Chemical Reactions

Set 17

1. a) 1 mole of $Pb(NO_3)_2$ requires 2 moles of KI
0.300 mole of $Pb(NO_3)_2$ requires 2 x 0.300 = 0.600 mol of KI
n(KI required) > n(KI available)
∴ KI is LR

b) $n(PbI_2)$ = ½ n(KI)
= ½ x 0.400
= 0.200 mol
$n(PbI_2)$ = 0.200 x 461.0
= 92.2 g

2. a) $n(NaOH) = \frac{5.55}{39.998}$
= 0.139 mol

$n(HC\ell) = \frac{4.88}{36.458}$
= 0.134 mol

1 mol of NaOH requires 1 mol of HCℓ
0.139 mol of NaOH requires 0.139 mol of HCℓ
n(HCℓ required) > n(HCℓ available)
∴ HCℓ is LR

b) n(NaCℓ) = n(HCℓ)
= 0.134 mol
m(NaCℓ) = 0.134 x 58.44
= 7.82 g

3. a) $n(CH_3COOH) = \frac{4.78}{60.052}$
= 7.96×10^{-2} mol

$n(CaCO_3) = \frac{2.22}{100.09}$
= 2.22×10^{-2} mol

1 mole of $CaCO_3$ requires 2 moles of CH_3COOH
2.22×10^{-2} mol of $CaCO_3$ requires 2 x (2.22×10^{-2}) = 4.44×10^{-2} mol CH_3COOH
n(CH_3COOH requ) < n(CH_3COOH avail)
∴ $CaCO_3$ is LR

b) $n(CO_2) = n(CaCO_3)$
= 2.22×10^{-2} mol
$m(CO_2)$ = (2.22×10^{-2}) x 44.01
= 0.976 g

c) $n(Ca(CH_3COO)_2) = n(CaCO_3)$
= 2.22×10^{-2} mol
$m(Ca(CH_3COO)_2)$ = (2.22×10^{-2}) x 158.148
= 3.51 g

4. a) $n(Mg) = \frac{6.08}{24.3}$
= 0.250 mol

$n(H_2SO_4) = \frac{20.0}{98.076}$
= 0.2039 mol

1 mol of Mg requires 1 mol of H_2SO_4

0.250 mol of Mg requires 0.250 mol of H_2SO_4
$n(H_2SO_4\ req) > n(H_2SO_4\ avail)$
$\therefore$ H_2SO_4 is LR

b) $n(H_2) = n(H_2SO_4)$
$= 0.2039$ mol
$m(H_2) = 0.2039 \times 2.016$
$= 0.411$ g

c) $n(MgSO_4.7H_2O) = n(H_2SO_4)$
$= 0.2039$ mol
$m(MgSO_4.7H_2O) = 0.2039 \times 246.472$
$= 50.3$ g

5. a) $n(NaOH) = \frac{1.600}{39.998}$ $n(H_2SO_4) = \frac{1.472}{98.076}$
$= 4.00 \times 10^{-2}$ mol $= 1.50 \times 10^{-2}$ mol
1 mol of H_2SO_4 requires 2 mol of NaOH
1.5×10^{-2} mol of H_2SO_4 requires $2 \times (1.50 \times 10^{-2}) = 3.00 \times 10^{-2}$ mol
$n(NaOH\ req) < n(NaOH\ avail)$
$\therefore$ H_2SO_4 is LR

b) $n(Na_2SO_4) = n(H_2SO_4)$
$= 1.50 \times 10^{-2}$ mol
$m(Na_2SO_4) = (1.50 \times 10^{-2}) \times 142.04$
$= 2.13$ g

c) $n(NaOH\ rem) = 4.00 \times 10^{-2} - 3.00 \times 10^{-2}$
$= 1.00 \times 10^{-2}$ mol
$m(NaOH) = (1.00 \times 10^{-2}) \times 39.998$
$= 0.400$ g

6. a) $n(Ag) = \frac{16.25}{107.9}$ $n(HNO_3) = \frac{18.4}{63.018}$
$= 0.151$ mol $= 0.292$ mol
1 mol of Ag requires 4/3 mol of HNO_3
0.151 mol of Ag requires $4/3 \times 0.151 = 0.201$ mol
$n(HNO_3\ req) < n(HNO_3\ avail)$
$\therefore$ Ag is LR

b) $n(NO) = 1/3\ n(Ag)$
$= 1/3 \times 0.151$
$= 0.0503$ mol
$m(NO) = 0.0503 \times 30.01$
$= 1.51$ g

c) $n(HNO_3\ rem) = 0.292 - 0.201$
$= 0.091$ mol
$m(HNO_3) = 0.091 \times 63.018$
$= 5.75$ g

7. a) $n(KO_2) = \frac{5.00}{71.1}$ $n(CO_2) = \frac{9.00}{44.01}$
$= 7.03 \times 10^{-2}$ mol $= 0.204$ mol

1 mol of CO_2 requires 2 mol of KO_2
0.204 mol requires 2 x 0.204 = 0.408 mol of KO_2
n(KO_2 required) > n(KO_2 avail)
∴ KO_2 is LR
n(K_2CO_3) = ½ n(KO_2)
= ½ x (7.03 x 10^{-2})
= 3.52 x 10^{-2} mol
m(K_2CO_3) = (3.52 x 10^{-2}) x 138.21
= 4.86 g

b) n(O_2) = 3/2 n(KO_2)
= 3/2 x (7.03 x 10^{-2})
= 0.105 ol
m(O_2) = 0.105 x 32.00
= 3.36 g

n(CO_2 rem) = 0.204 – ½ x (7.02 x 10^{-2})
= 0.269 mol
m(CO_2) = 0.269 x 44.01
= 7.43 g

8. n($Ca_3(PO_4)_2$) = $\frac{25.0x10^6}{310.18}$
= 8.06 x 10^4 mol

n(H_3PO_4) = $\frac{30.0x10^6}{97.94}$
= 3.06 x 10^5 mol

1 mol of $Ca_3(PO_4)_2$ requires 4 mol of H_3PO_4
8.06 x 10^4 mol of $Ca_3(PO_4)_2$ requires 4 x (8.06 x 10^4) = 3.224 x 10^5 mol of H_3PO_4
n(H_3PO_4 req) > n(H_3PO_4 avail)
∴ H_3PO_4 is LR
n($Ca(H_2PO_4)2$) = ¾ n(H_3PO_4)
= ¾ x (3.06 x 10^5)
= 2.296 x 10^5 mol
m($Ca(H_2PO_4)_2$) = (2.296 x 10^5) x 234.052
= 5.37 x 10^7 g (53.7 tonne)

9. n(CO_2) = $\frac{2.94}{44.01}$
= 6.68 x 10^{-2} mol
n(Na_2CO_3) = n(CO_2)
= 6.68 x 10^{-2} mol
m(Na_2CO_3) = (6.68 x 10^{-2}) x 105.99
= 7.08 g
%Na_2CO_3: $\frac{7.08}{7.20}$ x 100 = 98.3%

10. n(Cl_2) = $\frac{2.84}{70.9}$
= 4.01 x 10^{-2} mol
n(MnO_2) = n(Cl_2)
= 4.01 x 10^{-2} mol
m(MnO_2) = (4.01 x 10^{-2}) x 86.94
= 2.49 g
%MnO_2: $\frac{3.49}{3.52}$ x 100 = 99.0%