

**SEC. SCH. - HKUST
DUAL PROGRAM
LEVEL 1**

**INTRODUCTORY
CHEMISTRY
SAMPLE 01**



1

Dept of Chemistry, HKUST

CHEMISTRY IN DAILY LIVES

Lemon-powered clock?



Water-powered clock?



ELECTROCHEMICAL SERIES

- $\text{Ag}^+(\text{aq}) + \text{e}^- \rightarrow \text{Ag}(\text{s}) \quad E^\circ = +0.80\text{V}$
- $\text{Cu}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Cu}(\text{s}) \quad E^\circ = +0.34\text{V}$
- $2\text{H}^+(\text{aq}) + 2\text{e}^- \rightarrow \text{H}_2(\text{g}) \quad E^\circ = 0.00\text{V}$
- $\text{Pb}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Pb}(\text{s}) \quad E^\circ = -0.13\text{V}$
- $\text{Sn}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Sn}(\text{s}) \quad E^\circ = -0.14\text{V}$
- $\text{Ni}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Ni}(\text{s}) \quad E^\circ = -0.23\text{V}$
- $\text{Zn}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Zn}(\text{s}) \quad E^\circ = -0.76\text{V}$
- $\text{Al}^{3+}(\text{aq}) + 3\text{e}^- \rightarrow \text{Al}(\text{s}) \quad E^\circ = -1.67\text{V}$
- $\text{Mg}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Mg}(\text{s}) \quad E^\circ = -2.34\text{V}$
- $\text{Na}^+(\text{aq}) + \text{e}^- \rightarrow \text{Na}(\text{s}) \quad E^\circ = -2.71\text{V}$

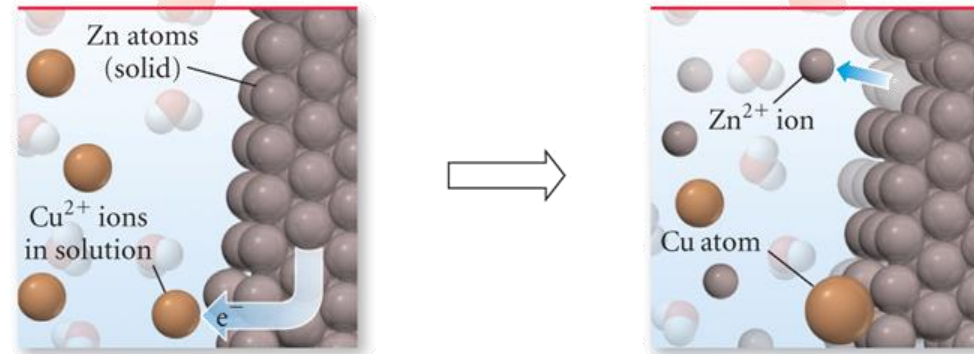
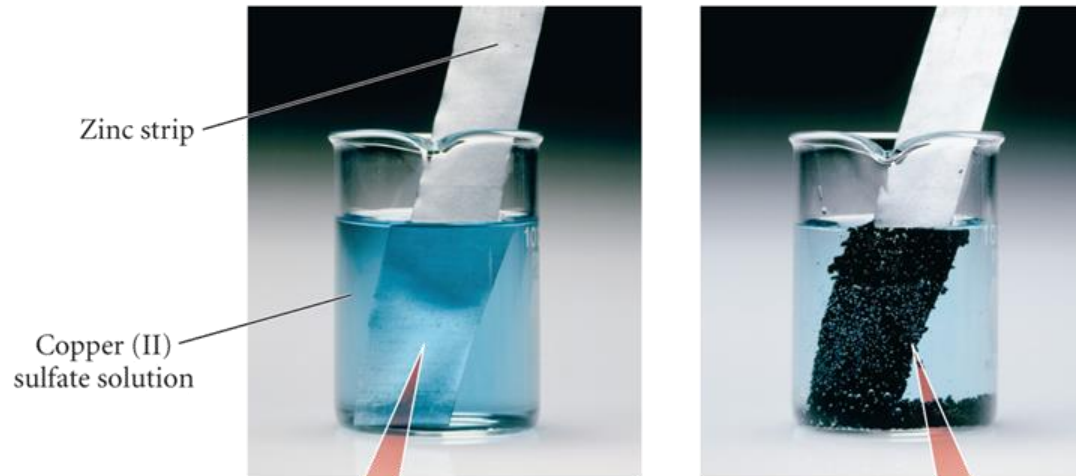
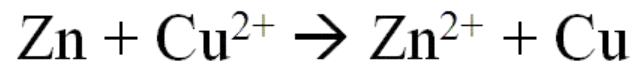
	E° in volt
$\text{F}_2(\text{g}) + 2\text{e}^- \rightarrow 2\text{F}^-(\text{aq})$	+2.87
$\text{H}_2\text{O}_2(\text{aq}) + 2\text{H}^+(\text{aq}) + 2\text{e}^- \rightarrow 2\text{H}_2\text{O}(\text{l})$	+1.77
$\text{Au}^+(\text{aq}) + \text{e}^- \rightarrow \text{Au}(\text{s})$	+1.68
$\text{Cl}_2(\text{g}) + 2\text{e}^- \rightarrow 2\text{Cl}^-(\text{aq})$	+1.36
$\text{O}_2(\text{g}) + 4\text{H}^+(\text{aq}) + 4\text{e}^- \rightarrow 2\text{H}_2\text{O}(\text{l})$	+1.23
$\text{Br}_2(\text{l}) + 2\text{e}^- \rightarrow 2\text{Br}^-(\text{aq})$	+1.09
$\text{Ag}^+(\text{aq}) + \text{e}^- \rightarrow \text{Ag}(\text{s})$	+0.80
$\text{Fe}^{3+}(\text{aq}) + \text{e}^- \rightarrow \text{Fe}^{2+}(\text{aq})$	+0.77
$\text{I}_2(\text{s}) + 2\text{e}^- \rightarrow 2\text{I}^-(\text{aq})$	+0.54
$\text{O}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l}) + 4\text{e}^- \rightarrow 4\text{OH}^-(\text{aq})$	+0.40
$\text{Cu}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Cu}(\text{s})$	+0.34
$\text{S}(\text{s}) + 2\text{H}^+(\text{aq}) + 2\text{e}^- \rightarrow \text{H}_2\text{S}(\text{g})$	+0.14
$2\text{H}^+(\text{aq}) + 2\text{e}^- \rightarrow \text{H}_2(\text{g})$	0.00
$\text{Pb}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Pb}(\text{s})$	-0.13
$\text{Sn}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Sn}(\text{s})$	-0.14
$\text{Ni}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Ni}(\text{s})$	-0.23
$\text{Co}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Co}(\text{s})$	-0.28
$\text{Fe}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Fe}(\text{s})$	-0.44
$\text{Zn}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Zn}(\text{s})$	-0.76
$2\text{H}_2\text{O}(\text{l}) + 2\text{e}^- \rightarrow \text{H}_2(\text{g}) + 2\text{OH}^-(\text{aq})$	-0.83
$\text{Mn}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Mn}(\text{s})$	-1.03
$\text{Al}^{3+}(\text{aq}) + 3\text{e}^- \rightarrow \text{Al}(\text{s})$	-1.67
$\text{Mg}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Mg}(\text{s})$	-2.34
$\text{Na}^+(\text{aq}) + \text{e}^- \rightarrow \text{Na}(\text{s})$	-2.71
$\text{Ca}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Ca}(\text{s})$	-2.87
$\text{K}^+(\text{aq}) + \text{e}^- \rightarrow \text{K}(\text{s})$	-2.93
$\text{Li}^+(\text{aq}) + \text{e}^- \rightarrow \text{Li}(\text{s})$	-3.02

Principles of electrochemistry

A Spontaneous Redox Reaction: $\text{Zn} + \text{Cu}^{2+}$

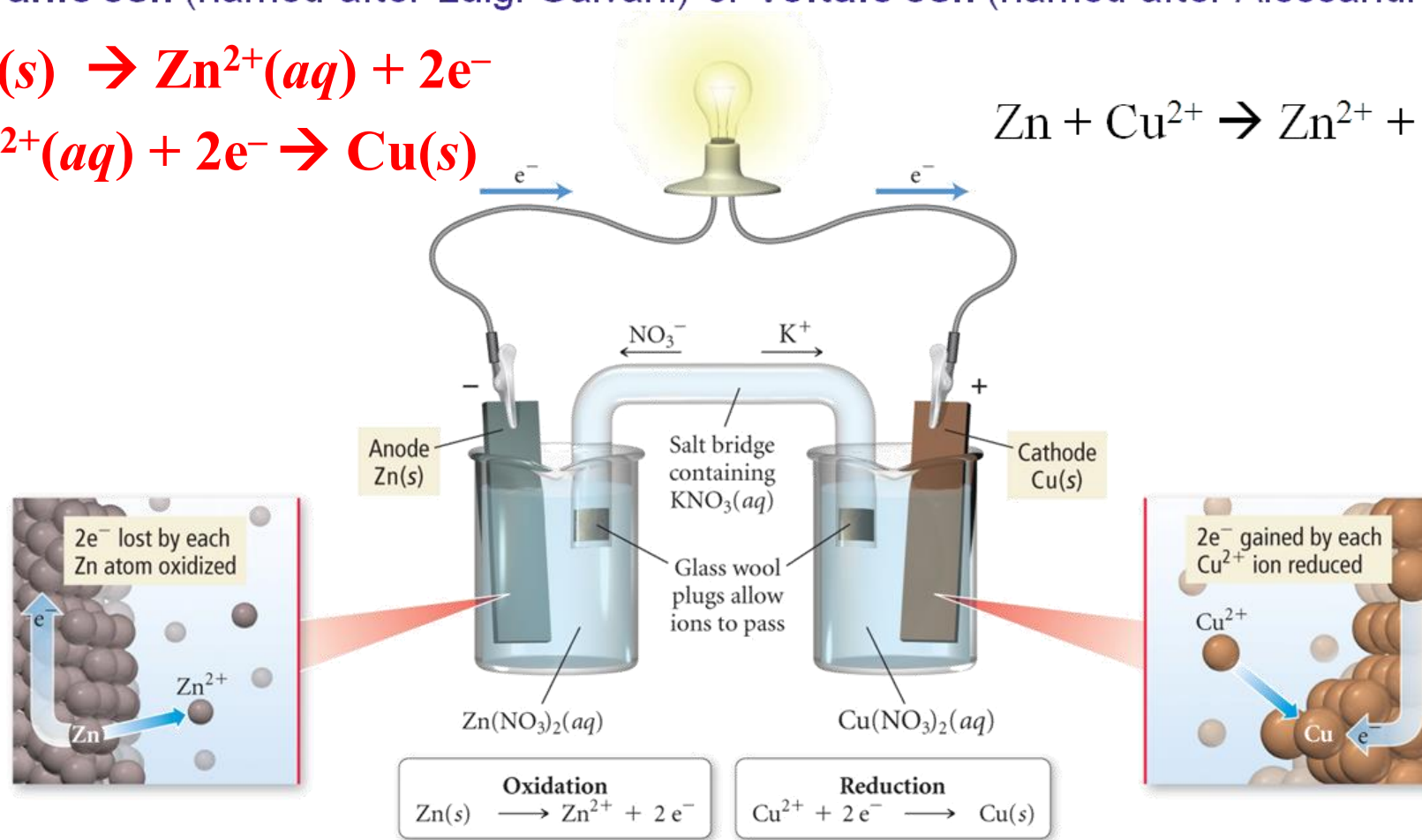
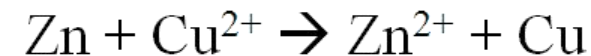
In one pot reaction, electric current flows directly between atoms

- $\text{Zn(s)} + \text{CuSO}_4(\text{aq}) \rightarrow \text{ZnSO}_4(\text{aq}) + \text{Cu(s)}$
- **Simplified:**



Electric Current Flowing Indirectly Between Atoms

Galvanic cell (named after Luigi Galvani) or Voltaic cell (named after Alessandro Volta)

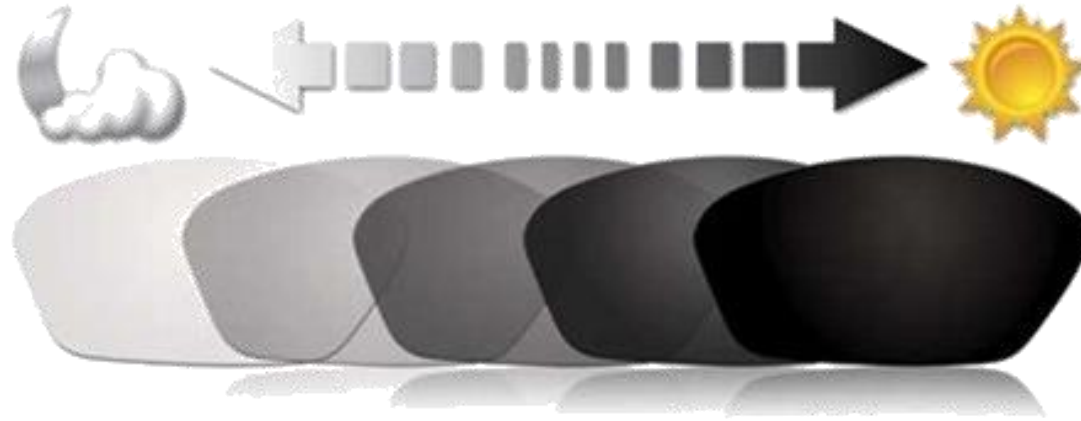


Current will be produced if the Cu^{2+} and Zn are separated and connected with a wire.



CHEMISTRY IN DAILY LIVES

oPhotochromic glass / lenses



LENSES ARE CLEAR WHEN INDOORS OR AT NIGHT AND AUTOMATICALLY DARKEN TO A SUNGLASS TINT WHEN EXPOSED TO SUNLIGHT.

Protection against UV

Photochromic glass

- Sunglasses - Protection from harmful UV rays. Eyeglasses with photochromic lenses eliminate the need for sunglasses.
- Ordinary glass – a matrix of silicates – transparent to visible lights

Lenses are responsive to outside environment! How to achieve this?



HOW TO CHOOSE THE RIGHT CHEMICAL REACTION TO HELP?

- $\text{Ag}^+(\text{aq}) + \text{e}^- \rightarrow \text{Ag}(\text{s})$ $E^\circ = +0.80\text{V}$
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CHEMISTRY IN DAILY LIVES

- Vegetables turn yellow after cooking.
- How can we keep it green?
 - Natural pigment in vegetables

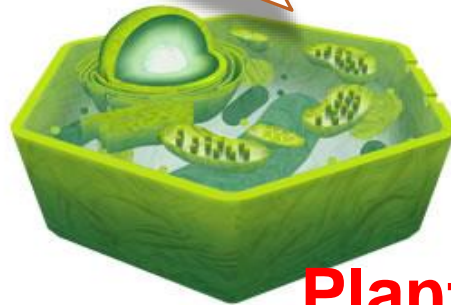


CHLOROPHYLL IN GREEN VEGETABLE

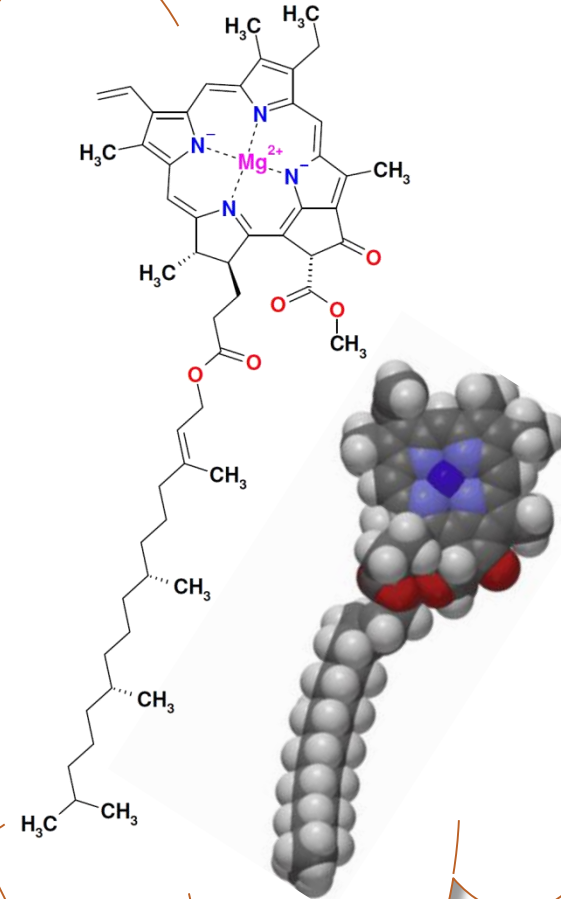
- What is the chemical structure of chlorophyll?



chloroplasts



Plant cell



Reactivity of chlorophyll

- What is the chemical property of chlorophyll?

