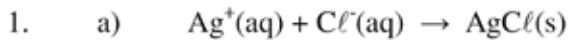
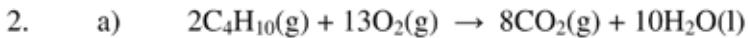


Chemical Reactions

Set 20

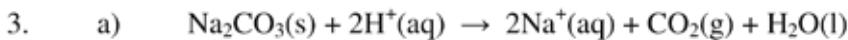


$$\begin{aligned}\text{b)} \quad n(\text{AgCl}) &= n(\text{Ag}^+) = n(\text{AgNO}_3) \\ &= 0.0250 \times 0.0227 \\ &= 5.675 \times 10^{-4} \text{ mol} \\ m(\text{AgCl}) &= 5.675 \times 10^{-3} (143.35) \\ &= 8.14 \times 10^{-2} \text{ g}\end{aligned}$$



$$\begin{aligned}\text{b)} \quad n(\text{CO}_2) &= 4 n(\text{C}_4\text{H}_{10}) \\ V(\text{CO}_2) &= 4 V(\text{C}_4\text{H}_{10}) \\ &= 4 \times 47.3 \\ &= 189 \text{ L}\end{aligned}$$

$$\begin{aligned}\text{c)} \quad n(\text{C}_4\text{H}_{10}) &= \frac{47.3}{22.4} \\ &= 2.11 \text{ mol} \\ n(\text{H}_2\text{O}) &= 5 n(\text{H}_2\text{O}) \\ &= 5 \times 2.11 \\ &= 10.56 \text{ mol} \\ m(\text{H}_2\text{O}) &= 10.56 \times 18.016 \\ &= 1.90 \times 10^2 \text{ g}\end{aligned}$$



$$\begin{aligned}\text{b)} \quad n(\text{Na}_2\text{CO}_3) &= \frac{1.34}{105.99} \\ &= 0.0126 \text{ mol} \\ n(\text{CO}_2) &= n(\text{Na}_2\text{CO}_3) \\ &= 1.26 \times 10^{-2} \text{ mol} \\ V(\text{CO}_2) &= (1.26 \times 10^{-2}) \times 22.4 \\ &= 0.283 \text{ L}\end{aligned}$$

$$\begin{aligned}\text{c)} \quad n(\text{HNO}_3) &= 2 n(\text{Na}_2\text{CO}_3) \\ &= (1.26 \times 10^{-2}) \times 2 \\ &= 2.53 \times 10^{-2} \text{ mol} \\ V(\text{HNO}_3) &= \frac{2.53 \times 10^{-2}}{0.125} \\ &= 0.202 \text{ L}\end{aligned}$$

4. a) $n(\text{Mg}) = \frac{0.720}{24.3}$

$$\begin{aligned}&= 2.96 \times 10^{-2} \text{ mol} \\ n(\text{HCl}) &= 2 n(\text{Mg}) \\ &= 2 \times (2.96 \times 10^{-2}) \\ &= 5.93 \times 10^{-2} \text{ mol} \\ V(\text{HCl}) &= \frac{5.93 \times 10^{-2}}{0.950} \\ &= 6.24 \times 10^{-2} \text{ L}\end{aligned}$$

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

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

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

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

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

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

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

$$\begin{aligned} \text{c)} \quad n(\text{CaCl}_2) &= n(\text{CaCO}_3) \\ &= 0.101 \text{ mol} \\ c(\text{CaCl}_2) &= \frac{0.101}{0.189} \\ &= 0.534 \text{ mol L}^{-1} \end{aligned}$$

8. $\text{CaCO}_3 + 2\text{H}^+ \rightarrow \text{Ca}^{2+} + \text{CO}_2 + \text{H}_2\text{O}$

$$\begin{aligned} m(\text{CaCO}_3 \text{ react}) &= 5.60 - 5.09 \\ &= 0.510 \text{ g} \\ n(\text{CaCO}_3) &= \frac{0.510}{100.09} \\ &= 5.10 \times 10^{-3} \text{ mol} \\ n(\text{HCl}) &= n(\text{H}^+) = 2 n(\text{CaCO}_3) \\ &= 2 \times (5.10 \times 10^{-3}) \\ &= 1.01 \times 10^{-2} \text{ mol} \\ c(\text{HCl}) &= \frac{1.02 \times 10^{-2}}{0.0200} \\ &= 0.510 \text{ mol L}^{-1} \end{aligned}$$

9. a) $n(\text{AgCl}) = \frac{5.74}{143.35}$
 $= 4.00 \times 10^{-2} \text{ mol}$
 $n(\text{Ag}_2\text{CO}_3) = \frac{1}{2} n(\text{AgCl})$
 $= \frac{1}{2} \times (4.00 \times 10^{-2})$
 $= 2.00 \times 10^{-2} \text{ mol}$
 $m(\text{Ag}_2\text{CO}_3) = (2.00 \times 10^{-2}) \times 275.81$
 $= 5.52 \text{ g}$

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

c) $n(\text{CO}_2) = \frac{1}{2} n(\text{AgCl})$
 $= \frac{1}{2} \times (4.00 \times 10^{-2})$
 $= 2.00 \times 10^{-2} \text{ mol}$
 $V(\text{CO}_2) = (2.00 \times 10^{-2}) \times 22.4$
 $= 0.448 \text{ L}$

10. a) $n(\text{P}_4) = \frac{6.20}{123.88}$
 $= 5.00 \times 10^{-2} \text{ mol}$
 $n(\text{P}_4\text{O}_{10}) = n(\text{P}_4)$
 $= 5.00 \times 10^{-2} \text{ mol}$
 $m(\text{P}_4\text{O}_{10}) = (5.00 \times 10^{-2}) \times 283.88$
 $= 14.2 \text{ g}$

b) $n(\text{O}_2) = 5 n(\text{P}_4)$
 $= 5 \times (5.00 \times 10^{-2})$
 $= 0.250 \text{ mol}$
 $V(\text{O}_2) = 0.250 \times 22.4$
 $= 5.605 \text{ L}$
 $= 20\% \text{ air}$
 $V(\text{air}) = \frac{100}{20} \times 5.605 \text{ L}$

$$= 28.0 \text{ L}$$

11. a) $n(\text{Zn consumed}) = 15.0 - 2.00$
 $= 13.0 \text{ g}$

$$\begin{aligned} n(\text{Zn}) &= \frac{13.0}{65.38} \\ &= 0.199 \text{ mol} \\ n(\text{HCl}) &= 2 n(\text{Zn}) \\ &= 2 \times 0.199 \\ &= 0.398 \text{ mol} \end{aligned}$$

b) $n(\text{ZnCl}_2) = n(\text{Zn})$
 $= 0.199 \text{ mol}$
 $m(\text{ZnCl}_2) = 0.199 \times 136.28$
 $= 27.1 \text{ g}$

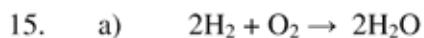
c) $n(\text{H}_2) = n(\text{Zn})$
 $= 0.199 \text{ mol}$
 $V(\text{H}_2) = 0.199 \times 22.4$
 $= 4.45 \text{ L}$

12. a) $n(\text{O}_2) = \frac{8.00}{32.00}$
 $= 0.250 \text{ mol}$
 $n(\text{H}_2\text{S}) = 2/3 n(\text{O}_2)$
 $= 2/3 \times 0.250$
 $= 0.167 \text{ mol}$

b) $V(\text{H}_2\text{S}) = 0.167 \times 22.4$
 $= 3.73 \text{ L}$

13. $m(\text{NO}) = 3.00 \times (1.60 \times 10^4)$
 $= 4.80 \times 10^4 \text{ g}$
 $n(\text{NO}) = \frac{4.80 \times 10^4}{30.01}$
 $= 1.599 \times 10^3 \text{ mol}$
 $n(\text{NH}_3) = 4/6 n(\text{NO})$
 $= 4/6 \times (1.599 \times 10^3)$
 $= 1.067 \times 10^3 \text{ mol}$
 $V(\text{NH}_3) = (1.067 \times 10^3) \times 22.4$
 $= 2.39 \times 10^4 \text{ L}$

14. $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$
 $n(\text{H}_2) = \frac{2.00 \times 10^3}{2.016}$
 $= 9.92 \times 10^2 \text{ mol}$
 $n(\text{O}_2) = 1/2 n(\text{H}_2)$
 $= 1/2 \times (9.92 \times 10^2)$
 $= 4.96 \times 10^2 \text{ mol}$
 $V(\text{O}_2) = (4.96 \times 10^2) \times 22.4$
 $= 1.11 \times 10^4 \text{ L}$



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

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

1 mol of H₂ requires ½ mole of O₂
 0.794 mol of H₂ requires ½ x 0.794 = 0.397 mol of O₂
 n(O₂ required) < n(O₂ available)
 ∴ H₂ is LR

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

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

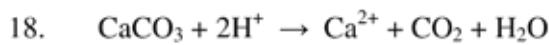
c) $V(H_2O) = 0.794 \times 22.4 \\ = 17.8 \text{ L}$

16. a) $2H_2 + O_2 \rightarrow 2H_2O$
 $n(O_2) = \frac{1}{2} n(H_2)$
 $V(O_2) = \frac{1}{2} V(H_2)$
 $= \frac{1}{2} \times 1.00$
 $= 0.500 \text{ L}$

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

17. $Ba^{2+} + SO_4^{2-} \rightarrow BaSO_4(s)$
 $n(BaSO_4) = \frac{0.483}{233.36}$
 $= 2.07 \times 10^{-3} \text{ mol}$
 $n(H_2SO_4) = n(SO_4^{2-})$
 $= 2.07 \times 10^{-3} \text{ mol in } 25.0 \text{ mL}$
 $n(H_2SO_4 \text{ in } 125.0 \text{ mL}) = \frac{125.0}{25.0} \times (2.07 \times 10^{-3})$
 $= 1.03 \times 10^{-2} \text{ mol}$

$H^+ + OH^- \rightarrow H_2O$
 $n(H^+) = 2n(H_2SO_4)$
 $= 2 \times (1.03 \times 10^{-2})$
 $= 2.07 \times 10^{-2} \text{ mol}$
 $= n(OH^-) \text{ required}$
 $V(OH^-) = \frac{2.07 \times 10^{-2}}{0.0134}$
 $= 1.54 \text{ L}$



$$\begin{aligned} n(\text{H}^+) &= n(\text{HCl}) = 0.0200 \times 2.50 \\ &= 5.00 \times 10^{-2} \text{ mol} \end{aligned}$$

$$\begin{aligned} n(\text{CaCO}_3) &= \frac{1}{2} n(5.00 \times 10^{-2}) \\ &= 2.50 \times 10^{-2} \text{ mol} \end{aligned}$$

$$\begin{aligned} m(\text{CaCO}_3) &= (2.50 \times 10^{-2}) \times 100.09 \\ &= 2.502 \text{ g} \end{aligned}$$

$$\% \text{CaCO}_3: \frac{2.502}{3.00} \times 100 = 83.4 \%$$



$$\begin{aligned} n(\text{AgCl}) &= n(\text{Cl}^-) = n(\text{NaCl}) \\ &= 0.0415 \times 0.0993 \\ &= 4.12 \times 10^{-3} \text{ mol} \\ &= n(\text{Ag}) \end{aligned}$$

$$\begin{aligned} m(\text{Ag}) &= (4.12 \times 10^{-3}) \times 107.9 \\ &= 0.445 \text{ g} \end{aligned}$$

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

20. a) $n((\text{NH}_4)_2\text{SO}_4) = \frac{30.3}{132.144} = 0.227 \text{ mol}$ $n(\text{KNO}_2) = \frac{34.0}{101.11} = 0.336 \text{ mol}$

1 mol of $(\text{NH}_4)_2\text{SO}_4$ requires 2 mol of KNO_2

0.227 mol of $(\text{NH}_4)_2\text{SO}_4$ requires $2 \times 0.227 = 0.454$ mol of KNO_2

$n(\text{KNO}_2 \text{ req}) > n(\text{KNO}_2 \text{ avail})$

$\therefore \text{KNO}_2$ is LR

b) $n((\text{NH}_4)_2\text{SO}_4 \text{ rem}) = 0.227 - (\frac{1}{2} \times 0.336)$
 $= 5.89 \times 10^{-2} \text{ mol}$

$$m((\text{NH}_4)_2\text{SO}_4) = (5.89 \times 10^{-2}) \times 132.144 = 7.80 \text{ g}$$

c) $n(\text{N}_2) = n(\text{KNO}_2)$

$$= 0.336 \text{ mol}$$

$$V(\text{N}_2) = 0.336 \times 22.4 = 7.53 \text{ L}$$