UNIT 10: CHEMICAL REACTIONS

REDOX REACTIONS (OXIDATION-REDUCTION)

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CP Chemistry

Rev. April 2017

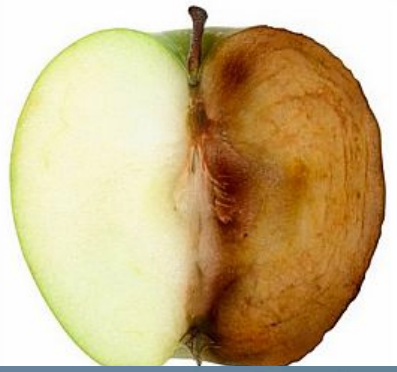
UNIT 10 Chemical Reactions

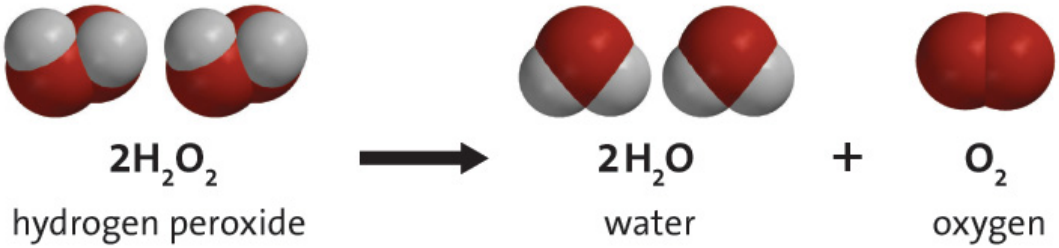
Redox Reactions

Learners will be able to…

- Define oxidation
- Define reduction
- Identify oxidation in a redox half-reaction
- Identify reduction in a redox half-reaction
- List real-life examples of redox reactions
- Design a lab to determine effects of rust and test method(s) of corrosion prevention

What do these have in common?

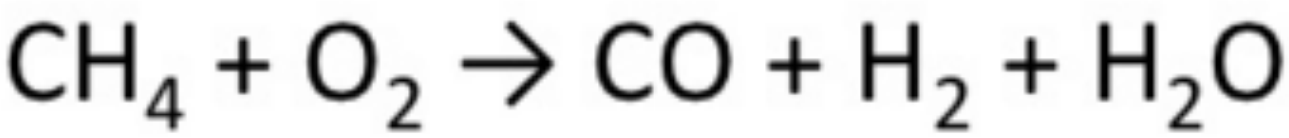




Early definition of OXIDATION

- Originally, scientists described “oxidation” reactions as simply a substance combining with oxygen to form an oxide

- **EXAMPLE:** Burning of methane—methane oxidizes to form oxides of carbon and hydrogen



REDOX in REAL LIFE

- **RUSTING:** Elemental IRON slowly oxidizes to form iron (III) oxide
- **BLEACHING:** Stain removal from fabrics!
- **HYDROGEN PEROXIDE:** Releases oxygen when it undergoes decomposition

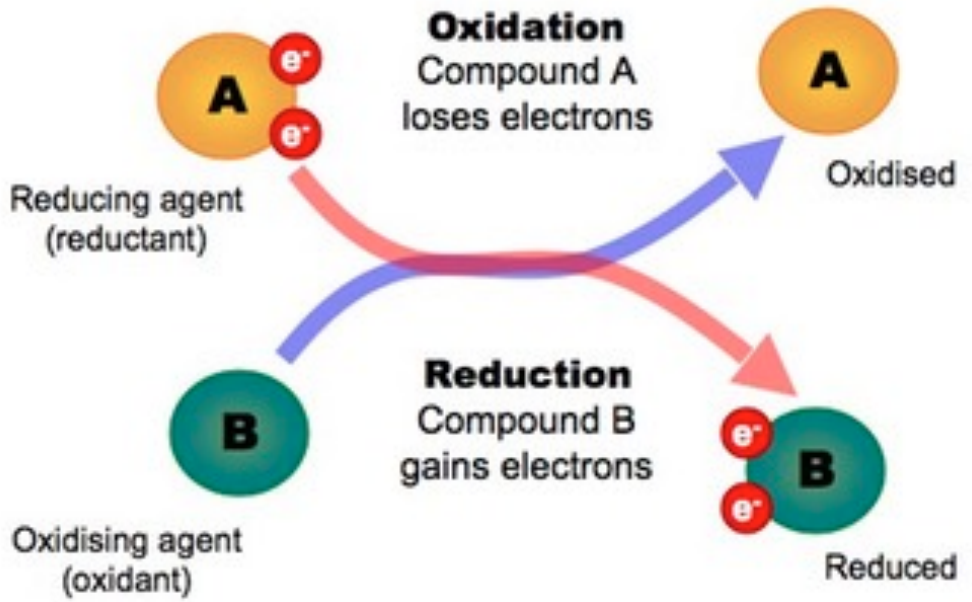
Opposite of oxidation …

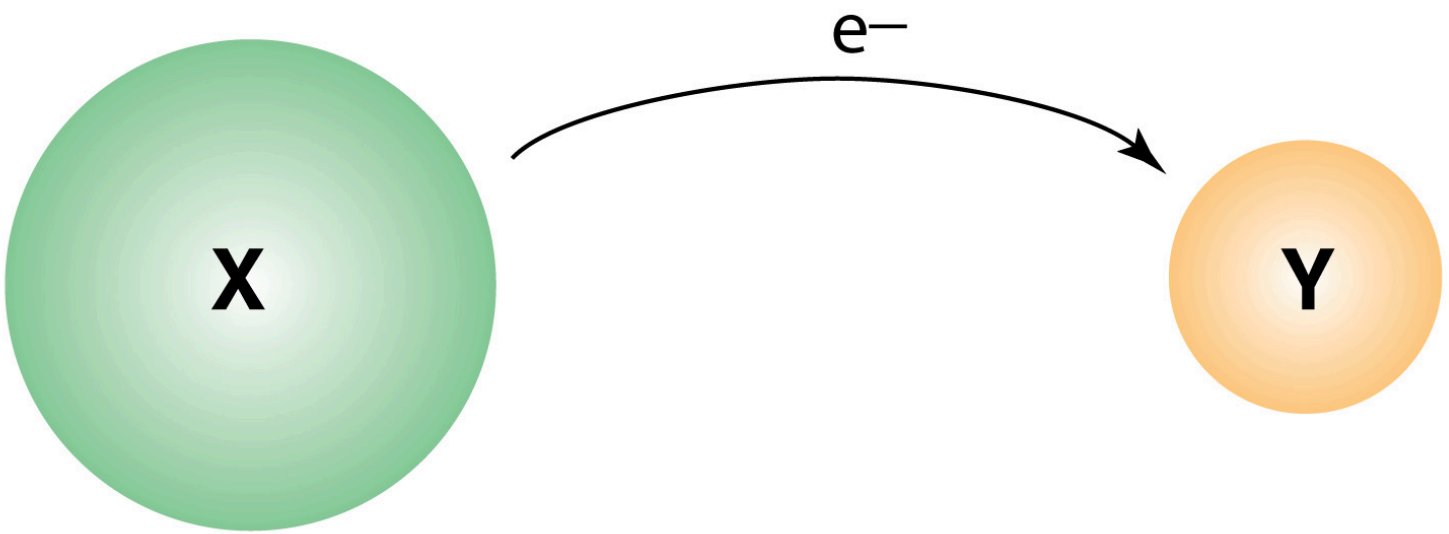
- REDUCTION is the OPPOSITE of oxidation
  - Originally believed to only involve loss of oxygen from a compound

- **OXIDATION and REDUCTION** always occur simultaneously!!!
- OXIDIZED substance gains oxygen OR loses electrons
- REDUCED substance loses oxygen OR gains electrons

Learning the LINGO…

- Substance that is oxidized is the REDUCING agent
- Substance that is reduced is the OXIDIZING agent





Reducing agent	Oxidizing agent
X loses electrons	Y gains electrons
X is oxidized by Y (becomes more positive)	Y is reduced by X (becomes more negative)

When oxygen is NOT involved…

- Oxidation-Reduction reactions ("redox") do not always involve oxygen
- **In redox reactions, electrons are transferred between the reactants**

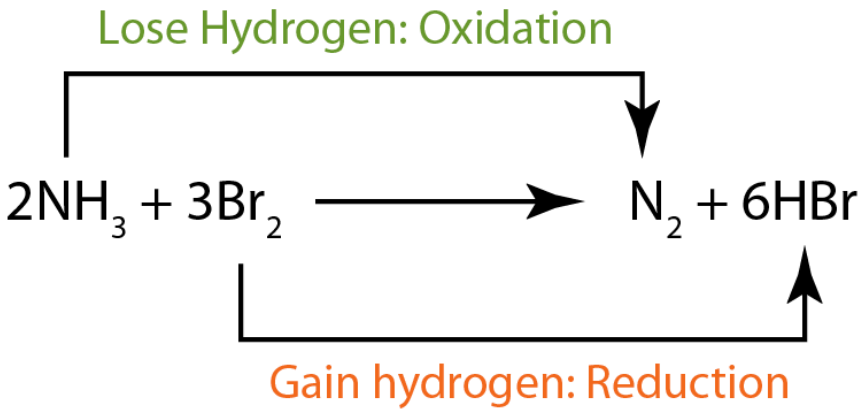
$$Mg + S \rightarrow Mg^{2+} + S^{2-} \quad (MgS)$$

- **Mg** (with 0 charge) loses 2 electrons = OXIDIZED to $\mathbf{Mg^{2+}}$
- **S** atom (no charge) gains 2 electrons = REDUCED to $\mathbf{S^{2-}}$

When oxygen is NOT involved

- Oxidation also considered LOSS of HYDROGEN
- Reduction also considered GAIN of HYDROGEN

- REMEMBER they are <u>OPPOSITE PROCESSES</u>!! ☺



How do you remember?

- **O**xidation is **L**osing **E**lectrons
- **R**eduction is **G**aining **E**lectrons

Lose **G**ain
Electrons **E**lectrons
Oxidation **R**eduction

How do you remember?

- **O**xidation is **L**osing **E**lectrons
- **R**eduction is **G**aining **E**lectrons

HALF REACTIONS

- Oxidation-Reduction reactions are often looked at using half-reactions, isolating the oxidation and reduction

$$Fe^{2+} \rightarrow Fe^{3+} + e^- \quad \text{(oxidation half-reaction)}$$

$$Ce^{4+} + e^- \rightarrow Ce^{3+} \quad \text{(reduction half-reaction)}$$

$$Fe^{2+} + Ce^{4+} \rightarrow Fe^{3+} + Ce^{3+}$$

Examples

Lose Electrons = Oxidation

$$\overset{0}{Na} \rightarrow \overset{+1}{Na} + e^-$$

Sodium is oxidized

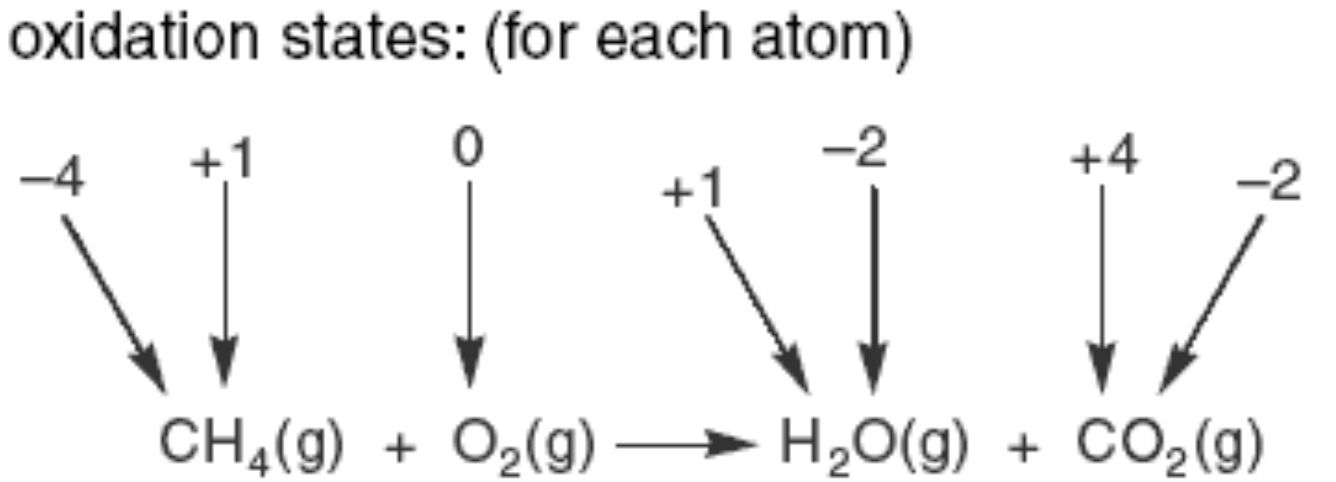
Gain Electrons = Reduction

$$\overset{0}{Cl} + e^- \rightarrow \overset{-1}{Cl}$$

Chlorine is reduced

What do the numbers mean?

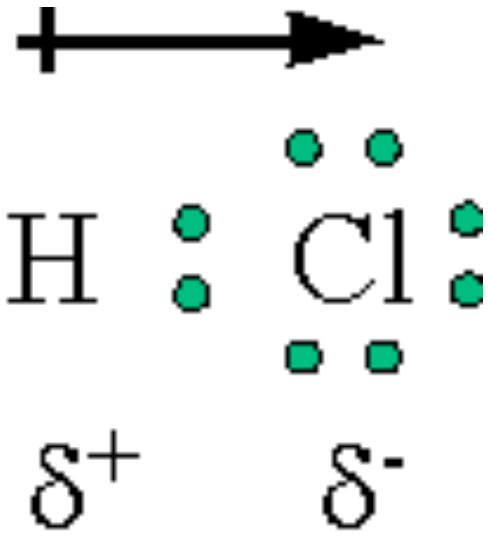
- **OXIDATION NUMBERS** = Charges that represent transfer of electrons – used for 'bookkeeping' when balancing the equations



The overall charges of each molecule is 0. The change in oxidation states come from changes in how atoms share electrons, a function of electronegativity differences

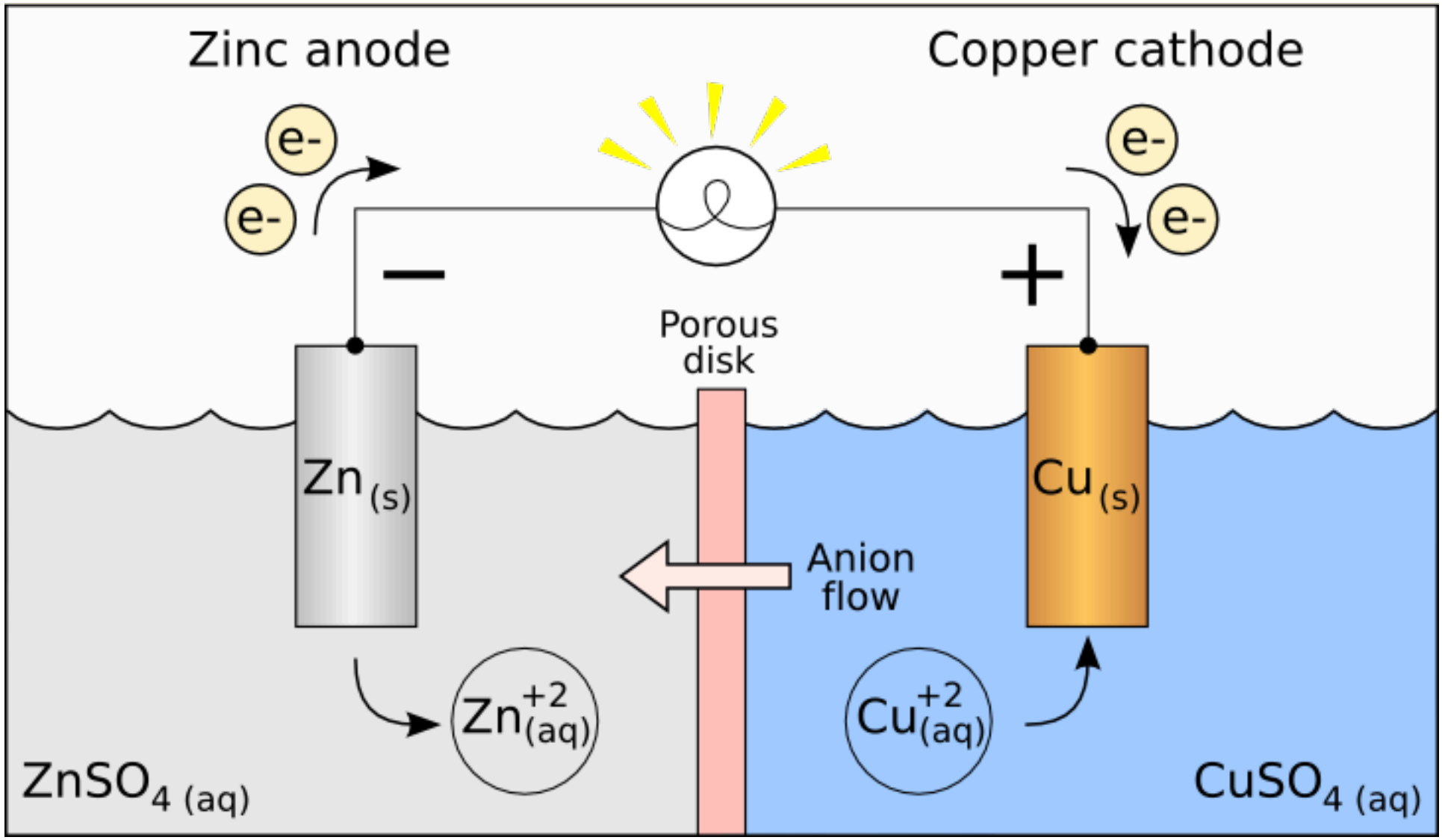
Oxidation-Reduction - COVALENT

- NO actual transfer of electrons
- COVALENT = sharing of electrons
- Oxidation – Reduction when sharing is NOT EQUAL

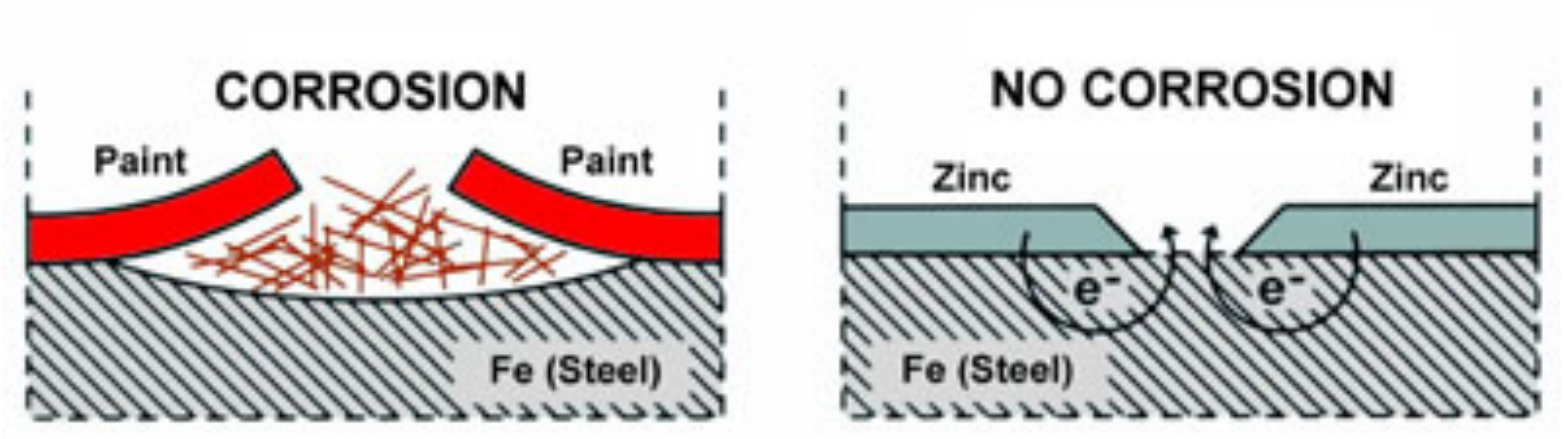


In this covalent compound, CHLORINE pulls the electrons toward it more strongly than HYDROGEN

Electrochemical Cell



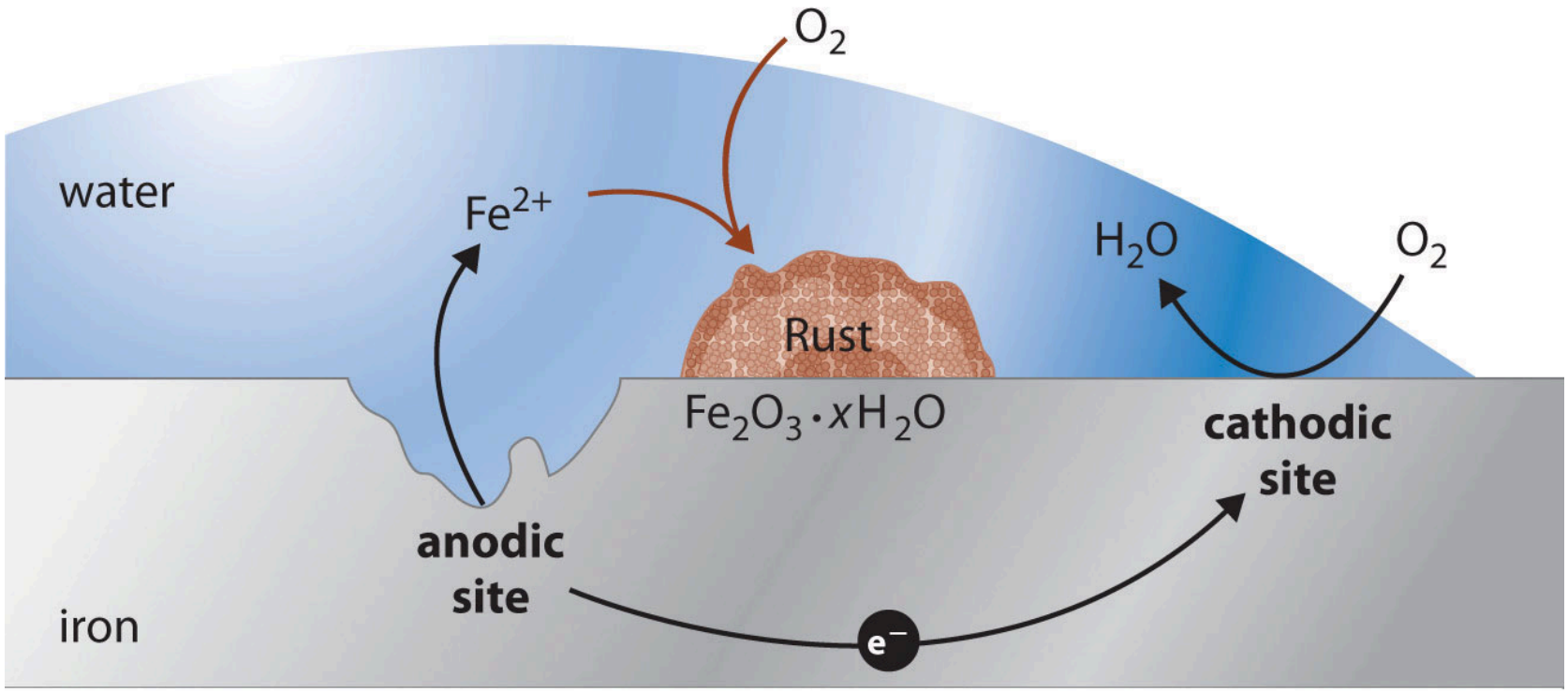
CORROSION ~ REDOX REACTION



Drinking water pipes:

Which one had corrosion control?

Corrosion



$$Fe(s) \rightarrow Fe^{2+}(aq) + 2e^-$$

$$O_2(g) + 4H^+(aq) + 4e^- \rightarrow 2H_2O(l)$$

Flint Water Crisis

- Corrosion of pipes lead to contaminated water
- Lead poisoning in children

- VIDEO (Scientific American): http://www.scientificamerican.com/video/corrosive-chemistry-how-lead-ended-up-in-flint-s-drinking-water1/