Balancing Redox Reactions

redox reaction

$$Fe + Cu^{2+} \longrightarrow Fe^{2+} + Cu$$

electron transfer occurs

redox reaction

$Fe + Cu^{2+} \rightarrow Fe^{2+} + Cu$

oxidation

(lost two electrons)

redox reaction

$Fe + Cu^{2+} \rightarrow Fe^{2+} + Cu$

reduction

(gained two electrons)

Simple redox reaction

To balance this reaction we just look at electrical charges

redox reaction

$$Fe + Cu^{2+} \longrightarrow Fe^{2+} + Cu$$

iron transfers two electrons to the copper ion

Another Redox Reaction
Firstly divide into half reactions

$$Cr_2O_7^{2-} + Fe^{2+} \rightarrow Cr^{3+} + Fe^{3+}$$

oxidation half-reaction

$$Fe^{2+} \rightarrow Fe^{3+}$$

Loss of one electron

reduction half-reaction

$$Cr_2O_7^{2-} \rightarrow Cr^{3+}$$

+6 **+3**

Balance elements other than H and O

$$Cr_2O_7^{2-} + Fe^{2+} \rightarrow Cr^{3+} + Fe^{3+}$$

oxidation half-reaction

$$Fe^{2+} \rightarrow Fe^{3+}$$

reduction half-reaction

$$Cr_2O_7^{2-} \rightarrow 2Cr^{3+}$$

Balance O with water molecules

$$Cr_2O_7^{2-} + Fe^{2+} \rightarrow Cr^{3+} + Fe^{3+}$$

oxidation half-reaction

$$Fe^{2+} \rightarrow Fe^{3+}$$

reduction half-reaction

$$Cr_2O_7^{2-} \rightarrow 2Cr^{3+}$$

$$Cr_2O_7^{2-} \rightarrow 2Cr^{3+} + 7H_2O$$

Balance H with hydrogen ions

$$Cr_2O_7^{2-} + Fe^{2+} \rightarrow Cr^{3+} + Fe^{3+}$$

oxidation half-reaction

$$Fe^{2+} \rightarrow Fe^{3+}$$

reduction half-reaction

$$Cr_2O_7^{2-} \rightarrow 2Cr^{3+}$$

$$Cr_2O_7^{2-} + 14H^+ \rightarrow 2Cr^{3+} + 7H_2O$$

Balance charge with electrons

$$Cr_2O_7^{2-} + Fe^{2+} \rightarrow Cr^{3+} + Fe^{3+}$$

oxidation half-reaction

$$Fe^{2+} \rightarrow Fe^{3+} + e^-$$

reduction half-reaction

$$Cr_2O_7^{2-} \rightarrow 2Cr^{3+}$$

$$Cr_2O_7^{2-} + 14H^+ \rightarrow 2Cr^{3+} + 7H_2O$$

-2 + 14(1) = 12

2(3) = 6

Balance charge with electrons

$$Cr_2O_7^{2-} + Fe^{2+} \rightarrow Cr^{3+} + Fe^{3+}$$

oxidation half-reaction

$$Fe^{2+} \rightarrow Fe^{3+} + e^-$$

reduction half-reaction

$$Cr_2O_7^{2-} \rightarrow 2Cr^{3+}$$

$$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$$

Make the electron numbers equal

$$Cr_2O_7^{2-} + Fe^{2+} \rightarrow Cr^{3+} + Fe^{3+}$$

oxidation half-reaction

$$(Fe^{2+} \rightarrow Fe^{3+} + e^-)6$$

reduction half-reaction

$$Cr_2O_7^{2-} \rightarrow 2Cr^{3+}$$

$$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$$

Make the electron numbers equal

$$Cr_2O_7^{2-} + Fe^{2+} \rightarrow Cr^{3+} + Fe^{3+}$$

oxidation half-reaction

$$6Fe^{2+} \rightarrow 6Fe^{3+} + 6e^-$$

reduction half-reaction

$$Cr_2O_7^{2-} \rightarrow 2Cr^{3+}$$

$$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$$

Combine the half reactions

$$Cr_2O_7^{2-} + Fe^{2+} \rightarrow Cr^{3+} + Fe^{3+}$$

oxidation half-reaction

$$6Fe^{2+} \rightarrow 6Fe^{3+} + 6e^-$$

reduction half-reaction

$$Cr_2O_7^{2-} \rightarrow 2Cr^{3+}$$

$$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$$

$$6Fe^{2+} + Cr_2O_7^{2-} + 14H^+ + \cancel{6e^-} \rightarrow 2Cr^{3+} + 7H_2O + 6Fe^{3+} + \cancel{6e^-}$$

Balanced reaction

$$Cr_2O_7^{2-} + Fe^{2+} \longrightarrow Cr^{3+} + Fe^{3+}$$

$$6Fe^{2+} + Cr_2O_7^{2-} + 14H^{+} \longrightarrow 2Cr^{3+} + 7H_2O + 6Fe^{3+}$$