SCIENCE FOUNDATIONS

Oxidation numbers

Difficulty level: Advanced

Science Foundations

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Overview of the concept

This is how a chemist tracks electrons through a reaction to spot what gets oxidised and what gets reduced, which is how batteries, rust, and bleaching all work. A battery charges and discharges by moving electrons from one side to the other, and oxidation numbers show where they went. A piece of iron rusts when it loses electrons to oxygen in the air. Knowing oxidation numbers tells you who gained electrons and who lost them, which is the key to understanding any reaction that moves charge around.



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Rule

Oxidation numbers: the sum of the oxidation numbers in a compound = the total charge of the compound, which is zero for a neutral compound.

A free element has oxidation number 0, oxygen is usually -2, and hydrogen is usually +1. Group 1 metals are +1 and Group 2 metals are +2.

Worked examples

EXAMPLE 1

Q **Find the oxidation number of sulfur in H_2SO_4.**

SOLUTION

Assign knowns: hydrogen is +1 each, oxygen is -2 each.

Set the sum to zero:

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

Solve:

$2 + S - 8 = 0$

$S = +6$

The result is sulfur is +6.

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EXAMPLE 2

Q Find the oxidation number of carbon in CO_2.

SOLUTION

Assign knowns: oxygen is -2 each, two of them.

Set the sum to zero:

C + 2(-2) = 0

Solve for carbon:

C = +4

The result is carbon is +4.

Practice questions

1 In sulfur trioxide, SO_3, what is the oxidation number of sulfur?

- **A** +4
- **B** +6
- **C** -2
- **D** 0

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2 In sulfur dioxide, SO_2, sulfur has oxidation number +4. Sulfur metal on its own has oxidation number 0. Has the sulfur been oxidised or reduced?

- **A** Oxidised
- **B** Reduced
- **C** Neither
- **D** Both

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3 Carbon in carbon monoxide, CO, is +2, and in carbon dioxide, CO_2, it is +4. Which compound has the more oxidised carbon?

- **A** CO
- **B** CO_2
- **C** They are equally oxidised
- **D** Neither is oxidised

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4 **In methane, CH_4, what is the oxidation number of carbon?**

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5 **What is the oxidation number of iron metal on its own?**

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6 **What is the usual oxidation number of oxygen?**

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7 **What is the usual oxidation number of hydrogen?**

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8 **What do the oxidation numbers in a neutral compound add up to?**

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9 In ammonia, NH_3, nitrogen has oxidation number -3. If the nitrogen loses electrons, does its oxidation number go up or down?

- A Up
- B Down
- C It stays the same
- D It becomes zero

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10 In table salt, NaCl, what are the oxidation numbers of sodium and chlorine?

- A Sodium +1, chlorine -1
- B Sodium -1, chlorine +1
- C Sodium +2, chlorine -2
- D Sodium 0, chlorine 0

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ANSWER KEY

1. +6

2. Oxidised

3. CO2

4. -4

5. 0

6. -2

7. +1

8. 0

9. Up

10. Sodium +1, chlorine -1

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