Set 20

1. a) $Ag^+(aq) + C\ell^-(aq) \rightarrow AgC\ell(s)$

   b) $n(AgC\ell) = n(Ag^+) = n(AgNO_3)$
   $= 0.0250 \times 0.0227$
   $= 5.675 \times 10^{-4}$ mol
   $m(AgC\ell) = 5.675 \times 10^{-3}(143.35)$
   $= 8.14 \times 10^{-2}$ g

2. a) $2C_4H_{10}(g) + 13O_2(g) \rightarrow 8CO_2(g) + 10H_2O(l)$

   b) $n(CO_2) = 4\ n(C_4H_{10})$
   $V(CO_2) = 4\ V(C_4H_{10})$
   $= 4 \times 47.3$
   $= 189$ L

   c) $n(C_4H_{10}) = \dfrac{47.3}{22.4}$
   $= 2.11$ mol
   $n(H_2O) = 5\ n(H_2O)$
   $= 5 \times 2.11$
   $= 10.56$ mol
   $m(H_2O) = 10.56 \times 18.016$
   $= 1.90 \times 10^2$ g

3. a) $Na_2CO_3(s) + 2H^+(aq) \rightarrow 2Na^+(aq) + CO_2(g) + H_2O(l)$

   b) $n(Na_2CO_3) = \dfrac{1.34}{105.99}$
   $= 0.0126$ mol
   $n(CO_2) = n(Na_2CO_3)$
   $= 1.26 \times 10^{-2}$ mol
   $V(CO_2) = (1.26 \times 10^{-2}) \times 22.4$
   $= 0.283$ L

   c) $n(HNO_3) = 2\ n(Na_2CO_3)$
   $= (1.26 \times 10^{-2}) \times 2$
   $= 2.53 \times 10^{-2}$ mol
   $V(HNO_3) = \dfrac{2.53x10^{-2}}{0.125}$
   $= 0.202$ L

4. a) $n(Mg) = \dfrac{0.720}{24.3}$
   $= 2.96 \times 10^{-2}$ mol
   $n(HCl) = 2\ n(Mg)$
   $= 2 \times (2.96 \times 10^{-2})$
   $= 5.93 \times 10^{-2}$ mol
   $V(HCl) = \dfrac{5.93x10^{-2}}{0.950}$
   $= 6.24 \times 10^{-2}$ L

b) $n(H_2) = n(Mg)$
$= 2.96 \times 10^{-2}$ mol
$V(H_2) = (2.96 \times 10^{-2}) \times 22.4$
$= 0.663$ L

c) $n(MgCl_2) = n(Mg)$
$= 2.96 \times 10^{-2}$ mol
$m(MgCl_2) = (2.96 \times 10^{-2}) \times 95.2$
$= 2.82$ g

5. $n(H_2) = \frac{19.6}{22.4}$
$= 0.875$ mol
$n(H_2SO_4) = n(H_2)$
$= 0.875$ mol
$V(H_2SO_4) = \frac{0.875}{6.00}$
$= 0.146$ L
$n(Al) = 2/3\ n(H_2)$
$= 2/3 \times 0.875$
$= 0.583$ mol
$m(Al) = 0.583 \times 26.98$
$= 15.7$ g

6. a) $Pb^{2+}(aq) + 2I^-(aq) \rightarrow PbI_2(s)$
$n(Pb^{2+}) = n(Pb(NO_3)_2)$
$= 0.0250 \times 0.212$
$= 5.30 \times 10^{-3}$ mol
$n(NaI) = n(I^-) = 2n(Pb^{2+})$
$= 2 \times (5.30 \times 10^{-3})$
$= 1.06 \times 10^{-2}$ mol
$V(NaI) = \frac{1.06x10^{-2}}{0.260}$
$= 4.08 \times 10^{-2}$ L

b) $n(PbI_2) = n(Pb^{2+})$
$= 5.30 \times 10^{-3}$ mol
$m(PbI_2) = (5.30 \times 10^{-3}) \times 461$
$= 2.44$ g

7. a) $CaCO_3 + 2H^+ \rightarrow Ca^{2+} + CO_2 + H_2O$
$n(CaCO_3) = \frac{10.0}{100.09}$
$= 0.101$ mol
$n(H^+) = 2\ n(CaCO_3)$
$= 2 \times 0.101$
$= 0.202$ mol
$V(H^+) = \frac{0.202}{1.07}$
$= 0.189$ L

b) $n(CO_2) = n(CaCO_3)$
$= 0.101$ mol
$V(CO_2) = 0.101 \times 22.4$
$= 2.26$ L

c) $n(CaCl_2) = n(CaCO_3)$
$= 0.101$ mol

$$c(CaCl_2) = \frac{0.101}{0.189}$$

$= 0.534$ mol L^{-1}

8. $CaCO_3 + 2H^+ \rightarrow Ca^{2+} + CO_2 + H_2O$

$m(CaCO_3 \text{ react}) = 5.60 - 5.09$
$= 0.510$ g

$$n(CaCO_3) = \frac{0.510}{100.09}$$

$= 5.10 \times 10^{-3}$ mol

$n(HCl) = n(H^+) = 2\ n(CaCO_3)$
$= 2 \times (5.10 \times 10^{-3})$
$= 1.01 \times 10^{-2}$ mol

$$c(HCl) = \frac{1.02x10^{-2}}{0.0200}$$

$= 0.510$ mol L^{-1}

9. a) $n(AgCl) = \frac{5.74}{143.35}$
$= 4.00 \times 10^{-2}$ mol

$n(Ag_2CO_3) = ½\ n(AgCl)$
$= ½ \times (4.00 \times 10^{-2})$
$= 2.00 \times 10^{-2}$ mol

$m(Ag_2CO_3) = (2.00 \times 10^{-2}) \times 275.81$
$= 5.52$ g

b) $n(\text{HCl consumed}) = n(AgCl)$
$= 4.00 \times 10^{-2}$ mol

c) $n(CO_2) = ½\ n(AgCl)$
$= ½ \times (4.00 \times 10^{-2})$
$= 2.00 \times 10^{-2}$ mol

$V(CO_2) = (2.00 \times 10^{-2}) \times 22.4$
$= 0.448$ L

10. a) $n(P_4) = \frac{6.20}{123.88}$
$= 5.00 \times 10^{-2}$ mol

$n(P_4O_{10}) = n(P_4)$
$= 5.00 \times 10^{-2}$ mol

$m(P_4O_{10}) = (5.00 \times 10^{-2}) \times 283.88$
$= 14.2$ g

b) $n(O_2) = 5\ n(P_4)$
$= 5 \times (5.00 \times 10^{-2})$
$= 0.250$ mol

$V(O_2) = 0.250 \times 22.4$
$= 5.605$ L
$= 20\%$ air

$$V(\text{air}) = \frac{100}{20} \times 5.605 \text{ L}$$

= 28.0 L

11. a) n(Zn consumed) = 15.0 – 2.00
= 13.0 g

$$n(Zn) = \frac{13.0}{65.38}$$
= 0.199 mol
n(HCl) = 2 n(Zn)
= 2 x 0.199
= 0.398 mol

b) $n(ZnCl_2) = n(Zn)$
= 0.199 mol
$m(ZnCl_2) = 0.199 \times 136.28$
= 27.1 g

c) $n(H_2) = n(Zn)$
= 0.199 mol
$V(H_2) = 0.199 \times 22.4$
= 4.45 L

12. a) $$n(O_2) = \frac{8.00}{32.00}$$
= 0.250 mol
$n(H_2S) = 2/3\ n(O_2)$
= 2/3 x 0.250
= 0.167 mol

b) $V(H_2S) = 0.167 \times 22.4$
= 3.73 L

13. $m(NO) = 3.00 \times (1.60 \times 10^4)$
$= 4.80 \times 10^4$ g

$$n(NO) = \frac{4.80x10^4}{30.01}$$
$= 1.599 \times 10^3$ mol
$n(NH_3) = 4/6\ n(NO)$
$4/6 \times (1.599 \times 10^3)$
$= 1.067 \times 10^3$ mol
$V(NH_3) = (1.067 \times 10^3) \times 22.4$
$= 2.39 \times 10^4$ L

14. $2H_2 + O_2 \rightarrow 2H_2O$

$$n(H_2) = \frac{2.00x10^3}{2.016}$$
$= 9.92 \times 10^2$ mol
$n(O_2) = ½\ n(H_2)$
$= ½ \times (9.92 \times 10^2)$
$= 4.96 \times 10^2$ mol
$V(O_2) = (4.96 \times 10^2) \times 22.4$
$= 1.11 \times 10^4$ L

15. a) $2H_2 + O_2 \rightarrow 2H_2O$

$$n(H_2) = \frac{1.60}{2.018}$$
$$= 0.794 \text{ mol}$$

$$n(O_2) = \frac{10}{22.4}$$
$$= 0.446 \text{ mol}$$

1 mol of H_2 requires ½ mole of O_2
0.794 mol of H_2 requires ½ x 0.794 = 0.397 mol of O_2
$n(O_2 \text{ required}) < n(O_2 \text{ available})$
$\therefore$ H_2 is LR

$n(H_2O) = n(H_2)$
$= 0.794$ mol
$m(H_2O) = 0.794 \times 18.016$
$= 14.3$ g

b) $n(O_2 \text{ rem}) = 0.446 - 0.397$
$= 0.0490$ mol
$V(O_2) = 0.0490 \times 22.4$
$= 1.10$ L

c) $V(H_2O) = 0.794 \times 22.4$
$= 17.8$ L

16. a) $2H_2 + O_2 \rightarrow 2H_2O$
$n(O_2) = ½\ n(H_2)$
$V(O_2) = ½\ V(H_2)$
$= ½ \times 1.00$
$= 0.500$ L

b) $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$
$n(O_2) = 2\ n(CH_4)$
$= 2 \times (2.00 \times 10^3)$
$= 4.00 \times 10^3$ mL

17. $Ba^{2+} + SO_4^{2-} \rightarrow BaSO_4(s)$
$$n(BaSO_4) = \frac{0.483}{233.36}$$
$= 2.07 \times 10^{-3}$ mol
$n(H_2SO_4) = n(SO_4^{2-})$
$= 2.07 \times 10^{-3}$ mol in 25.0 mL
$$n(H_2SO_4 \text{ in } 125.0 \text{ mL}) = \frac{125.0}{25.0} \times (2.07 \times 10^{-3})$$
$= 1.03 \times 10^{-2}$ mol
$H^+ + OH^- \rightarrow H_2O$
$n(H^+) = 2n(H_2SO_4)$
$= 2 \times (1.03 \times 10^{-2})$
$= 2.07 \times 10^{-2}$ mol
$= n(OH^-)$ required
$$V(OH^-) = \frac{2.07x10^{-2}}{0.0134}$$
$= 1.54$ L

18. $CaCO_3 + 2H^+ \rightarrow Ca^{2+} + CO_2 + H_2O$

$n(H^+) = n(HCl) = 0.0200 \times 2.50$

$= 5.00 \times 10^{-2}$ mol

$n(CaCO_3) = \frac{1}{2}\, n(5.00 \times 10^{-2})$

$= 2.50 \times 10^{-2}$ mol

$m(CaCO_3) = (2.50 \times 10^{-2}) \times 100.09$

$= 2.502$ g

$\%CaCO_3$: $\frac{2.502}{3.00} \times 100 = 83.4\ \%$

19. $Ag^+ + Cl^-$ AgCl

$n(AgCl) = n(Cl^-) = n(NaCl)$

$= 0.0415 \times 0.0993$

$= 4.12 \times 10^{-3}$ mol

$= n(Ag)$

$m(Ag) = (4.12 \times 10\text{-}3) \times 107.9$

$= 0.445$ g

$\%Ag$: $\frac{0.445}{0.482} \times 100 = 92.3\ \%$

20. a) $n((NH_4)_2SO_4) = \frac{30.3}{132.144}$

$= 0.227$ mol

$n(KNO_2) = \frac{34.0}{101.11}$

$= 0.336$ mol

1 mol of $(NH_4)_2SO_4$ requires 2 mol of KNO_2

0.227 mol of $(NH_4)_2SO_4$ requires $2 \times 0.227 = 0.454$ mol of KNO_2

$n(KNO_2\ req) > n(KNO_2\ avail)$

$\therefore$ KNO_2 is LR

b) $n((NH_4)_2SO_4\ rem) = 0.227 - (\frac{1}{2} \times 0.336)$

$= 5.89 \times 10^{-2}$ mol

$m((NH_4)_2SO_4) = (5.89 \times 10^{-2}) \times 132.144$

$= 7.80$ g

c) $n(N_2) = n(KNO_2)$

$= 0.336$ mol

$V(N_2) = 0.336 \times 22.4$

$= 7.53$ L