## General Chemistry

Balancing Redox Equations using half equations

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## Using half equations to balance redox equations

1. Ensure both equations have the same number of electrons.
2. Check which equation will be reversed
3. Combine the equations
4. Cancel species that appear on both sides.

Example 1 - Construct the equation for $\mathrm{MnO}_{4}{ }^{-}$reacting with $\mathrm{Fe}^{2+}$

$$
\begin{equation*}
\mathrm{Fe}^{3+}{ }_{(\mathrm{aq})}+\mathrm{e}^{-} \rightarrow \mathrm{Fe}^{2+}{ }_{(\mathrm{aq})} \tag{1}
\end{equation*}
$$

$$
\begin{equation*}
\mathrm{MnO}_{4}^{-}{ }_{(\mathrm{aq})}+8 \mathrm{H}^{+}{ }_{(\mathrm{aq})}+5 \mathrm{e}^{-} \rightarrow \mathrm{Mn}^{2+}{ }_{(\mathrm{aq})}+4 \mathrm{H}_{2} \mathrm{O}_{(\mathrm{l})} \tag{2}
\end{equation*}
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2. Check which equation will be reversed
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Example 1 - Construct the equation for $\mathrm{MnO}_{4}{ }^{-}$reacting with $\mathrm{Fe}^{2+}$
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Example 1 - Construct the equation for $\mathrm{MnO}_{4}{ }^{-}$reacting with $\mathrm{Fe}^{2+}$
$5 \mathrm{Fe}^{3+}{ }_{(\mathrm{aq})}+5 \mathrm{e}^{-} \rightarrow 5 \mathrm{Fe}^{2+}{ }_{(\mathrm{aq})}$
$\mathrm{MnO}_{4}^{-}{ }_{(\mathrm{aq})}+8 \mathrm{H}^{+}{ }_{(\mathrm{aq})}+5 \mathrm{e}^{-} \rightarrow \mathrm{Mn}^{2+}{ }_{(\mathrm{aq})}+4 \mathrm{H}_{2} \mathrm{O}_{(\mathrm{l})}$
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5 \mathrm{Fe}^{2+}{ }_{(\text {aq) }} \mathrm{MnO}_{4}^{-}{ }_{(\mathrm{aq})}+8 \mathrm{H}^{+}{ }_{(\mathrm{aq})} \rightarrow 5 \mathrm{Fe}^{3+}{ }_{(\mathrm{aq})}+\mathrm{Mn}^{2+}{ }_{(\mathrm{aq})}+4 \mathrm{H}_{2} \mathrm{O}_{(\mathrm{l})}
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\begin{align*}
& \mathrm{MnO}_{4}^{-}+8 \mathrm{H}^{+}+5 \mathrm{e}^{-} \rightarrow \mathrm{Mn}^{2+}+4 \mathrm{H}_{2} \mathrm{O}  \tag{3}\\
& \mathrm{Cr}_{2} \mathrm{O}_{7}^{2-}+14 \mathrm{H}^{+}+6 \mathrm{e}^{-} \rightarrow 2 \mathrm{Cr}^{3+}+7 \mathrm{H}_{2} \mathrm{O}
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Example 2 - Construct the equation for $\mathrm{MnO}_{4}^{-}$reacting with $\mathrm{Cr}^{3+}$

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\begin{align*}
& 6 \mathrm{MnO}_{4}^{-}+48 \mathrm{H}^{+}+30 \mathrm{e}^{-} \rightarrow 6 \mathrm{Mn}^{2+}+24 \mathrm{H}_{2} \mathrm{O}  \tag{3}\\
& 5 \mathrm{Cr}_{2} \mathrm{O}_{7}^{2-}+70 \mathrm{H}^{+}+30 \mathrm{e}^{-} \rightarrow 10 \mathrm{Cr}^{3+}+35 \mathrm{H}_{2} \mathrm{O} \tag{4}
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& 6 \mathrm{MnO}_{4}^{-}+48 \mathrm{H}^{+}-10 \mathrm{Cr}^{3+}+35 \mathrm{H}_{2} \mathrm{O} \rightarrow 6 \mathrm{Mn}^{2+}+24 \mathrm{H}_{2} \mathrm{O}+5 \mathrm{Cr}_{2} \mathrm{O}_{7}^{2-}+70 \mathrm{H}^{+}
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$6 \mathrm{MnO}_{4}^{-}+44^{++}+10 \mathrm{Cr}^{3+}+35 \mathrm{H}_{2} \mathrm{O} \rightarrow 6 \mathrm{Mn}^{2+}+24 \mathrm{H}_{2} \mathrm{O}+5 \mathrm{Cr}_{2} \mathrm{O}_{7}{ }^{2-}+22 \mathrm{H}^{-}$

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\end{align*}
$$

$6 \mathrm{MnO}_{4}^{-}+10 \mathrm{Cr}^{3+}+11 \mathrm{H}_{2} \mathrm{O} \rightarrow 6 \mathrm{Mn}^{2+}+24 \mathrm{C}^{-} \mathrm{O}-5 \mathrm{Cr}_{2} \mathrm{O}_{7}{ }^{2-}+22 \mathrm{H}^{+}$

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