

Questions Answered by Oxidation Numbers

Is the reaction redox?	If any atoms change their oxidation number, yes.
What's oxidized?	The element that increases its oxidation number
What's reduced?	The element that decreases its oxidation number
What's the reducing agent?	The substance with the element oxidized
What's the oxidizing agent?	The substance with the element reduced

Steps for Determination of Oxidation Numbers



- **Step 1:** Assign oxidation numbers to as many atoms as you can using the guidelines described on the next slide.
- **Step 2:** To determine oxidation numbers for atoms not described on the next slide, use the following guideline.
 - The sum of the oxidation numbers for each atom in the formula is equal to the overall charge on the formula. (This includes uncharged formulas where the sum of the oxidation numbers is zero.)

Oxidation Numbers for Common Elements

	Oxidation number	Examples	Exceptions
Pure element	0	The oxidation number for each atom in Zn, H ₂ , and S ₈ is zero.	none
Monatomic ions	charge on ion	Cd in CdCl ₂ is +2. Cl in CdCl ₂ is -1.	none
Fluorine in the combined form	-1	F in AlF ₃ is -1. F in CF ₄ is -1.	none
Oxygen in the combined form	-2	O in ZnO is -2. O in H ₂ O is -2.	O is -1 in peroxides, such as H ₂ O ₂
Hydrogen in the combined form	+1	H in H ₂ O is +1. H in HSO ₄ ⁻ is +1.	H is -1 when combined with a metal.

Examples



- Determine the oxidation number for each of the atoms or ions in the following formulas.
- **N₂**
0 (Uncharged element)
- **N³⁻**
-3 (monatomic ion)
- **H₂S**
+1 for H (covalently bonded H)
-2 for S (solve $0 = 2(1) + x$ for x)
- **LiH**
+1 for Li, -1 for H (monatomic ions)

Examples

- Determine the oxidation number for each of the atoms or ions in the following formulas.



+1 for K (monatomic ion)

+1 for H (covalently bonded in polyatomic ion)

-2 for O (combined oxygen, not a peroxide)

+5 for P (solve the following equation for x)

$$0 = 2(1) + 1 + x + 4(-2)$$

$$0 = 3 + x - 8$$

$$0 = x - 5$$

$$+5 = x$$

Examples

- Determine the oxidation number for each of the atoms or ions in the following formulas.



+1 for H (covalently bonded in a polyatomic ion)

-2 for O (combined oxygen, not a peroxide)

+6 for Cr (solve the following equation for x)

$$-1 = 1 + 2x + 7(-2)$$

$$-1 = 1 + 2x - 14$$

$$-1 = 2x - 13$$

$$12 = 2x$$

$$6 = x$$

Examples

- Determine the oxidation number for each of the atoms or ions in the following formulas.
- **NH₄⁺**
 - +1 for H (covalently bonded in polyatomic ion)
 - 3 for N (solve the following equation for x)
 - +1 = x + 4(+1)
 - +1 = x + 4
 - 3 = x

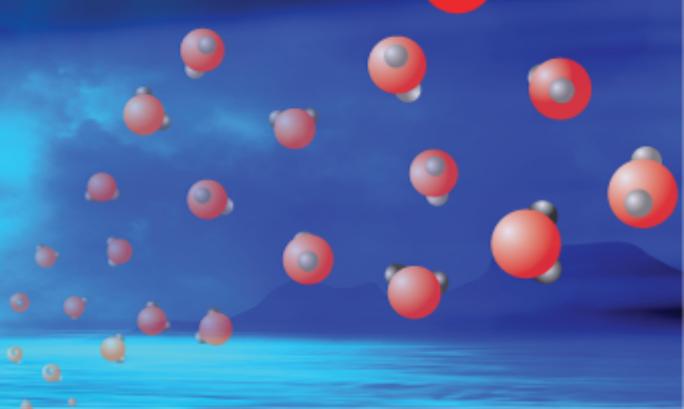
Examples

- Determine the oxidation number for each of the atoms or ions in the following formulas.
- H_2PO_2^-
 - +1 for H (covalently bonded in polyatomic ion)
 - 2 for O (combined oxygen)
 - +1 for P (solve the following equation for x)
 - $-1 = 2(1) + x + 2(-2)$
 - $-1 = 2 + x - 4$
 - $-1 = x - 2$
 - $+1 = x$

Examples

- Determine the oxidation number for each of the atoms or ions in the following formulas.
- **Cu₂SO₄**
 - +1 for Cu (monatomic ion)
 - 2 for O (combined oxygen, not a peroxide)
 - +6 for S (solve the following equation for x)
 - $0 = 2(1) + x + 4(-2)$
 - $0 = 2 + x - 8$
 - $0 = x - 6$
 - $+6 = x$

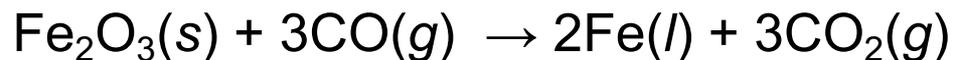
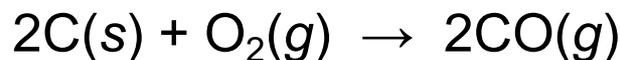
Questions Answered by Oxidation Numbers



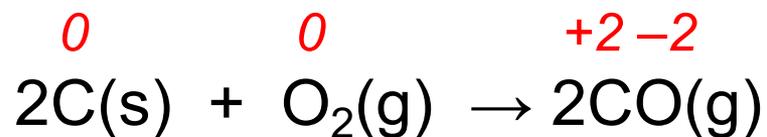
Is the reaction redox?	If any atoms change their oxidation number, yes.
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Examples

- In one part of the steel manufacturing process, carbon is combined with iron to form pig iron. Pig iron is easier to work with than pure iron because it has a lower melting point (about 1130 °C, compared to 1539 °C for pure iron) and is more pliable. The following equations describe its formation. Determine the oxidation number for each atom in the formulas. Decide whether each reaction is a redox reaction, and if it is, identify what is oxidized, what is reduced, what the oxidizing agent is, and what the reducing agent is.

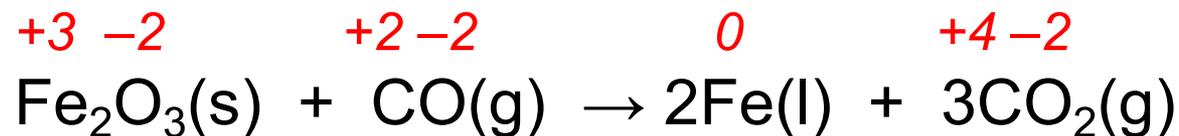


Exercise



- Oxidation numbers
 - 0 for C and O in O₂ (uncharged elements)
 - 2 for O in CO (combined oxygen, not a peroxide)
 - +2 for C in CO (solve 0 = x + (-2) for x)
- C goes from 0 to +2 so it is oxidized.
- O goes from 0 to -2 so it is reduced
- O in O₂ is reduced so O₂ is the oxidizing agent.
- C in C(s) is oxidized so C is the reducing agent.

Exercise



- Oxidation numbers
 - 2 for O in all formulas with O (combined oxygen, not a peroxide)
 - +3 for Fe in Fe₂O₃ (solve $0 = 2x + 3(-2)$ for x)
 - +2 for C in CO (solve $0 = x + (-2)$ for x)
 - 0 for Fe in Fe(l) (uncharged element)
 - +4 for C in CO₂ (solve $0 = x + 2(-2)$ for x)
- Fe goes from +3 to 0, so it is reduced.
- C goes from +2 to +4, so it is oxidized
- Fe in Fe₂O₃ is reduced, so Fe₂O₃ is the oxidizing agent.
- C in CO is oxidized, so CO is the reducing agent.

Exercise



- Oxidation numbers
 - 2 for O in all formulas with O (combined oxygen, not a peroxide)
 - +2 for C in CO (solve $0 = x + (-2)$ for x)
 - 0 for C (uncharged element)
 - +4 for C in CO₂ (solve $0 = x + 2(-2)$ for x)
- C in CO goes from +2 to 0 in C, so it is reduced.
- C in CO goes from +2 to +4 in CO₂, so it is oxidized.
- C in CO is both oxidized and reduced, so CO is both the oxidizing agent and the reducing agent. (This is called disproportionation.)