



Electrochemistry introduction



In electrochemistry, a potential difference between two half-cells is set up by having different redox couples and/or different concentrations of a given redox couple present.

Part A Introduction

The potential of the side half-cell is measured relative to the side one, so the cell potential is given by subtracting the reduction potential of the side from the reduction potential of the side. Standard reduction potentials can be tabulated, which correspond to values recorded under standard conditions against the standard electrode. The conventional cell reaction consists of the right-hand side and the left-hand side (which can be thought of as subtracting the left-hand side) , making sure that the number of electrons (n) transferred is the same for both sides.

Items:

Part B Linking equations

Working out cell potentials can be useful in itself, but as a result of connections to other thermodynamic quantities, tabulated standard reduction potentials allow us to calculate, for example, equilibrium constants even of non-redox reactions or processes such as a salt dissolving.

Given that $\Delta_r G^\ominus = -nFE^\ominus = -RT \ln K$, rearrange the equation for K (the equilibrium constant) as a function of n (the number of electrons transferred), F (the Faraday constant), E^\ominus (the standard cell potential, for which you should use E^\ominus in your expression), R (the universal gas constant) and T (the temperature).

The following symbols may be useful: E^\ominus , F , K , R , T , e , $\ln()$, $\log()$, n



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Name the element whose reduction is used as a standard by which all electrode potentials are measured.

- ☐ Helium
- ☐ Hydrogen
- ☐ Silver
- ☐ Lithium
- ☐ Iron
- ☐ Fluorine
- ☐ Platinum
- ☐ Oxygen

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The standard electrode potential, E^\ominus , for the reduction, $\text{Br}_2(\text{aq}) + 2\text{e}^- \longrightarrow 2\text{Br}^-(\text{aq})$ is 1.09 V. Give the E^\ominus value for the reduction, $\frac{1}{2}\text{Br}_2(\text{aq}) + \text{e}^- \longrightarrow \text{Br}^-(\text{aq})$.

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Essential Pre-Uni Chemistry L1.4



E^\ominus for the reaction, $\text{Ce}^{4+}(\text{aq}) + \text{e}^- \longrightarrow \text{Ce}^{3+}(\text{aq})$ is 1.70 V. Give the E^\ominus value for the oxidation half-reaction, $\text{Ce}^{3+}(\text{aq}) \longrightarrow \text{Ce}^{4+}(\text{aq}) + \text{e}^-$.

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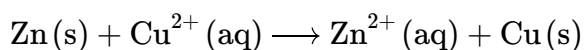
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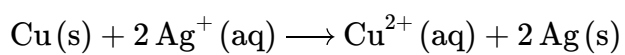
Reduction	E^\ominus / V
$\text{Zn}^{2+}(\text{aq}) + 2\text{e}^- \longrightarrow \text{Zn}(\text{s})$	-0.76
$\text{Cr}^{3+}(\text{aq}) + 3\text{e}^- \longrightarrow \text{Cr}(\text{s})$	-0.74
$\text{Fe}^{2+}(\text{aq}) + 2\text{e}^- \longrightarrow \text{Fe}(\text{s})$	-0.44
$\text{Cu}^{2+}(\text{aq}) + \text{e}^- \longrightarrow \text{Cu}^+(\text{aq})$	+0.16
$\text{Cu}^{2+}(\text{aq}) + 2\text{e}^- \longrightarrow \text{Cu}(\text{s})$	+0.34
$\text{Cu}^+(\text{aq}) + \text{e}^- \longrightarrow \text{Cu}(\text{s})$	+0.52
$\text{Fe}^{3+}(\text{aq}) + \text{e}^- \longrightarrow \text{Fe}^{2+}(\text{aq})$	+0.77
$\text{Ag}^+(\text{aq}) + \text{e}^- \longrightarrow \text{Ag}(\text{s})$	+0.80
$\text{Cr}_2\text{O}_7^{2-}(\text{aq}) + 6\text{e}^- + 14\text{H}^+(\text{aq}) \longrightarrow 2\text{Cr}^{3+}(\text{aq}) + 7\text{H}_2\text{O}(\text{l})$	+1.33

Use the standard electrode potentials tabulated above to calculate the standard cell potentials due to the following reactions:

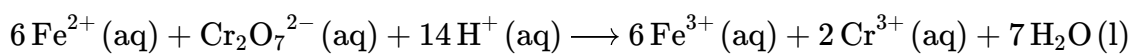
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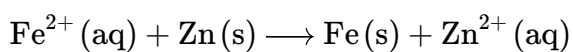
Part B (b)



Part C (c)



Part D (d)





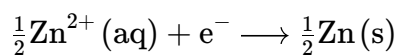
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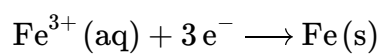
Reduction	E^\ominus / V
$\text{Zn}^{2+}(\text{aq}) + 2\text{e}^- \longrightarrow \text{Zn}(\text{s})$	-0.76
$\text{Cr}^{3+}(\text{aq}) + 3\text{e}^- \longrightarrow \text{Cr}(\text{s})$	-0.74
$\text{Fe}^{2+}(\text{aq}) + 2\text{e}^- \longrightarrow \text{Fe}(\text{s})$	-0.44
$\text{Cu}^{2+}(\text{aq}) + \text{e}^- \longrightarrow \text{Cu}^+(\text{aq})$	+0.16
$\text{Cu}^{2+}(\text{aq}) + 2\text{e}^- \longrightarrow \text{Cu}(\text{s})$	+0.34
$\text{Cu}^+(\text{aq}) + \text{e}^- \longrightarrow \text{Cu}(\text{s})$	+0.52
$\text{Fe}^{3+}(\text{aq}) + \text{e}^- \longrightarrow \text{Fe}^{2+}(\text{aq})$	+0.77
$\text{Ag}^+(\text{aq}) + \text{e}^- \longrightarrow \text{Ag}(\text{s})$	+0.80
$\text{Cr}_2\text{O}_7^{2-}(\text{aq}) + 6\text{e}^- + 14\text{H}^+(\text{aq}) \longrightarrow 2\text{Cr}^{3+}(\text{aq}) + 7\text{H}_2\text{O}(\text{l})$	+1.33

Using the data tabulated above, calculate the standard electrode potentials for the following reductions:

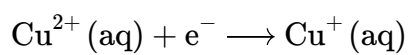
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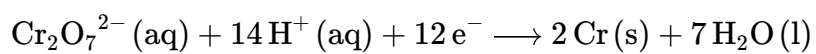
Part B (b)



Part C (c)



Part D (d)





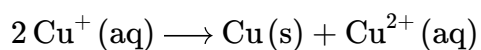
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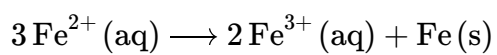
Reduction	E^\ominus / V
$\text{Zn}^{2+}(\text{aq}) + 2\text{e}^- \longrightarrow \text{Zn}(\text{s})$	-0.76
$\text{Cr}^{3+}(\text{aq}) + 3\text{e}^- \longrightarrow \text{Cr}(\text{s})$	-0.74
$\text{Fe}^{2+}(\text{aq}) + 2\text{e}^- \longrightarrow \text{Fe}(\text{s})$	-0.44
$\text{Cu}^{2+}(\text{aq}) + \text{e}^- \longrightarrow \text{Cu}^+(\text{aq})$	+0.16
$\text{Cu}^{2+}(\text{aq}) + 2\text{e}^- \longrightarrow \text{Cu}(\text{s})$	+0.34
$\text{Cu}^+(\text{aq}) + \text{e}^- \longrightarrow \text{Cu}(\text{s})$	+0.52
$\text{Fe}^{3+}(\text{aq}) + \text{e}^- \longrightarrow \text{Fe}^{2+}(\text{aq})$	+0.77
$\text{Ag}^+(\text{aq}) + \text{e}^- \longrightarrow \text{Ag}(\text{s})$	+0.80
$\text{Cr}_2\text{O}_7^{2-}(\text{aq}) + 6\text{e}^- + 14\text{H}^+(\text{aq}) \longrightarrow 2\text{Cr}^{3+}(\text{aq}) + 7\text{H}_2\text{O}(\text{l})$	+1.33

Using the data tabulated above, calculate the standard cell potential for:

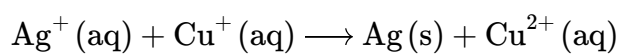
Part A (a)



Part B (b)



Part C (c)



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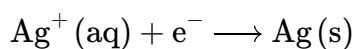
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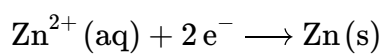
Reduction	E^\ominus / V
$\text{Zn}^{2+}(\text{aq}) + 2\text{e}^- \longrightarrow \text{Zn}(\text{s})$	-0.76
$\text{Cr}^{3+}(\text{aq}) + 3\text{e}^- \longrightarrow \text{Cr}(\text{s})$	-0.74
$\text{Fe}^{2+}(\text{aq}) + 2\text{e}^- \longrightarrow \text{Fe}(\text{s})$	-0.44
$\text{Cu}^{2+}(\text{aq}) + 2\text{e}^- \longrightarrow \text{Cu}(\text{s})$	+0.34
$\text{Cu}^+(\text{aq}) + \text{e}^- \longrightarrow \text{Cu}(\text{s})$	+0.52
$\text{Fe}^{3+}(\text{aq}) + \text{e}^- \longrightarrow \text{Fe}^{2+}(\text{aq})$	+0.77
$\text{Ag}^+(\text{aq}) + \text{e}^- \longrightarrow \text{Ag}(\text{s})$	+0.80
$\text{Cr}_2\text{O}_7^{2-}(\text{aq}) + 6\text{e}^- + 14\text{H}^+(\text{aq}) \longrightarrow 2\text{Cr}^{3+}(\text{aq}) + 7\text{H}_2\text{O}(\text{l})$	+1.33

Use the standard electrode potentials tabulated above to find ΔG^\ominus for the following reactions:

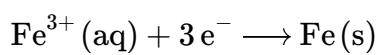
Part A (a)



Part B (b)



Part C (c)



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Reduction	E^\ominus / V
$\text{Zn}^{2+}(\text{aq}) + 2\text{e}^- \longrightarrow \text{Zn}(\text{s})$	-0.76
$\text{Cr}^{3+}(\text{aq}) + 3\text{e}^- \longrightarrow \text{Cr}(\text{s})$	-0.74
$\text{Fe}^{2+}(\text{aq}) + 2\text{e}^- \longrightarrow \text{Fe}(\text{s})$	-0.44
$\text{Cu}^{2+}(\text{aq}) + 2\text{e}^- \longrightarrow \text{Cu}(\text{s})$	+0.34
$\text{Cu}^+(\text{aq}) + \text{e}^- \longrightarrow \text{Cu}(\text{s})$	+0.52
$\text{Fe}^{3+}(\text{aq}) + \text{e}^- \longrightarrow \text{Fe}^{2+}(\text{aq})$	+0.77
$\text{Ag}^+(\text{aq}) + \text{e}^- \longrightarrow \text{Ag}(\text{s})$	+0.80
$\text{Cr}_2\text{O}_7^{2-}(\text{aq}) + 6\text{e}^- + 14\text{H}^+(\text{aq}) \longrightarrow 2\text{Cr}^{3+}(\text{aq}) + 7\text{H}_2\text{O}(\text{l})$	+1.33

Use the standard electrode potentials tabulated above to find ΔG^\ominus for the following reactions:

Part A (a)

$\text{Ag}^+(\text{aq}) + \text{Fe}^{2+}(\text{aq}) \longrightarrow \text{Fe}^{3+}(\text{aq}) + \text{Ag}(\text{s})$. Give your answer to 1 significant figure.

Part B (b)

$3 \text{Zn(s)} + \text{Cr}_2\text{O}_7^{2-}(\text{aq}) + 14 \text{H}^+(\text{aq}) \longrightarrow 3 \text{Zn}^{2+}(\text{aq}) + 2 \text{Cr}^{3+}(\text{aq}) + 7 \text{H}_2\text{O(l)}$. Give your answer to 3 significant figures.

Part C (c)

$2 \text{Cr(s)} + 3 \text{Cu}^{2+}(\text{aq}) \longrightarrow 2 \text{Cr}^{3+}(\text{aq}) + 3 \text{Cu(s)}$. Give your answer to 3 significant figures.

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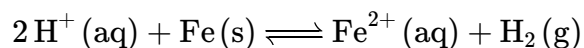
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Essential Pre-Uni Chemistry H2.9



The displacement of hydrogen from acid by iron,



has a standard cell potential of 0.44 V. Find the associated standard Gibbs free energy change. (Faraday constant = 96 485 C mol⁻¹)

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