# Standard reduction potentials

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## Standard **reduction** potentials

**S**tandard **H**ydrogen **E**lectrode (**SHE**) has $E^o = 0$ V

$2\ H^+(1\ M) + 2\ e^- \rightarrow H_2(1\ atm),\ E^o = 0$ V

All other reductions defined ***relative to* SHE**

$Zn^{2+}(1\ M) + 2\ e^- \rightarrow Zn(s),\ E^o = -0.763$ V

$Cu^{2+}(1\ M) + 2\ e^- \rightarrow Cu(s),\ E^o = +0.340$ V

etc.






## **Combining** reduction potentials

$Zn^{2+}(1\ M) + 2\ e^- \rightarrow Zn(s),\ E^o = -0.763$ V

$Cu^{2+}(1\ M) + 2\ e^- \rightarrow Cu(s),\ E^o = +0.340$ V

$Cu^{2+}(1\ M) + Zn(s) \rightarrow Cu(s) + Zn^{2+}(1\ M),\ E^o = ?$

$E^o = E^o_{cathode} - E^o_{anode}$

$= +0.340\ V - (-0.763\ V) = +1.103\ V$

So, Zn is **oxidized** by $Cu^{2+}$






## **Combining** reduction potentials

$E^o = E^o_{cathode} - E^o_{anode}$

Why?

$\Delta G^o_{cell} = \Delta G^o_{cathode} + \Delta G^o_{anode}$

$-n\ F\ E^o_{cell} = -n\ F\ E^o_{cathode} - (-n\ F\ E^o_{anode})$ …

**"–" since *anode* runs as an *oxidation***

$E^o_{cell} = E^o_{cathode} - E^o_{anode}$

 

## **Combining** reduction potentials

$Fe^{3+}$(1 M) + $e^-$ → $Fe^{2+}$(1 M ), $E^o_a$ = +0.771 V,

$Fe^{2+}$(1 M) + 2 $e^-$ → Fe(*s*), $E^o_b$ = −0.409 V,

$Fe^{3+}$(1 M) + 3 $e^-$ → Fe(*s*), ***E*° = ?**

$\Delta G^o = \Delta G^o_a + \Delta G^o_b$

$-3\,F\,E^o = -F\,E^o_a + (-2\,F\,E^o_b)$ ...

**since *both* are *reductions***

$E^o = E^o_a/3 + 2\,E^o_b/3$

= (+0.771 V)/3 + 2(−0.409 V)/3 **= −0.016 V**

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## **Combining** reduction potentials

When result ***does not*** contain $e^-$ ...

$Cu^{2+}$(1 M) + Zn(*s*) → Cu(*s*) + $Zn^{2+}$(1 M)

$$E^o = E^o_{cathode} - E^o_{anode}$$

When result ***does*** contain $e^-$ ...

$Fe^{3+}$(1 M) + 3 $e^-$ → Fe(*s*),

use $\Delta G^o$ !!!

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