

Redox Potential

Oxidation and Reduction Reactions

Oxidation

- Oxidation is the process of the loss of electrons from an atom or ion



Oxidation

- Oxidation results in the increase of the oxidation number of an atom or ion

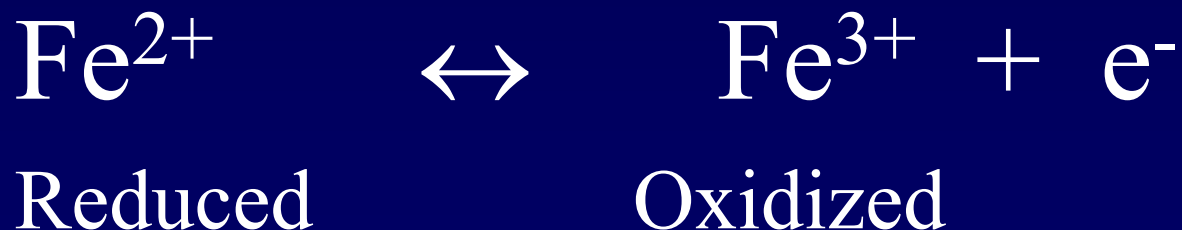


Reduced

Oxidized

Oxidation

- Oxidizing agents are substances which increase the oxidation number of an atom or ion



Reduction

- Reduction is the process of the gain of electrons from an atom or ion



Reduction

- Reduction results in the decrease of the oxidation number of an atom or ion

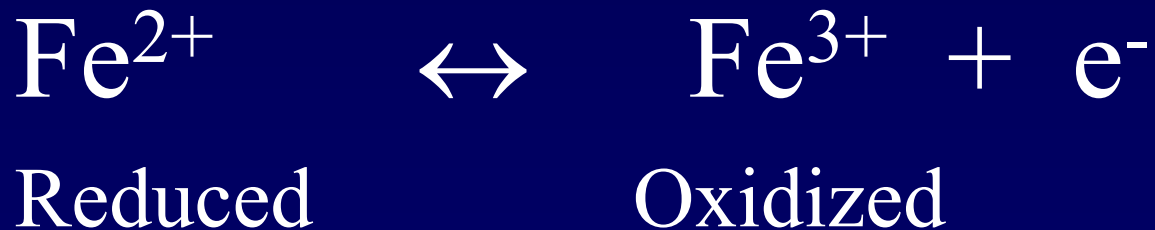


Reduced

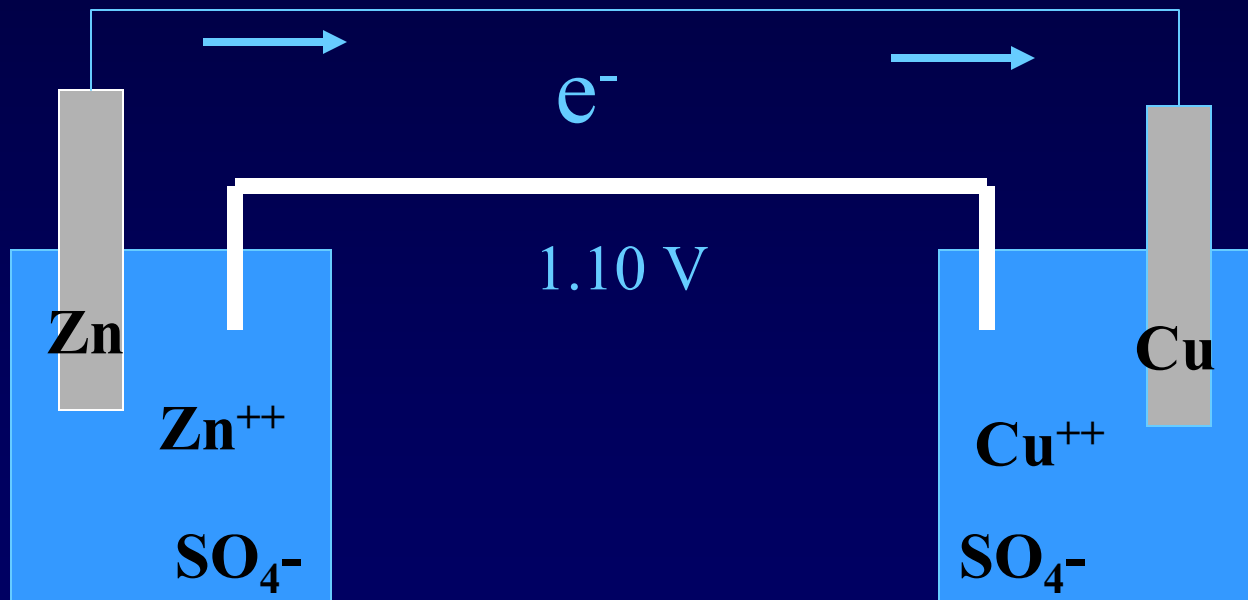
Oxidized

Reduction

- Reducing agents are substances which decrease the oxidation number of an atom or ion



Battery



Redox Potential

- If an electrical current (a flow of electrons) is applied in the opposite direction, the strength of the electron activity or flow of electrons in the reduction reaction can be measured.
- The potential is measured at the point that there is no net flow of electrons.

Redox Potential

- Just as we measure the activity of the hydrogen ion (a proton) by pH

$$\text{pH} = -\log[\text{H}^+]$$

- We measure the activity of electrons as pE (redox potential)

$$\text{pE} = -\log[\text{e}^-]$$

Measurement of Redox Potential

- Redox reactions are standardized against the redox reaction of hydrogen



Measurement of Redox Potential

- A hydrogen electrode is created by bubbling H_2 gas at one atmosphere of pressure over a platinum plate or wire
- The redox potential standardized against the hydrogen electrode is termed the E_h

Redox Potential

- E_h of natural lakes and streams ranges from 500 - 600 mV
- E_h of distilled water at pH 7 should be 812 mV

Effect of O₂ on Redox Potential

- E_h of natural lakes and streams is relatively insensitive to changes in dissolved oxygen concentration except under very low oxygen concentrations (< 0.1 mg O₂/L)
- With depletion of O₂, E_h decreases greatly to 0 - 200 mV

Effect of pH on Redox Potential

- E_h is sensitive to changes in pH

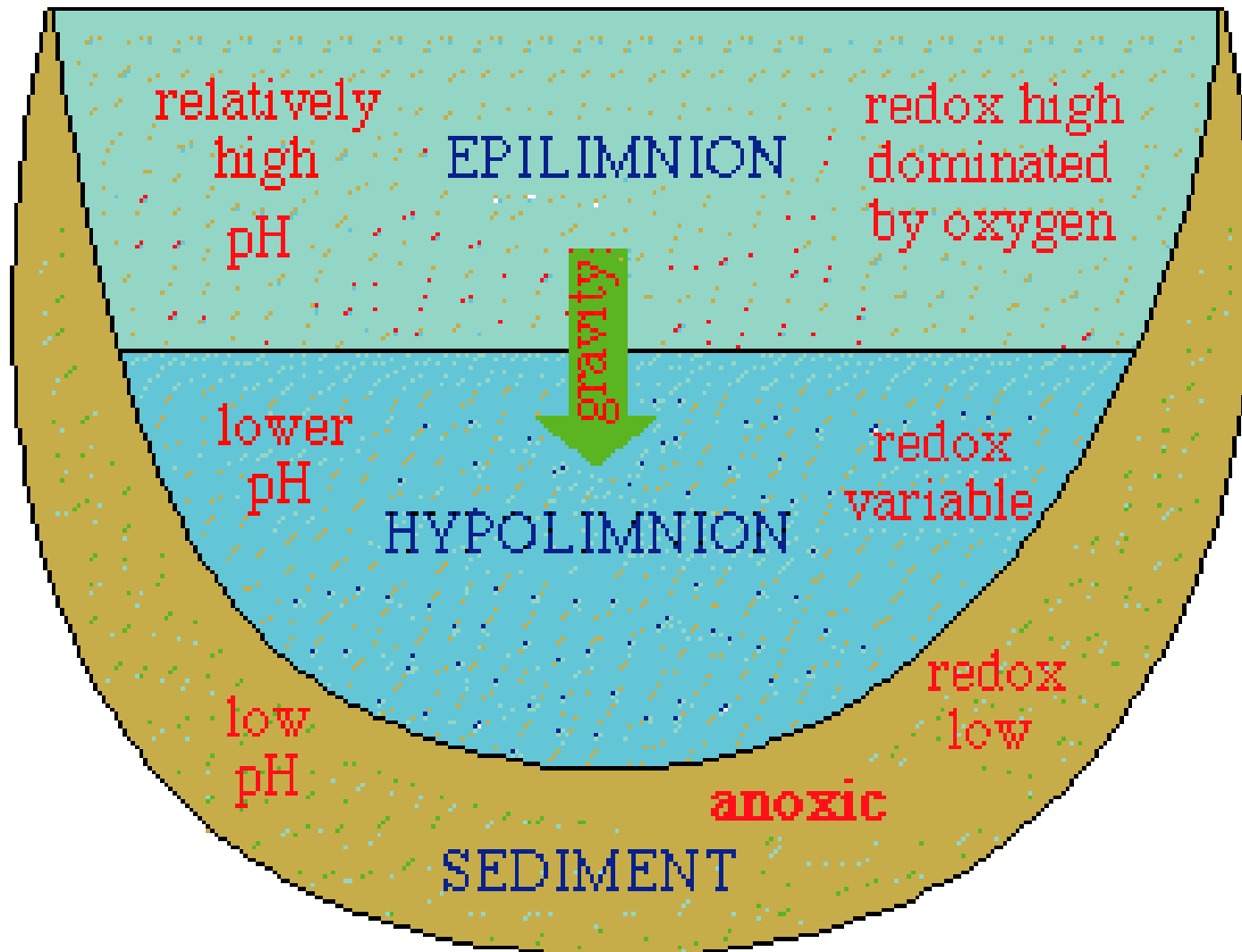


Effect of pH on Redox Potential

- A decrease of one pH unit is accompanied by an increase in E_h of 58 mV
- E_h is frequently adjusted for pH by adding 58 mV for every pH unit on the basic side of neutrality and subtracting 58 mV for every pH unit on the acid side of neutrality
---- or E_7

Vertical Profiles of E_h in Lakes

- In well oxygenated lakes, there is little change in E_h with depth
- In anoxic waters of the hypolimnion of eutrophic lakes, E_h drops sharply (0 - 200 mV)
- E_h may be negative in the sediments



So What?

- Redox potential strongly affects the ionic forms of many atoms and molecules
- Ionic forms determine solubility or reactivity of many atoms or compounds
- Insoluble complexes affect availability of nutrients, especially phosphorus