

# Totally Epic AP Chem Review: Oxidation Numbers and Redox Balancing!

## Oxidation-Reduction (Redox) Review

Oxidation-reduction (redox) reactions: where electrons are transferred from one atom to another.

- If a substance accepts an electron, it is reduced.
- If a substance loses an electron, it is oxidized.

Two great mnemonics!

1. OIL RIG: Oxidation Is Loss (OIL) and Reduction Is Gain (RIG)
2. LEO goes GER: A species loses electrons when oxidized, and gains electrons when reduced.

If a chemical reaction has two species which change oxidation number: yes, it's redox!

**Oxidation Numbers/States:** Oxidation states are imaginary charges assigned based on a set of rules simply used to determine electron flow. Even though they look like them, oxidation states are **NOT** ionic charges!

### Rules for Assigning Oxidation Numbers (in order of priority)

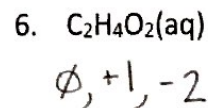
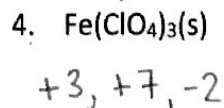
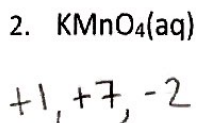
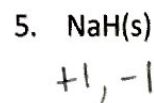
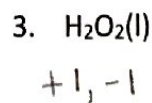
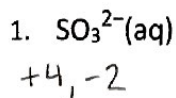
If any rules are in conflict, follow the rule that is higher on the list!

#### Oxidation Rules:

1. Free elements = 0
2. All atoms in a neutral compound add up to 0.
3. All atoms in a polyatomic ion add up to the ion's charge.  
*The rules below apply to bonded elements:*
4. Group 1A metals = +1
5. Group 2A = +2
6. Non-metals **usually** follow the chart to the right, in order:
  - a. Note: the carbon family (4A) isn't mentioned – you will ALWAYS have to solve for the oxidation number of group 4A elements in a compound.

Nonmetal	Oxidation State	Example
Fluorine	-1	MgF <sub>2</sub> -1 ox state
Hydrogen	+1	H <sub>2</sub> O +1 ox state
Oxygen	-2	CO <sub>2</sub> -2 ox state
Group 7A	-1	CCl <sub>4</sub> -1 ox state
Group 6A	-2	H <sub>2</sub> S -2 ox state
Group 5A	-3	NH <sub>3</sub> -3 ox state

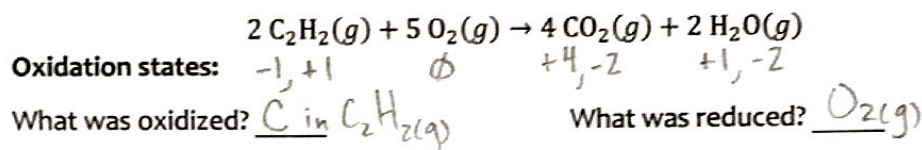
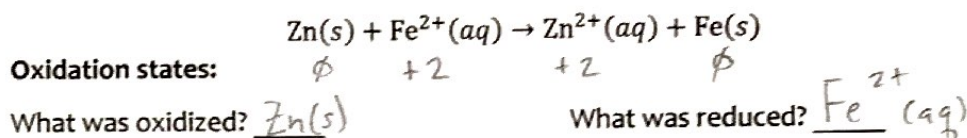
**Oxidation State Practice:** Give the oxidation number of each element for the chemical species listed below.



## How to Identify What is Oxidized or Reduced in a Reaction

A substance that has the element that has been oxidized (LOST electrons) will have an oxidation number that becomes more positive (or less negative).

A substance that has the element that has been reduced (GAINED electrons) will have an oxidation number that becomes more negative (or less positive).

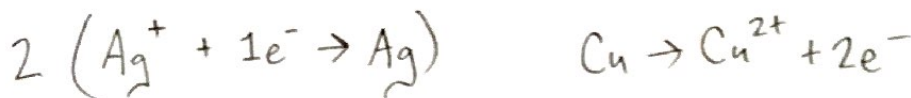


### Steps to Balance Redox Reactions using the Half-Reaction Method

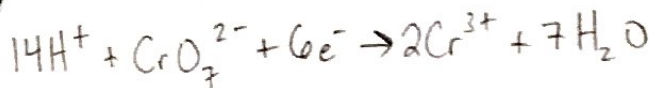
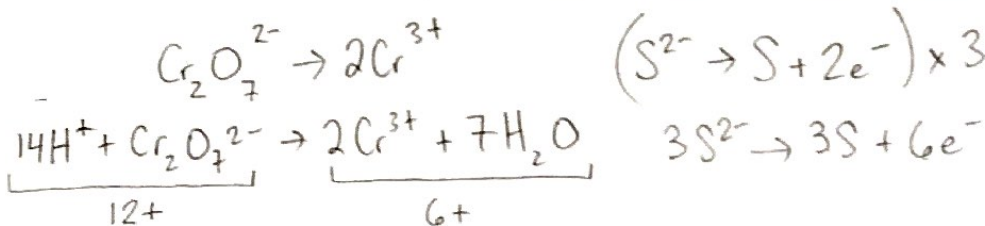
1. Write the oxidation and reduction half-reactions (without electrons).
2. Balance all atoms other than H and O.
3. Balance O by adding H<sub>2</sub>O, and balance H by adding H<sup>+</sup>.
4. Balance charge in each half reaction using electrons.
5. Equalize electron transfer by multiplying so both half-reactions have the same # of electrons exchanged.
6. Add the two half-reactions, cancelling anything that appears on both sides of the equation.
7. **In a basic solution:** add <sup>equal</sup> OH<sup>-</sup> ions to ~~each~~ <sup>both</sup> side of the equation to neutralize H<sup>+</sup> ions. Combine H<sup>+</sup> and OH<sup>-</sup> to form H<sub>2</sub>O, and cancel if needed.

#### Practice:

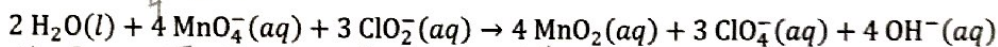
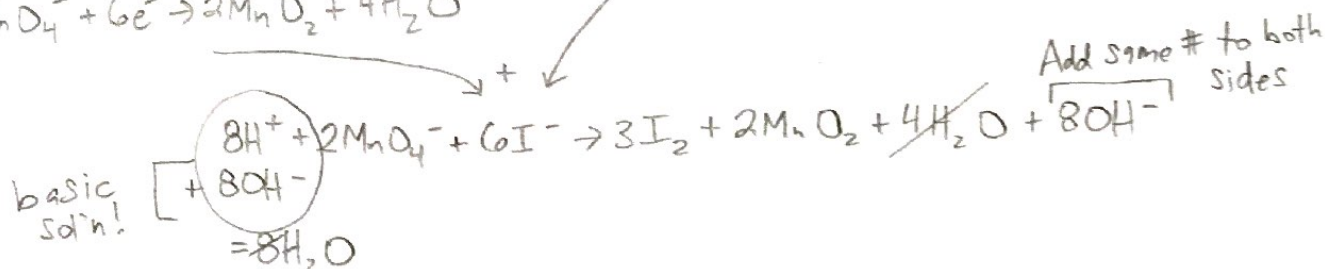
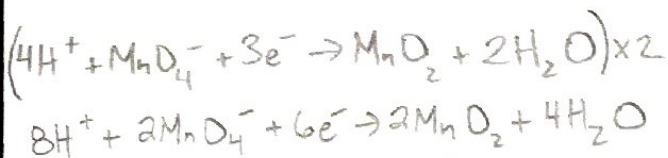
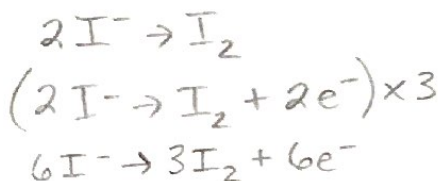
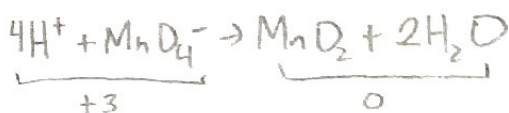
1. Balance the following redox reaction: 2 Ag<sup>+</sup>(aq) + 1 Cu(s) → 2 Ag(s) + 1 Cu<sup>2+</sup>(aq)



2. Balance the following redox reaction: 14 H<sup>+</sup> + 1 Cr<sub>2</sub>O<sub>7</sub><sup>2-</sup> + 3 S<sup>2-</sup> → 2 Cr<sup>3+</sup> + 3 S + 7 H<sub>2</sub>O



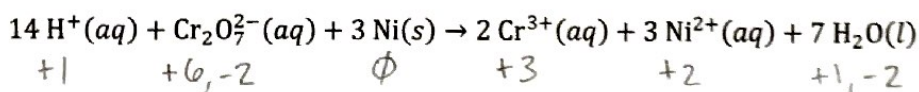
3. Balance the following redox reaction:  $\underline{4} \text{H}_2\text{O} + \underline{2} \text{MnO}_4^- + \underline{6} \text{I}^- \rightarrow \underline{3} \text{I}_2 + \underline{2} \text{MnO}_2 + \underline{8} \text{OH}^-$



4. Which species is reduced in the reaction represented above?

- a.  $\text{MnO}_2$       b.  $\text{ClO}_2^-$       c.  $\text{MnO}_4^-$       d.  $\text{ClO}_4^-$

5. In the reaction below, a piece of solid nickel is added to a solution of potassium dichromate.



Which species is being oxidized and which is being reduced?

- | Oxidized                            | Reduced                          |
|-------------------------------------|----------------------------------|
| a. $\text{Cr}_2\text{O}_7^{2-}(aq)$ | $\text{Ni}(s)$                   |
| b. $\text{Cr}^{3+}(aq)$             | $\text{Ni}^{2+}(aq)$             |
| c. $\text{Ni}(s)$                   | $\text{Cr}_2\text{O}_7^{2-}(aq)$ |
| d. $\text{Ni}^{2+}(aq)$             | $\text{Cr}^{3+}(aq)$             |

6. Which net ionic equation below represents a possible reaction that takes place when a strip of magnesium metal is oxidized by a solution of chromium (III) nitrate?

- a.  $\text{Mg}(s) + \text{Cr}(\text{NO}_3)_3(aq) \rightarrow \text{Mg}^{2+}(aq) + \text{Cr}^{3+}(aq) + 3 \text{NO}_3^-(aq)$
- b.  $3 \text{Mg}(s) + 2 \text{Cr}^{3+}(aq) \rightarrow 3 \text{Mg}^{2+}(aq) + 2 \text{Cr}(s)$  (net ionic = no  $\text{NO}_3^-$ !)
- c.  $\text{Mg}(s) + \text{Cr}^{3+}(aq) \rightarrow \text{Mg}^{2+}(aq) + \text{Cr}(s)$
- d.  $3 \text{Mg}(s) + 2 \text{Cr}(\text{NO}_3)_3(aq) \rightarrow 3 \text{Mg}^{2+}(aq) + 2 \text{Cr}(s) + \text{NO}_3^-(aq)$