Complete and balance the following equations.

1. $Pb(OH)_4^{2-}{}_{(aq)} + ClO^-{}_{(aq)} \longrightarrow PbO_{2(s)} + Cl^-{}_{(aq)}$ *basic solution*

$Pb(OH)_4^{2-} \longrightarrow PbO_2$

$Pb(OH)_4^{2-} \longrightarrow PbO_2 + 2H_2O$

$Pb(OH)_4^{2-} \longrightarrow PbO_2 + 2H_2O$

$Pb(OH)_4^{2-} \longrightarrow PbO_2 + 2H_2O + 2e^-$

$ClO^- \longrightarrow Cl^-$

$ClO^- \longrightarrow Cl^- + H_2O$

$2H^+ + ClO^- \longrightarrow Cl^- + H_2O$

$2e^- + 2H^+ + ClO^- \longrightarrow Cl^- + H_2O$

$Pb(OH)_4^{2-} \longrightarrow PbO_2 + 2H_2O + 2e^-$

$2e^- + 2H^+ + ClO^- \longrightarrow Cl^- + H_2O$

$Pb(OH)_4^{2-} + 2H^+ + ClO^- \longrightarrow PbO_2 + Cl^- + 3H_2O$

$2OH^- + Pb(OH)_4^{2-} + 2H^+ + ClO^- \longrightarrow PbO_2 + Cl^- + 3H_2O + 2OH^-$

$Pb(OH)_4^{2-} + 2H_2O + ClO^- \longrightarrow PbO_2 + Cl^- + 3H_2O + 2OH^-$

$$Pb(OH)_4^{2-}{}_{(aq)} + ClO^-{}_{(aq)} \longrightarrow PbO_{2(s)} + Cl^-{}_{(aq)} + H_2O_{(l)} + 2OH^-{}_{(aq)}$$

2. $Tl_2O_{3(s)} + NH_2OH_{(aq)} \longrightarrow TlOH_{(s)} + N_{2(g)}$ *basic solution*

$Tl_2O_3 \longrightarrow TlOH$

$Tl_2O_3 \longrightarrow 2TlOH$

$Tl_2O_3 \longrightarrow 2TlOH + H_2O$

$4H^+ + Tl_2O_3 \longrightarrow 2TlOH + H_2O$

$4e^- + 4H^+ + Tl_2O_3 \longrightarrow 2TlOH + H_2O$

$NH_2OH \longrightarrow N_2$

$2NH_2OH \longrightarrow N_2$

$2NH_2OH \longrightarrow N_2 + 2H_2O$

$2NH_2OH \longrightarrow N_2 + 2H_2O + 2H^+$

$2NH_2OH \longrightarrow N_2 + 2H_2O + 2H^+ + 2e^-$

$4e^- + 4H^+ + Tl_2O_3 \longrightarrow 2TlOH + H_2O$

$2NH_2OH \longrightarrow N_2 + 2H_2O + 2H^+ + 2e^-$

multiply by 2 to balance electrons

$4e^- + 4H^+ + Tl_2O_3 \longrightarrow 2TlOH + H_2O$

$4NH_2OH \longrightarrow 2N_2 + 4H_2O + 4H^+ + 4e^-$

$4NH_2OH + Tl_2O_3 \longrightarrow 2TlOH + 2N_2 + 5H_2O$

$$4NH_2OH_{(aq)} + Tl_2O_{3(s)} \longrightarrow 2TlOH_{(s)} + 2N_{2(g)} + 5H_2O_{(l)}$$

3. $Cr_2O_7^{2-}{}_{(aq)} + CH_3OH_{(aq)} \longrightarrow HCO_2H_{(aq)} + Cr^{3+}{}_{(aq)}$ *acidic solution*

$Cr_2O_7^{-2}{}_{(aq)} \longrightarrow Cr^{+3}{}_{(aq)}$

$Cr_2O_7^{-2}{}_{(aq)} \longrightarrow 2Cr^{+3}{}_{(aq)}$

$Cr_2O_7^{-2}{}_{(aq)} \longrightarrow 2Cr^{+3}{}_{(aq)} + 7H_2O$

$14H^+ + Cr_2O_7^{-2}{}_{(aq)} \longrightarrow 2Cr^{+3}{}_{(aq)} + 7H_2O$

$6e^- + 14H^+ + Cr_2O_7^{-2}{}_{(aq)} \longrightarrow 2Cr^{+3}{}_{(aq)} + 7H_2O$

$CH_3OH \longrightarrow HCO_2H$

$H_2O + CH_3OH \longrightarrow HCO_2H$

$H_2O + CH_3OH \longrightarrow HCO_2H + 4H^+$

$H_2O + CH_3OH \longrightarrow HCO_2H + 4H^+ + 4e^-$

$6e^- + 14H^+ + Cr_2O_7^{-2}{}_{(aq)} \longrightarrow 2Cr^{+3}{}_{(aq)} + 7H_2O$ *multiply by 2 to balance electrons*

$H_2O + CH_3OH \longrightarrow HCO_2H + 4H^+ + 4e^-$ *multiply by 3 to balance electrons*

$12e^- + 28H^+ + 2Cr_2O_7^{-2}{}_{(aq)} \longrightarrow 4Cr^{+3}{}_{(aq)} + 14H_2O$

$3H_2O + 3CH_3OH \longrightarrow 3HCO_2H + 12H^+ + 12e^-$

$16H^+ + 2Cr_2O_7^{-2}{}_{(aq)} + 3CH_3OH \longrightarrow 3HCO_2H + 4Cr^{+3}{}_{(aq)} + 11H_2O$

$$16H^+_{(aq)} + 2Cr_2O_7^{-2}{}_{(aq)} + 3CH_3OH_{(aq)} \longrightarrow 3HCO_2H_{(aq)} + 4Cr^{+3}{}_{(aq)} + 11H_2O_{(l)}$$

4. $MnO_4^-{}_{(aq)} + Cl^-{}_{(aq)} \longrightarrow Mn^{2+}{}_{(aq)} + Cl_{2(g)}$ *acidic solution*

$MnO_4^-{}_{(aq)} \longrightarrow Mn^{+2}{}_{(aq)}$

$MnO_4^-{}_{(aq)} \longrightarrow Mn^{+2}{}_{(aq)} + 4H_2O$

$8H^+ + MnO_4^-{}_{(aq)} \longrightarrow Mn^{+2}{}_{(aq)} + 4H_2O$

$5e^- + 8H^+ + MnO_4^-{}_{(aq)} \longrightarrow Mn^{+2}{}_{(aq)} + 4H_2O$

$Cl^-{}_{(aq)} \longrightarrow Cl_{2(g)}$

$2Cl^- \longrightarrow Cl_{2(g)}$

$2Cl^- \longrightarrow Cl_{2(g)} + 2e^-$

$5e^- + 8H^+ + MnO_4^-{}_{(aq)} \longrightarrow Mn^{+2}{}_{(aq)} + 4H_2O$ *multiply by 2*

$2Cl^- \longrightarrow Cl_{2(g)} + 2e^-$ *multiply by 5*

$10e^- + 16H^+ + 2MnO_4^-{}_{(aq)} \longrightarrow 2Mn^{+2}{}_{(aq)} + 8H_2O$

$10Cl^- \longrightarrow 5Cl_{2(g)} + 10e^-$

$$16H^+{}_{(aq)} + 2MnO_4^-{}_{(aq)} + 10Cl^-{}_{(aq)} \longrightarrow 2Mn^{+2}{}_{(aq)} + 8H_2O_{(l)} + 5Cl_{2(g)}$$

5. $NO_2^-{}_{(aq)} + Cr_2O_7^{2-}{}_{(aq)} \longrightarrow Cr^{3+}{}_{(aq)} + NO_3^-{}_{(aq)}$ *acidic solution*

$Cr_2O_7^{-2}{}_{(aq)} \longrightarrow Cr^{+3}{}_{(aq)}$

$Cr_2O_7^{-2}{}_{(aq)} \longrightarrow 2Cr^{+3}{}_{(aq)}$

$Cr_2O_7^{-2}{}_{(aq)} \longrightarrow 2Cr^{+3}{}_{(aq)} + 7H_2O$

$14H^+ + Cr_2O_7^{-2}{}_{(aq)} \longrightarrow 2Cr^{+3}{}_{(aq)} + 7H_2O$

$6e^- + 14H^+ + Cr_2O_7^{-2}{}_{(aq)} \longrightarrow 2Cr^{+3}{}_{(aq)} + 7H_2O$

$NO_2^-{}_{(aq)} \longrightarrow NO_3^-{}_{(aq)}$

$H_2O + NO_2^-{}_{(aq)} \longrightarrow NO_3^-{}_{(aq)}$

$H_2O + NO_2^-{}_{(aq)} \longrightarrow NO_3^-{}_{(aq)} + 2H^+$

$H_2O + NO_2^-{}_{(aq)} \longrightarrow NO_3^-{}_{(aq)} + 2H^+ + 2e^-$

$6e^- + 14H^+ + Cr_2O_7^{-2}{}_{(aq)} \longrightarrow 2Cr^{+3}{}_{(aq)} + 7H_2O$

$H_2O + NO_2^-{}_{(aq)} \longrightarrow NO_3^-{}_{(aq)} + 2H^+ + 2e^-$ *multiply by 3*

$6e^- + 14H^+ + Cr_2O_7^{-2}{}_{(aq)} \longrightarrow 2Cr^{+3}{}_{(aq)} + 7H_2O$

$3H_2O + 3NO_2^-{}_{(aq)} \longrightarrow 3NO_3^-{}_{(aq)} + 6H^+ + 6e^-$

$$8H^+{}_{(aq)} + Cr_2O_7^{-2}{}_{(aq)} + 3NO_2^-{}_{(aq)} \longrightarrow 2Cr^{+3}{}_{(aq)} + 4H_2O_{(l)} + 3NO_3^-{}_{(aq)}$$

6. $Cr_2O_7^{2-}{}_{(aq)} + I^-_{(aq)} \longrightarrow Cr^{3+}{}_{(aq)} + IO_3^-{}_{(aq)}$ *acidic solution*

$Cr_2O_7^{-2}{}_{(aq)} \longrightarrow Cr^{+3}{}_{(aq)}$

$Cr_2O_7^{-2}{}_{(aq)} \longrightarrow 2Cr^{+3}{}_{(aq)}$

$Cr_2O_7^{-2}{}_{(aq)} \longrightarrow 2Cr^{+3}{}_{(aq)} + 7H_2O$

$14H^+ + Cr_2O_7^{-2}{}_{(aq)} \longrightarrow 2Cr^{+3}{}_{(aq)} + 7H_2O$

$6e^- + 14H^+ + Cr_2O_7^{-2}{}_{(aq)} \longrightarrow 2Cr^{+3}{}_{(aq)} + 7H_2O$

$I^-_{(aq)} \longrightarrow IO_3^-{}_{(aq)}$

$3H_2O + I^-_{(aq)} \longrightarrow IO_3^-{}_{(aq)}$

$3H_2O + I^-_{(aq)} \longrightarrow IO_3^-{}_{(aq)} + 6H^+$

$3H_2O + I^-_{(aq)} \longrightarrow IO_3^-{}_{(aq)} + 6H^+ + 6e^-$

$6e^- + 14H^+ + Cr_2O_7^{-2}{}_{(aq)} \longrightarrow 2Cr^{+3}{}_{(aq)} + 7H_2O$

$3H_2O + I^-_{(aq)} \longrightarrow IO_3^-{}_{(aq)} + 6H^+ + 6e^-$

$8H^+ + Cr_2O_7^{-2}{}_{(aq)} + I^-_{(aq)} \longrightarrow 2Cr^{+3}{}_{(aq)} + 4H_2O + IO_3^-{}_{(aq)}$

$$8H^+_{(aq)} + Cr_2O_7^{-2}{}_{(aq)} + I^-_{(aq)} \longrightarrow 2Cr^{+3}{}_{(aq)} + 4H_2O_{(l)} + IO_3^-{}_{(aq)}$$

7. $MnO_4^-{}_{(aq)} + Br^-{}_{(aq)} \longrightarrow MnO_{2(s)} + BrO_3^-{}_{(aq)}$ (basic)

$MnO_4^-{}_{(aq)} \longrightarrow MnO_{2(s)}$

$MnO_4^-{}_{(aq)} \longrightarrow MnO_{2(s)} + 2H_2O$

$4H^+ + MnO_4^-{}_{(aq)} \longrightarrow MnO_{2(s)} + 2H_2O$

$3e^- + 4H^+ + MnO_4^-{}_{(aq)} \longrightarrow MnO_{2(s)} + 2H_2O$

$Br^-{}_{(aq)} \longrightarrow BrO_3^-{}_{(aq)}$

$3H_2O + Br^-{}_{(aq)} \longrightarrow BrO_3^-{}_{(aq)}$

$3H_2O + Br^-{}_{(aq)} \longrightarrow BrO_3^-{}_{(aq)} + 6H^+$

$3H_2O + Br^-{}_{(aq)} \longrightarrow BrO_3^-{}_{(aq)} + 6H^+ + 6e^-$

$3e^- + 4H^+ + MnO_4^-{}_{(aq)} \longrightarrow MnO_{2(s)} + 2H_2O$ multiply by 2

$3H_2O + Br^-{}_{(aq)} \longrightarrow BrO_3^-{}_{(aq)} + 6H^+ + 6e^-$

$6e^- + 8H^+ + 2MnO_4^-{}_{(aq)} \longrightarrow 2\,MnO_{2(s)} + 4H_2O$

$3H_2O + Br^-{}_{(aq)} \longrightarrow BrO_3^-{}_{(aq)} + 6H^+ + 6e^-$

$2H^+ + 2MnO_4^-{}_{(aq)} + Br^-{}_{(aq)} \longrightarrow 2\,MnO_{2(s)} + H_2O + BrO_3^-{}_{(aq)}$

$2OH^- + 2H^+ + 2MnO_4^-{}_{(aq)} + Br^-{}_{(aq)} \longrightarrow 2\,MnO_{2(s)} + H_2O + BrO_3^-{}_{(aq)} + 2OH^-$

$2H_2O + 2MnO_4^-{}_{(aq)} + Br^-{}_{(aq)} \longrightarrow 2\,MnO_{2(s)} + H_2O + BrO_3^-{}_{(aq)} + 2OH^-$

$H_2O + 2MnO_4^-{}_{(aq)} + Br^-{}_{(aq)} \longrightarrow 2\,MnO_{2(s)} + BrO_3^-{}_{(aq)} + 2OH^-$

$$\boxed{H_2O_{(l)} + 2MnO_4^-{}_{(aq)} + Br^-{}_{(aq)} \longrightarrow 2\,MnO_{2(s)} + BrO_3^-{}_{(aq)} + 2OH^-{}_{(aq)}}$$