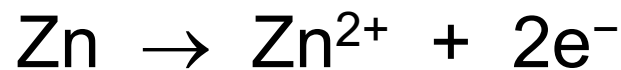
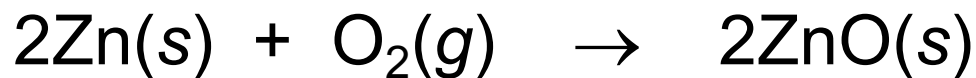


# Oxidation



- Historically, oxidation meant reacting with oxygen.

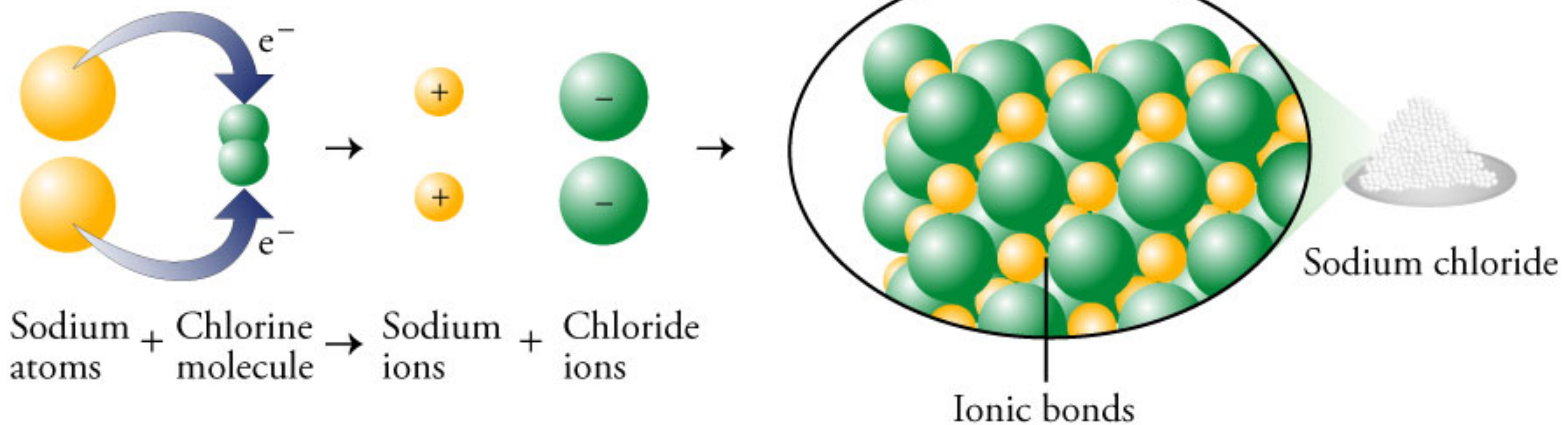


# Oxidation Redefined (1)

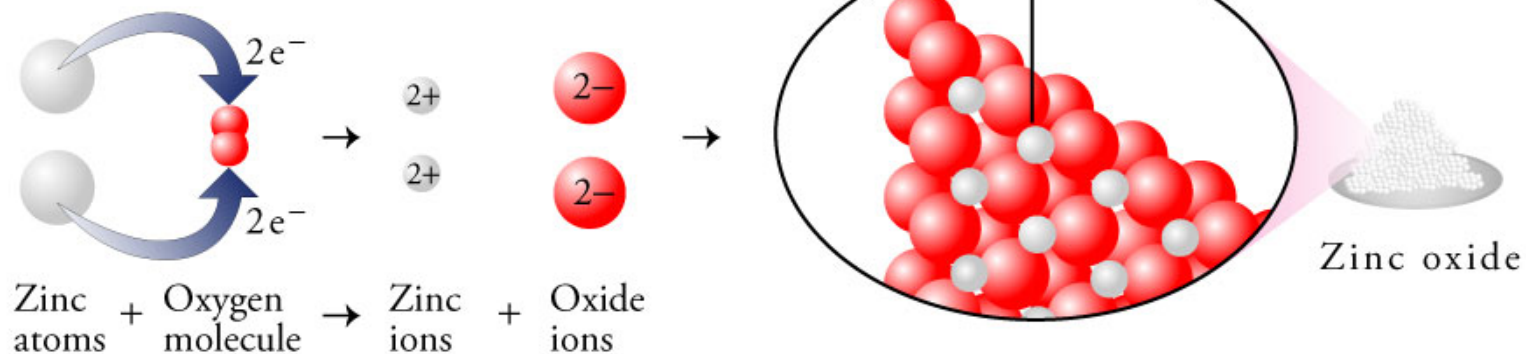
- Many reactions that are similar to the reaction between zinc and oxygen were not considered oxidation.
- For example, both the zinc-oxygen reaction and the reaction between sodium metal and chlorine gas (described on the next slide) involve the transfer of electrons.

# Oxidation and Formation of Binary Ionic Compounds

## Formation of NaCl



## Oxidation of zinc

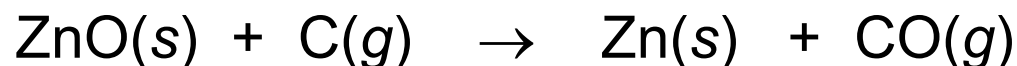


# Oxidation Redefined (2)

- To include the similar reactions in the same category, ***oxidation*** was redefined as any chemical change in which at least one element loses electrons.

# Zinc Oxide Reduction

- The following equation describes one of the steps in the production of metallic zinc.



- Because zinc is reducing the number of bonds to oxygen atoms, historically, zinc was said to be *reduced*.
- When we analyze the changes taking place, we see that zinc ions are gaining two electrons to form zinc atoms.



- The definition of reduction was broadened to coincide with the definition of oxidation. According to the modern definition, when something gains electrons, it is *reduced*.

# Reduction



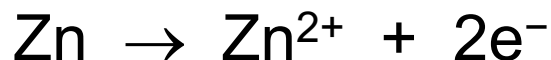
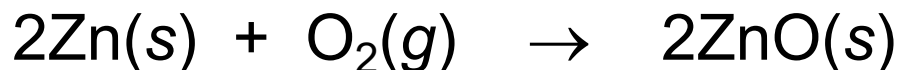
- The loss of electrons (oxidation) by one substance is accompanied by the gain of electrons by another (reduction).
- Electron transfer reactions are called ***oxidation-reduction reactions*** or ***redox*** for short.

# Memory Aid

Oxidation  
O I S L OSS

Reduction  
R I S G ain

# Identifying Oxidizing and Reducing Agents



- Zinc atoms lose electrons, making it possible for oxygen atoms to gain electrons and be reduced, so zinc is the ***reducing agent***.
- Oxygen atoms gain electrons, making it possible for zinc atoms to lose electrons and be oxidized, so  $\text{O}_2$  is the ***oxidizing agent***.

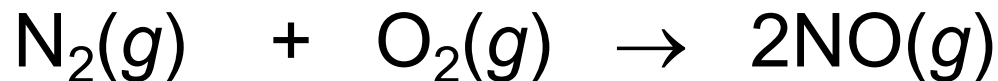


# Oxidizing and Reducing Agents



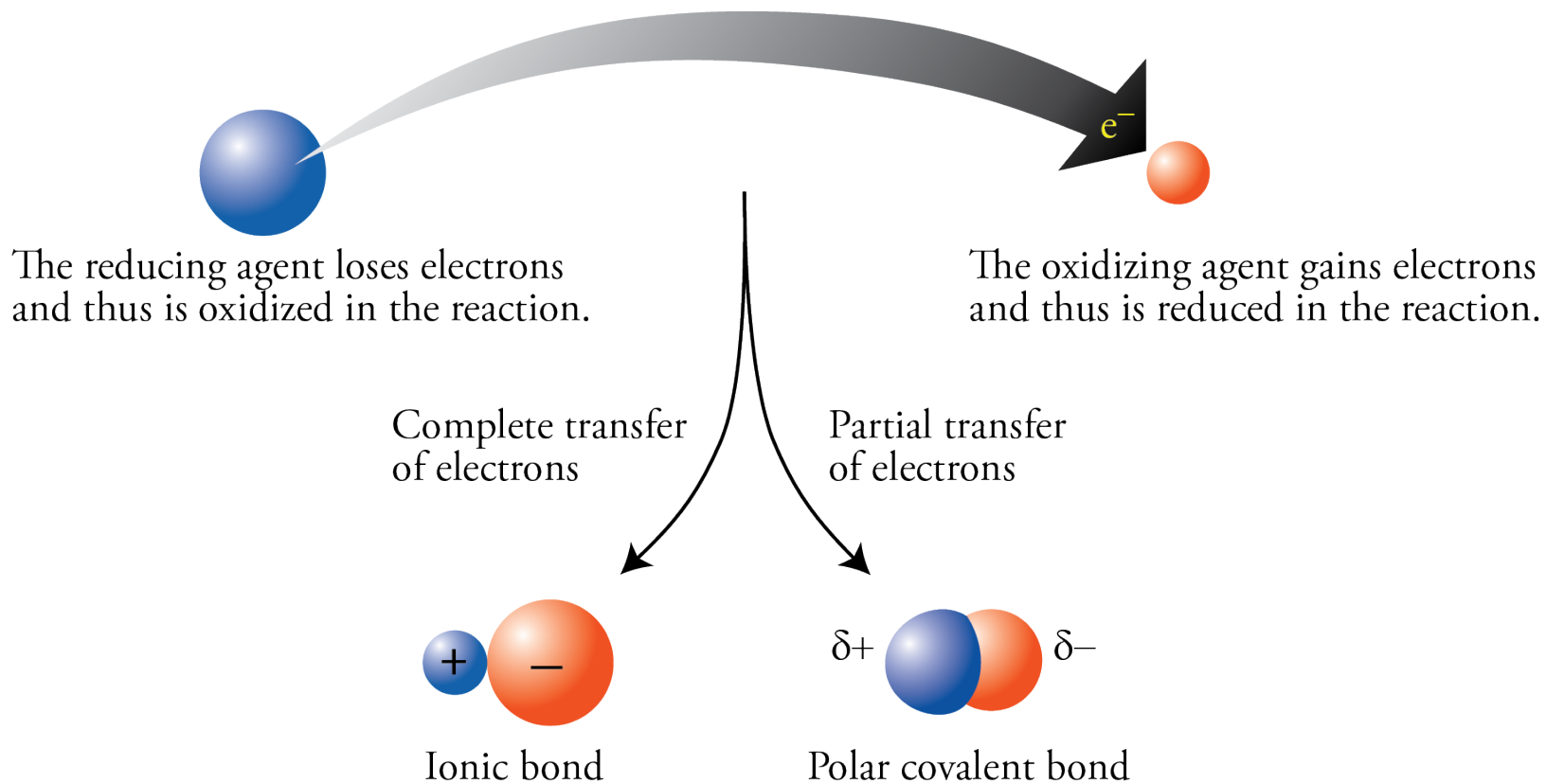
- A **reducing agent** is a substance that loses electrons, making it possible for another substance to gain electrons and be reduced. The oxidized substance is always the reducing agent.
- An **oxidizing agent** is a substance that gains electrons, making it possible for another substance to lose electrons and be oxidized. The reduced substance is always the oxidizing agent.

# Partial Loss and Gain of Electrons



- The N-O bond is a polar covalent bond in which the oxygen atom attracts electrons more than the nitrogen atom.
- Thus the oxygen atoms gain electrons *partially* and are reduced.
- The nitrogen atoms lose electrons *partially* and are oxidized.
- $\text{N}_2$  is the reducing agent.
- $\text{O}_2$  is the oxidizing agent.

# Redox Terms (1)



# Redox Terms (2)

- **Oxidation-Reduction (Redox) Reaction**
  - an electron transfer reaction
- **Oxidation**
  - complete or partial loss of electrons
- **Reduction**
  - complete or partial gain of electrons
- **Oxidizing Agent**
  - the substance reduced; gains electrons, making it possible for something to lose them.
- **Reducing Agent**
  - the substance oxidized; loses electrons, making it possible for something to gain them.