Oxidation Numbers

What are oxidation numbers

- The oxidation number of an element is the charge the element would have if it were an ion
- It helps us keep track of electrons in an oxidation-reduction reaction
- It may be real or make-believe

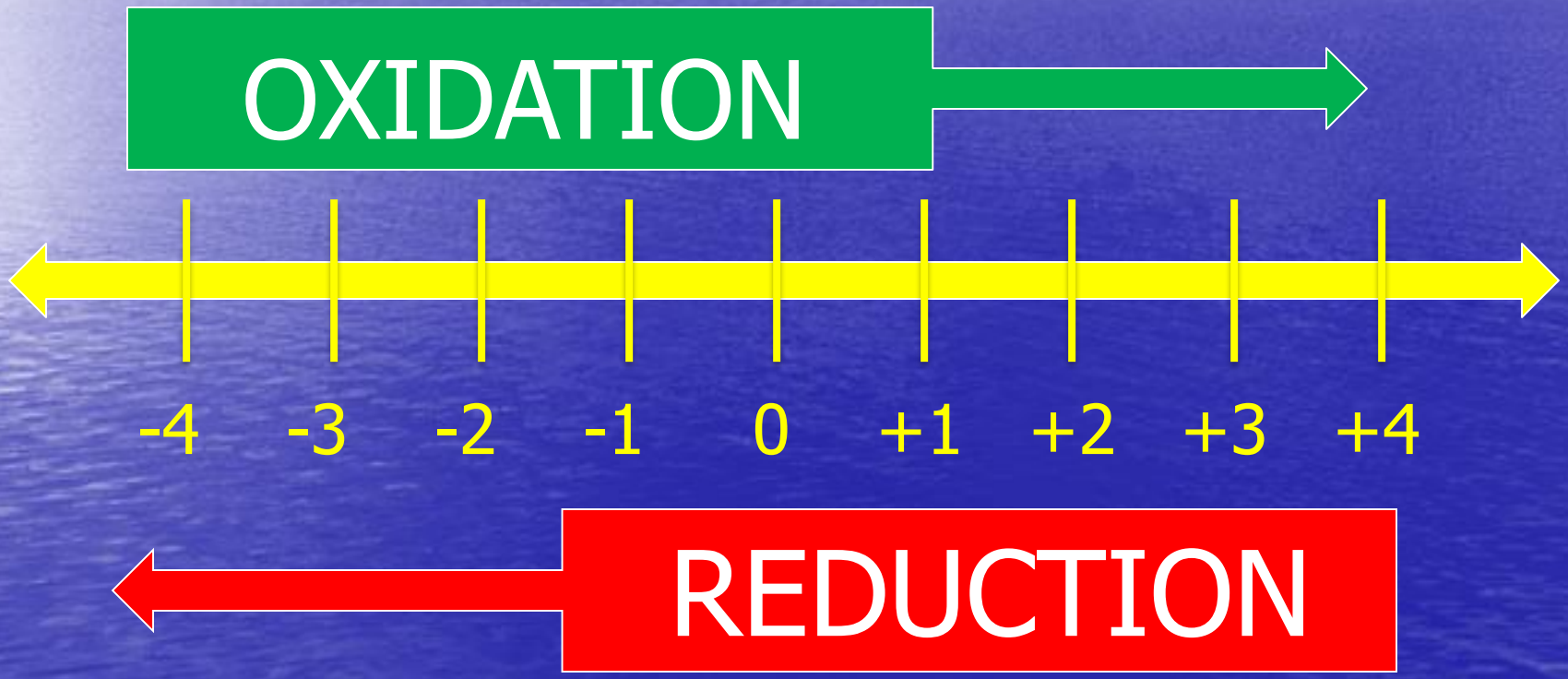
Oxidation

- The process whereby the <u>oxidation number of an element increases</u>
  - Becomes more positive
- Involves the ***loss*** of electrons
  - Electrons are a **<u>product</u>**
- $M^{\circ} \rightarrow M^{n+} + ne^{-}$
- $X^{-} \rightarrow X^{\circ} + e^{-}$
- $M^{2+} \rightarrow M^{3+} + e^{-}$

Reduction

- The process whereby the <u>oxidation number of an element decreases</u>
  - Becomes more negative
- Involves the ***gain*** of electrons
  - Electrons are a **<u>reactant</u>**
- $M^{n+} + ne^- \rightarrow M^\circ$
- $X_2 + 2e^- \rightarrow 2X^-$
- $M^{4+} + 2e^- \rightarrow M^{2+}$

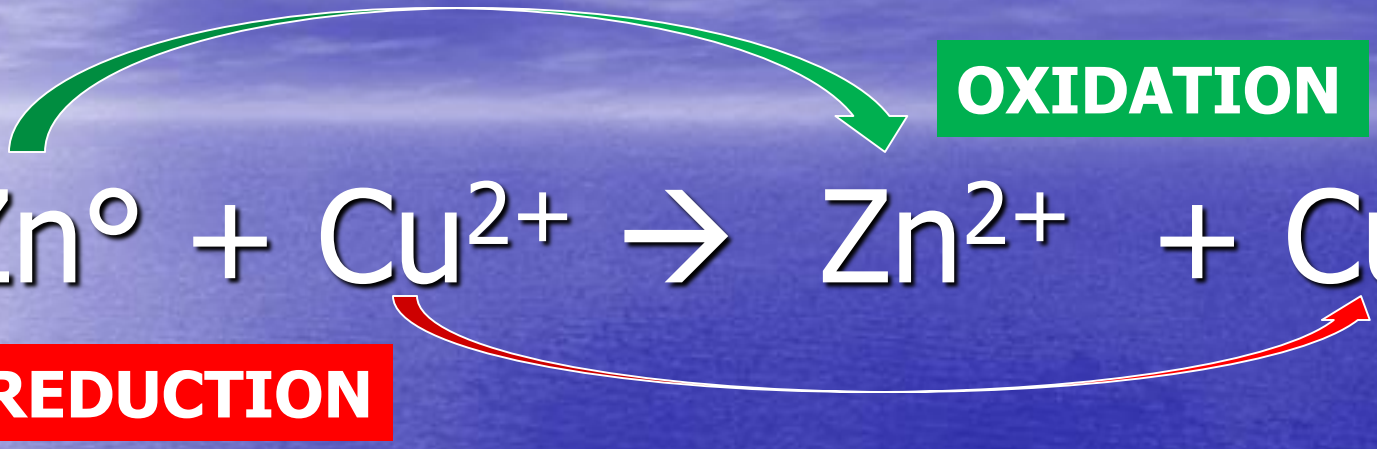
oxidation and reduction



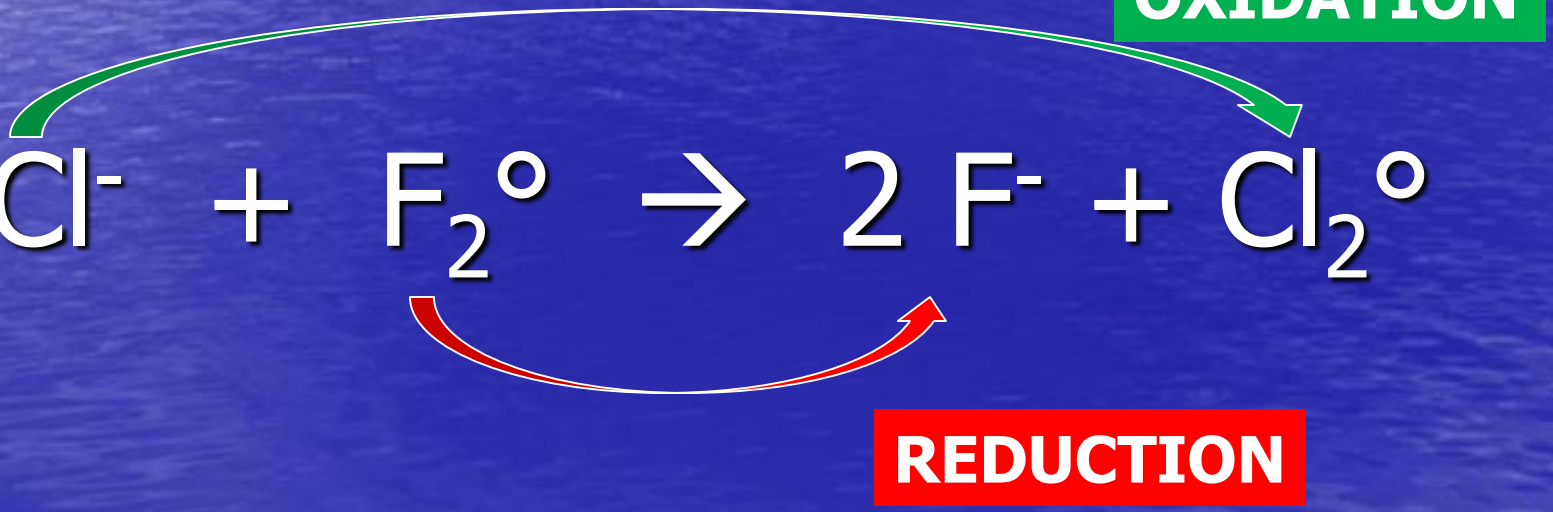
oxidation – reduction reactions

- Called "**redox**" reactions for short
- **Always** occur as a pair
- One element "loses" electrons
  - –Oxidation
- One element "gains" electrons
  - –Reduction

Redox reaction examples



- $Zn^{\circ} + Cu^{2+} \rightarrow Zn^{2+} + Cu^{\circ}$



- $2\ Cl^{-} + F_2^{\circ} \rightarrow 2\ F^{-} + Cl_2^{\circ}$

OXIDIZING AGENT

- **<u>Oxidizes something else</u>**

- Contains the element being **reduced**

REDUCING AGENT

- **reduces something else**

- Contains the element being **oxidized**

Determining oxidation numbers

1. The oxidation number of a free element is zero
   - ✓ Regardless of it is "monatomic" or if it has a subscript
   - ✓ Examples: Mg, O_2, P_4, Zn

Determining oxidation numbers

2. The oxidation number of a "monatomic" ion is the same as the charge of the ion
   - Na^{+} has an ox# of +1
   - S^{2-} has an ox# of -2
   - Fe^{3+} has an ox# of +3
   - I^{-} has an ox# of -1

Determining oxidation numbers

3. The sum of all the oxidation numbers of all the elements in a substance is the same as the charge of the substance

- The ox#'s in a neutral compound must all add up to zero
- The ox#'s in a polyatomic ion must all add up to the charge of the polyatomic ion

Determining oxidation numbers

In a compound…

4) The ox# of fluorine is -1

5) the ox# of hydrogen is +1

   except in a hydride, where it is -1

   ex: LiH, CaH_2

6) the ox# of oxygen is -2

   except in peroxides and superoxides

   ex: H_2O_2, KO_2, OF_2

Oxidation Numbers

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No, they’re not checked yet