Chem 11 - Stoich Unit Review

Pt 1. $CaCO_3 \rightarrow CaO + CO_2$

1. $17\,g\ CaCO_3 \times \frac{1\ mol\ CaCO_3}{100.1\,g} \times \frac{1\ CO_2}{1\ CaCO_3} \times \frac{22.4\,L}{1\ mol} =$

$\underline{3.8\,L}$

2. $4Fe + 3O_2 \rightarrow 2Fe_2O_3$

$21.5\,g\ Fe_2O_3 \times \frac{1\ mol}{159.6\,g} = 0.135\ mol\ Fe_2O_3$ produced.

$0.135\ mol\ Fe_2O_3 \times \frac{3O_2}{2Fe_2O_3} \times \frac{22.4\,L}{mol\,O_2} = \underline{4.53\,L}$

3. $2KClO_3 \rightarrow 2KCl + 3O_2$

$1.80\ mol\ O_2 \times \frac{2KClO_3}{3\,O_2} \times \frac{122.6\,g}{1\ mol} =$

$\underline{147\,g}$

4. $12.35\,g\ Zn \times \frac{1\ mol}{65.4\,g} \times \frac{1\ H_2}{1\ Zn} =$ 0.189 moles.

oops: $Zn + 2HCl \rightarrow H_2 + ZnCl_2$

5. $CaC_2 + 2H_2O \rightarrow C_2H_2 + Ca(OH)_2$

$30\,L\ C_2H_2 \times \frac{1\,mol}{22.4\,L} \times \frac{2\,H_2O}{C_2H_2} \times \frac{18.0\,g}{1\,mol} =$

$48\,g$

Pt 2.

1. $2H_2 + O_2 \rightarrow 2H_2O$

H_2 is limiting b/c it requires twice as much.

$20\ H_2$ molec. $\times \frac{2H_2O}{2H_2} = 20\ H_2O$'s.

2. ~~10.45g~~ $2Al + 3CuSO_4 \rightarrow 3Cu + Al_2(SO_4)_3$

Al: $10.45\,g \times \frac{1\,mol}{27.0\,g} \times \frac{3Cu}{2Al} = 0.581$ mol Cu

$CuSO_4$: $66.55\,g \times \frac{1\,mol}{159.6\,g} \times \frac{3Cu}{3CuSO_4} = 0.417$ mol Cu

- limiting reactant is $CuSO_4$ // Al is in excess

b) $0.417\ mol\ Cu \times \frac{63.5\,g}{mol} = 26.5\,g.$

c) $10.45\,g\ Al - \left(0.417\ Cu \times \frac{2Al}{3Cu} \times \frac{27\,g}{1\,mol}\right) =$ (7.506)

$2.94\,g$

3. $Pb(NO_3)_2 + 2NaCl \rightarrow PbCl_2 + 2NaNO_3$

$Pb(NO_3)_2$: $15.50\,g \times \frac{1\,mol}{331.2} \times \frac{1\,PbCl_2}{1\,Pb(NO_3)_2} = 0.0468\ mol\ PbCl_2$

NaCl: $3.84\,g \times \frac{1\,mol}{58.5} \times \frac{1\,PbCl_2}{2\,NaCl} = 0.0328\ mol\ PbCl_2$

- lim: NaCl // Excess: $Pb(NO_3)_2$

b) $0.0328\ mol\ PbCl_2 \times \frac{278.2\,g}{1\,mol} = 9.13\,g.$

c) $Pb(NO_3)_2$: $15.50\,g - \left(0.0328\ mol\ PbCl_2 \times \frac{1\,Pb(NO_3)_2}{1\,PbCl_2} \times \frac{331.2\,g}{1\,mol}\right)$

$10.86\,g$

$= 4.64\,g$

4. $2Cu + O_2 \rightarrow 2CuO$

Cu: $6.52\,g \times \frac{1\,mol}{63.5\,g} \times \frac{2\,CuO}{2\,Cu} = 0.103\ mol\ CuO$

O_2: $25.4\,L \times \frac{1\,mol}{22.4\,L} \times \frac{2\,CuO}{1\,O_2} = 2.27\ mol\ CuO$

- lim: Cu // XS: O_2

b) $0.103\ mol\ CuO \times \frac{79.5\,g}{mol} = 8.19\,g.$

c) $25.4\,L - \left(0.103\ mol\ CuO \times \frac{1\,O_2}{2\,CuO} \times \frac{22.4\,L}{mol}\right)$

$1.15\,L$

$= 24.2\,L$

5. $AlBr_3 + 3AgNO_3 \rightarrow 3AgBr_{(s)} + Al(NO_3)_3$

$AlBr_3$: $17.25\,mL \times 0.525\,\frac{mol}{L} \times \frac{3\,AgBr}{1\,AlBr_3} = 27.2\,mmol$

$AgNO_3$: $19.72\,mL \times 0.633\,\frac{mol}{L} \times \frac{3\,AgBr}{3\,AgNO_3} = 12.5\,mmol$

Lim: $AgNO_3$ // XS: $AlBr_3$.

b) $12.5\,mmol \times \frac{187.8\,g}{mol} = 2.348\,g$

c) $9.056\,mol - \left(12.5\,mol \times \frac{1\,AlBr_3}{3\,AgBr}\right) = \underset{remaining}{5.34\,mmol}$ in $36.97\,mL$

4.167

so... $0.144\,M$ or $1.424\,g$

Pt. 3.

1. $Fe + 2HCl \rightarrow H_2 + FeCl_2$

Fe: $6.57\,g \times \frac{1\,mol\,Fe}{55.8\,g} \times \frac{1\,FeCl_2}{1\,Fe} = 0.118\,mol \times \frac{126.8\,g}{mol}$

$= 14.9\,g$

b) $\frac{14.63\,g}{14.9\,g} \times 100\% = 97.8\%$.

2. $Cu + Cl_2 \rightarrow CuCl_2$

Cu: $12.5\,g \times \frac{1\,mol}{63.5\,g} \times \frac{1\,CuCl_2}{1\,Cu} = 0.197\,mol$ ← Lim

Cl_2: $15.3\,L \times \frac{1\,mol}{22.4\,L} \times \frac{1\,CuCl_2}{1\,Cl_2} = 0.683\,mol$ ← xs

$0.197\,mol\ CuCl_2 \times \frac{134.5\,g}{mol} = 26.5\,g$ ← theoretical yield.

$\frac{25.4\,g}{26.5\,g} \times 100\% = 95.9\%$.

3. $0.830\,M \Rightarrow 0.830\,\frac{mol}{L} \times \frac{60.0\,g}{mol} =$ [illegible]

$\frac{49.8\,g\ \text{of acetic acid}}{L}$

↑ how much does 1 L weigh?

$1\,L = 1000\,mL$ & $1\,mL = 1\,g$.
So... $1000\,g$.

$\frac{49.8\,g}{1000\,g} \times 100\% = 4.98\%$.

Pt. 4

1. $NaOH + HCl \rightarrow H_2O + NaCl$

moles of NaOH $= 0.253\,\frac{mol}{L} \times 0.02145\,L = 5.43 \times 10^{-3}\,mol$

moles of HCl $= 5.43 \times 10^{-3}\,mol\ NaOH \times \frac{1\,HCl}{1\,NaOH}$ ← from Bal. eq^n.

$[HCl] = M = \frac{n}{V}$ so $\frac{5.43 \times 10^{-3}\,mol\ HCl}{2.5 \times 10^{-2}\,L\ HCl} = 0.217\,M$

2. use trials 2, 3, 4 - trial 1 is overshot & not precise

$$\frac{19.09 + 19.11 + 19.24}{3} = 19.15\ mL \text{ avg.}$$

moles KOH = $19.15\ mL \times 0.500\ \frac{mol}{L} = 9.57$ mmoles.

moles H_3PO_4 : $H_3PO_4 + 3KOH \rightarrow 3H_2O + K_3PO_4$

so $9.57\ mmol\ KOH \times \frac{1\ H_3PO_4}{3\ KOH} = 3.19\ mmol\ H_3PO_4$

$$[H_3PO_4] = \frac{3.19\ mmol}{25\ mL} = \underline{0.128\ M}$$

3. Difficult - not on test ☆ - good for practice ☺

- $Na_2CO_3 = 106\ g/mol$ so for $Na_2CO_3 \cdot x H_2O$, anything greater than $106\ g/mol$ = water.
- need to find molar mass of hydrate ∴ $\frac{g}{mol}$.

Calculate # of moles. $Na_2CO_3 + 2HCl \rightarrow CO_2 + H_2O + 2NaCl$

moles HCl = $\frac{36.92\ mL}{1000\ mL/L} \times \frac{0.103\ mol}{L} = 3.80 \times 10^{-3}$ mol HCl

moles Na_2CO_3 = $3.80 \times 10^{-3}\ mol\ HCl \times \frac{1\ Na_2CO_3}{2\ HCl} = 1.90 \times 10^{-3}$ mol Na_2CO_3

molar mass = $\frac{0.54\ g}{1.90 \times 10^{-3}\ mol} = 284\ \frac{g}{mol}$ so ...

284 - 106 = mass of water = $178\ g \div 18\ \frac{g}{mol} = 9.9$ or ~ 10

$Na_2CO_3 \cdot 10H_2O$