \frac{0.160\ mol\ Fe(NO_3)_3}{1\,L} \times \frac{3\ mol\ NO_3^{1-}}{1\ mol\ Fe(NO_3)_3} = 0.480\ mol\ NO_3^{1-}$$

$$n_T^{NO_3^{1-}} = n_{KNO_3}^{NO_3^{1-}} + n_{Fe(NO_3)_3}^{NO_3^{1-}}$$

$$n_T^{NO_3^{1-}} = 0.120\ mol\ NO_3^{1-} + 0.480\ mol\ NO_3^{1-}$$

$$n_T^{NO_3^{1-}} = 0.600\ mol\ NO_3^{1-}$$

$$V_T = V_{KNO_3} + V_{Fe(NO_3)_3}$$

$$V_T = 1L + 1L$$

$$V_T = 2L$$

$$[NO_3^{1-}] = \frac{n_T^{NO_3^{1-}}}{V_T}$$

$$= \frac{0.600\ mol\ NO_3^{1-}}{2L}$$

$$= 0.300\ mol\ NO_3^{1-}/L \Rightarrow 0.300\ M\ NO_3^{1-}$$

2. $Ba(NO_3)_2(aq) + Na_2CO_3(s) \rightarrow BaCO_3(s) + 2NaNO_3(aq)$

$BaCO_3$: low solubility ∴ removes $Ba^{2+}$ through ppte

$NaNO_3$: bi-product

$$120\,mL \times \frac{1\,L}{1000\,mL} \times \frac{0.0500\,mol\,Ba(NO_3)_2}{1\,L} \;*$$

$$\times \frac{1\,mol\,Na_2CO_3}{1\,mol\,Ba(NO_3)_2} \times \frac{105.99\,g\,Na_2CO_3}{1\,mol\,Na_2CO_3} = 0.636\,g\,Na_2CO_3$$

3. $2Al(s) + 3CuSO_4(aq) \rightarrow 3Cu(s) + Al_2(SO_4)_3$

$CuSO_4$: 0.675 M, ? V

$Cu$: 4.88 g

$$4.88\,g\,Cu \times \frac{1\,mol\,Cu}{63.55\,g\,Cu} \times \frac{3\,mol\,CuSO_4}{3\,mol\,Cu} \;**$$

$$\times \frac{1\,L\,CuSO_4}{0.675\,mol\,CuSO_4} \times \frac{1000\,mL}{1\,L} = 113.8\,mL\,CuSO_4\ solution$$

1000 mL / 1 L: optional

* alternate to this point

$n = ?$

$C = 0.0500\,mol/L$

$V = 120\,mL \rightarrow 0.120\,L$

$n = CV$

$n = 0.0500\,mol/L \times 0.120\,L$

$n = 0.006\,mol\,Ba(NO_3)_2$

** alternate route - stop at mol $CuSO_4$ and use $n = CV$

4. $Zn_{(s)} + 2HCl_{(aq)} \rightarrow ZnCl_{2(aq)} + H_{2(g)}$

5.77 g | 80.1 mL, 4.00 mol/L | ? M, 80.1 mL

limiting

Consider Zn $\quad 5.77\text{ g Zn} \times \frac{1\text{ mol Zn}}{65.41\text{ g Zn}} = 0.0882\text{ mol Zn}$ available

$0.0882\text{ mol Zn} \times \frac{2\text{ mol HCl}}{1\text{ mol Zn}} = 0.176\text{ mol HCl}$ required

excess

Consider HCl $\quad 80.1\text{ mL HCl} \times \frac{1\text{ L}}{1000\text{ mL}} \times \frac{4.00\text{ mol HCl}}{1\text{ L}} = 0.320\text{ mol HCl}$ available

$0.320\text{ mol HCl} \times \frac{1\text{ mol Zn}}{2\text{ mol HCl}} = 0.160\text{ mol Zn}$ required

∴ Zn is the limiting reagent

$0.0882\text{ mol Zn} \times \frac{1\text{ mol } ZnCl_2}{1\text{ mol Zn}} = 0.0882\text{ mol } ZnCl_2$

$n = 0.0882\text{ mol } ZnCl_2$

$C = ?$

$V = 80.1\text{ mL} \rightarrow 0.0801\text{ L}$

$C = \frac{n}{V}$

$C = \frac{0.0882\text{ mol } ZnCl_2}{0.0801\text{ L}}$

$C = 1.101\text{ mol } ZnCl_2/L$

$C = 1.101\text{ M } ZnCl_2$

5. $Fe_{(s)} + CuSO_{4(aq)} \rightarrow FeSO_{4(aq)} + Cu_{(s)}$

1.942 g; 136.3 mL, 0.0750 mol/L; ? g

Consider Fe: $1.942\text{ g Fe} \times \frac{1\text{ mol Fe}}{55.85\text{ g Fe}} = 0.0348\text{ mol Fe}$ available (excess)

$0.0348\text{ mol Fe} \times \frac{1\text{ mol } CuSO_4}{1\text{ mol Fe}} = 0.0348\text{ mol } CuSO_4$ required

Consider $CuSO_4$: $136.3\text{ mL } CuSO_4 \times \frac{1\text{ L}}{1000\text{ mL}} \times \frac{0.0750\text{ mol } CuSO_4}{1\text{ L}} = 0.0102\text{ mol } CuSO_4$ available (limiting)

$0.0102\text{ mol } CuSO_4 \times \frac{1\text{ mol Fe}}{1\text{ mol } CuSO_4} = 0.0102\text{ mol Fe}$ required

$\therefore CuSO_4$ is the limiting reagent

$0.0102\text{ mol } CuSO_4 \times \frac{1\text{ mol Cu}}{1\text{ mol } CuSO_4} \times \frac{63.55\text{ g Cu}}{1\text{ mol Cu}} = 0.650\text{ g Cu}$

6. $2HCl(aq) + Mg(OH)_2(s) \rightarrow MgCl_2(aq) + 2H_2O(l)$

$$0.10\ g\ Mg(OH)_2 \times \frac{1\ mol\ Mg(OH)_2}{58.33\ g\ Mg(OH)_2} \times \frac{2\ mol\ HCl}{1\ mol\ Mg(OH)_2} \quad *$$

$$\times \frac{1\ L\ HCl}{0.10\ mol\ HCl} = 0.0343\ L\ HCl$$

or 34.3 mL HCl

* could stop at mol HCl and use $n = CV$

7. $Pb(C_2H_3O_2)_2(s) \rightarrow Pb^{2+}(aq) + 2C_2H_3O_2^{1-}(aq)$

$$0.400\ mol\ Pb^{2+} \times \frac{1\ mol\ Pb(C_2H_3O_2)_2}{1\ mol\ Pb^{2+}}$$

$$\times \frac{1L\ Pb(C_2H_3O_2)_2}{1.50\ mol\ Pb(C_2H_3O_2)_2} = 0.267\ L\ Pb(C_2H_3O_2)_2$$

or 267 mL $Pb(C_2H_3O_2)_2$