(5.4) Gas Stoich.

(31) $\underline{4} NH_3(g) + \underline{6} NO(g) \longrightarrow \underline{5} N_2(g) + \underline{6} H_2O(l)$

c̈ # Liters NH_3 required to change 12.8 L NO ?

(100% yield)

$$\frac{12.8\,L\,NO}{1} \times \frac{4\,L\,NH_3}{6\,L\,NO} = \underline{8.53\,L\,NH_3}$$

(32) (a) balanced chem eq.

$NF_3(g) + H_2O(g) \rightarrow HF(g) + NO(g) + NO_2(g)$

(i) all H in HF comes from H_2O

(1 NF_3 : 3 HF ratio) → 1 NF_3 → 3 HF doesn't work
$2NF_3 \rightarrow 6HF$ ← so try

$\underline{2} NF_3 + \underline{3} H_2O \longrightarrow \underline{6} HF + \underline{1} NO + \underline{1} NO_2$

(b) c̈ Vol NO → from 5.22 L NF_3
+ 5.22 L steam

(i) LR's

NF_3: $\frac{5.22\,L\,NF_3}{} \times \frac{1\,L\,NO}{2\,L\,NF_3} = 2.61\,L\,NO$

H_2O: $\frac{5.22\,L\,H_2O}{1} \times \frac{1\,L\,NO}{3\,L\,H_2O} = \boxed{1.74\,L\,NO}$

↑ LR

(NB) my method differs from Sol'n Workbook:

LR
- mol NF_3: $5.22\,L\,\frac{P}{RT} \times \frac{1\,mol\,NO}{2\,mol\,NF_3} = 2.61\,L\left(\frac{P}{RT}\right)(NO)$
- mol H_2O = $5.22\,L\,\frac{P}{RT} \times \frac{1\,mol\,NO}{3\,mol\,H_2O} = \underline{1.74}\left(\frac{P}{RT}\right)(NO)$

↑ LR

$\left(n_{NO} = 1.74\left(\frac{P}{RT}\right) = 1.74\,L\right)$

§5.4

33. $SO_{2(g)} + 2Cl_{2(g)} \rightarrow SOCl_{2(l)} + Cl_2O_{(g)}$

note - liquid

¿How many liters of Cl_2O can be produced from

(a) 5.85 L SO_2 & 9.00 L Cl_2

(using law of combining volumes) (100% yield)

(SO_2) $\frac{5.85\,L\,SO_2}{} \times \frac{1\,L\,Cl_2O}{1\,L\,SO_2} \rightarrow 5.85\,L\,Cl_2O$

(Cl_2) $\frac{9.00\,L\,Cl_2}{1} \times \frac{1\,L\,Cl_2O}{2\,L\,Cl_2} = \boxed{4.50\,L\,ClO_2}$

↑ L.R.

(b) ¿Liters of XS reactant remain?

amt. possibly made by SO_2 = 5.85 L Cl_2O
" actually " " " = 4.50 L Cl_2O
1.35 L Cl_2O not made

1.35 L Cl_2O → $\boxed{1.35\,L\,SO_2}$ (1:1 ratio)

remain unused XS reactant

(§ 5.4)

(34) $\underline{2}\ TiCl_4(g) + \underline{1}\ H_2(g) \rightarrow \underline{2}\ TiCl_3(s) + \underline{2}\ HCl(g)$

↑ note - solid

(100% yield)

(a) ¿How many liters HCl from 3.72 L $TiCl_4$ & 4.50 L H_2

($TiCl_4$) $3.72\ L\ TiCl_4 \times \frac{2\ L\ HCl}{2\ L\ TiCl_4} = 3.72\ L\ HCl$

(H_2) $4.50\ L\ H_2 \times \frac{2\ L\ HCl}{1\ L\ H_2} = 9.00\ L\ HCl$

LR

(b) ¿ L XS reactant (H_2): ?

$$\begin{array}{r} 9.00\ L\ HCl \\ -\ 3.72\ L\ HCl \\ \hline 5.28\ L\ HCl \end{array}$$

ratio: $\underline{2}HCl : \underline{1}H_2$ ↓ ÷2 $= 2.64\ L\ H_2$

(35) $\underline{1}\ N_2O_5(g) + \underline{1}\ H_2O(l) \rightarrow \underline{2}\ H^+(aq) + \underline{2}\ NO_3^-(aq)$

(The only gas)

(a) ¿ Moles H^+ from 1.50 L N_2O_5 @ 25°c & 1 atm

(i) moles N_2O_5 → $PV = nRT$ ⇒ $n = \frac{PV}{RT} = \frac{(1)(1.50)}{(0.08206)(298)}$

$n = 6.13 \times 10^{-2}$ mol N_2O_5

(ii) $\frac{6.13 \times 10^{-2}\ mol\ N_2O_5}{1} \times \frac{2\ mol\ H^+}{1\ mol\ N_2O_5} = 0.123\ mol\ H^+$

(con't)

(35b) con't

(b) after rxn, vol = 437 mL, ¿Molarity HNO_3 obtained?

(1) Molarity = $\frac{mol}{L}$

(mol H^+ = mol NO_3^- = mole HNO_3)

$= \frac{0.123 \text{ mol } HNO_3}{0.437 L} = \boxed{0.281 \text{ M } HNO_3}$

(n.b. vol results for original vol H_2O not used in rxn)

(36) $2 K_2O_{2(s)} + 2 CO_{2(g)} \rightarrow 2 K_2CO_{3(g)} + O_{2(g)}$

(a) $\frac{3.0 L \text{ air}}{1 \text{ min}}$ & air is 3.4% (v/v) CO_2

¿ # grams K_2O_2 / person for 5 day?

T = 25°C = 298K

P = $\frac{728 \text{ mmHg}}{760 \text{ mmHg}}$ = 0.958 atm

(1) Person exhales $\frac{3.0 L}{min}$ × 3.4% CO_2 = $\frac{0.102 L CO_2}{min}$

(2) for 5 days - L CO_2 exhaled

$\frac{0.102 L CO_2}{1 \text{ min}} \times \frac{60 \text{ min}}{1 hr} \times \frac{24 hr}{day} \times 5 \text{ day}$

= 734.4 L CO_2

(Can't use law multiple volumes b/c not @ STP, b/c liters affects # moles)

con't ⟹

(36) (con't) (b) 734.4 L CO_2 (needed for 5 day)

$PV = nRT \Rightarrow n = \frac{PV}{RT} = \frac{(0.958)(734.4)}{(0.08206)(298)} = 28.8 \text{ mol } CO_2$

(ii) mol CO_2 → mol K_2O_2 → g K_2O_2

$\frac{28.8 \text{ mol } CO_2}{1} = 28.8 \text{ mol } K_2O_2 \times \frac{110.196 \text{ g}}{1 \text{ mol}} = 3.170 \times 10^3 \text{ g } K_2$

2 sf (3.02

3.2×10^3 g

(37) $H^+(aq) + NaCN(s) \rightarrow HCN(g) + Na^+(aq)$

? vol of 6.00 M HCl → HCN to fill room 12 × 11 × 9 ft

P = 0.987 atm

T = 72°F = 22°C = 29

(i) vol in liters

(1) $12 \times 11 \times 9 \text{ ft} = 1.188 \times 10^3 \text{ ft}^3$

$1.188 \times 10^3 \text{ ft} \times \frac{(12 \text{ in})^3}{(1 \text{ ft})^3} \times \frac{(2.54 \text{ cm})^3}{(1 \text{ in})^3} \times \frac{1 \text{ mL}}{1 \text{ cm}^3} \times \frac{1 \text{ L}}{10^3 \text{ mL}} = 3 \times 1$

$(1.728 \times 10^3 \text{ in})$ $(1.639 \times 10^1 \text{ cm}^3)$

(ii) amt HCN(g) in room

$PV = nRT \Rightarrow n = \frac{PV}{RT} = \frac{(0.987)(3 \times 10^4)}{(0.08206)(295 \text{ K})} = 1 \times 10^3$ mol HCN

(iii) vol 6.00 M HCl → 1.37 mol HCN

$\frac{1 \times 10^3 \text{ mol}}{1} \times \frac{1 \text{ mol HCl}}{1 \text{ mol HCN}} \times \frac{1 \text{ L HCl}}{6.00 \text{ mol HCl}} = 2 \times 10^2 \text{ L}$

(38) $2H_2O_{2(aq)} \longrightarrow 2H_2O_{(l)} + 1O_{2(g)}$ (85.4)

25.00 mL of a 30.0% (m/m) of H_2O_2 → ? (L) $O_{2(g)}$

$P = 1\,atm$
$T = 298\,K$
$d_{H_2O_2} = 1.05\,g/mL$

(i) mol H_2O_2 used

$$25.00\,mL \times \frac{1.05\,g}{1\,mL} \times \frac{1\,mol\,H_2O_2}{34.02\,g\,H_2O_2} = 0.7716\,mol$$

$\times 30\% = 0.2$…

(ii) mol H_2O_2 → mol O_2 $= \frac{0.2315\,mol\,H_2O_2}{2\,(mol\,O_2)} = 0.1157\,m$…

(iii) mol O_2 → vol O_2

$$V = \frac{nRT}{P} = \frac{(0.1157)(0.08206)(298)}{1}$$

$V = 2.83\,L\,O_2$

(3 sf from 30.0%)

(39) (a) bal. equation (net ionic)

$NH_4NO_3 \rightarrow N_2 + O_2 + H_2O$

$NH_4^+ + NO_3^- \rightarrow N_2 + O_2 + H_2O$

- H in H_2O comes only from NH_4^+
  so ratio $\underline{1}\ NH_4^+ \rightarrow 2H_2O$

$\underline{1}\ NH_4^+ + NO_3^- \rightarrow N_2 + O_2 + 2H_2O$

{ Check
N: 1+2 = 2 → 2
H: 4 → 4
O: 3 → 4
} try $2NH_4NO_3$

$$2NH_4^+ (aq) + 2NO_3^- (aq) \rightarrow 2N_2 (g) + 1O_2 (g) + 4H_2O (g)$$

(b) 2.00 kg NH_4NO_3 / V = 50.0 L steel / T = 745°C = 1,018 K

P = ?

(1) moles → moles

$$2.00\,kg \times \frac{10^3\,g}{1\,kg} \times \frac{1\,mol}{80.043\,g} \times \frac{7\,mol\ gas}{2\,mol\ NH_4NO_3} = 87.4\,mol$$

(NH_4NO_3)

(TOTAL GAS (law of multiple volumes) 2+1+4 = 7

$$P = \frac{(87.4)(0.08206)(1018)}{50.0\,L} = 146\,atm$$

R given

§5.4

(40)

$C_9H_{18}O_6(s) \rightarrow$

(a) bal. chem.

_ $C_9H_{18}O_6$ + _ O_2 → _ CO_2 + H_2O

all H_2O from $C_9H_{18}O_6$ - ratio = 18 : 2 → 9 : 1

$\underline{2}\ C_9H_{18}O_6 + \underline{21}\ O_2 \longrightarrow \underline{18}\ H_2O + \underline{18}\ CO_2$

(note: nine carbons → coefficient is even)

(b) **P = ?**   V = 2.00 L / 5.00 g $C_9H_{18}O_2$ / T = 828 K

(100% combustion)

$$P = \frac{nRT}{V}$$

$$n = \underbrace{\frac{5.00\,g}{1} \times \frac{1\,mol}{222.24\,g}}_{C_9H_{18}O_6} \times \underbrace{\frac{36\,mol\ gas}{2\,mol}}_{gases}$$

n = 0.405 mol

P = (0.405)(0.08206)(828) / 2

P = 13.8 atm

(3 sf)

(2.00 L)