Oxidation States

Name: _____ **Date:** _____

Quick Review

An **oxidation state** (or **oxidation number**) is a number assigned to an atom that helps us track electrons in compounds and reactions.

Some useful rules:

- An element by itself has oxidation state **0**.
- A monatomic ion has an oxidation state equal to its **charge**.
- Oxygen is usually **−2**.
- Hydrogen is usually **+1**.
- Group 1 metals are usually **+1**.
- Group 2 metals are usually **+2**.
- In a neutral compound, all oxidation states add to **0**.
- In a polyatomic ion, all oxidation states add to the **overall charge of the ion**.

Oxidation: oxidation state increases → electrons are lost.

Reduction: oxidation state decreases → electrons are gained.

Part A — Multiple Choice

1. What is the oxidation state of an element by itself, such as Cu or O_2?

A. −2
B. −1
C. 0
D. +1

2. What is the oxidation state of Na in Na^+?

A. −1
B. 0
C. +1
D. +2

3. What is the usual oxidation state of oxygen in compounds?

A. −2
B. −1
C. +1
D. +2

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4. What is the usual oxidation state of hydrogen in compounds?

A. −2
B. −1
C. 0
D. +1

5. Oxidation occurs when an element's oxidation state:

A. decreases
B. increases
C. stays the same
D. becomes zero

6. Reduction occurs when an element's oxidation state:

A. increases
B. doubles
C. decreases
D. always becomes zero

Part B — Determine the Oxidation State

Find the oxidation state of the indicated element.

1. Na in NaCl: _____ **2. Cl in NaCl:** _____

3. Mg in MgO: _____ **4. O in MgO:** _____

5. H in H_2O: _____ **6. O in H_2O:** _____

7. Ca in $CaCl_2$: _____ **8. Cl in $CaCl_2$:** _____

Part C — Find the Unknown Oxidation State

Use the rule that oxidation states in a neutral compound add to **0**.

1. CO_2	O = −2	C + 2(−2) = 0	Oxidation state of C = _____
2. SO_2	O = −2	S + 2(−2) = 0	Oxidation state of S = _____
3. NH_3	H = +1	N + 3(+1) = 0	Oxidation state of N = _____
4. Fe_2O_3	O = −2	2(Fe) + 3(−2) = 0	Oxidation state of Fe = _____

Part D — Polyatomic Ions

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Remember: oxidation states must add to the **charge of the ion**.

1. SO_4^{2-} O = −2 S + 4(−2) = −2 Oxidation state of S = _____

2. NO_3^- O = −2 N + 3(−2) = −1 Oxidation state of N = _____

3. NH_4^+ H = +1 N + 4(+1) = +1 Oxidation state of N = _____

Part E — Oxidation or Reduction?

For each change, write **oxidation** or **reduction**.

1. Mg: 0 → +2

2. Cu: +2 → 0

3. Fe: +2 → +3

4. Cl: 0 → −1

Part F — Track the Electron Transfer

Consider the reaction:

$Mg + Cu^{2+} \rightarrow Mg^{2+} + Cu$

Complete the table.

Element	Initial Oxidation State	Final Oxidation State	Oxidized or Reduced?
Mg	_____	_____	_____
Cu	_____	_____	_____

1. Which element loses electrons?

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2. Which element gains electrons?

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3. How many electrons are transferred?

Part G — Apply to a Chemical Equation

Consider:

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$2Mg + O_2 \rightarrow 2MgO$

1. Oxidation state of Mg before the reaction: _____

2. Oxidation state of Mg after the reaction: _____

3. Is Mg oxidized or reduced? _____

4. Oxidation state of O before the reaction: _____

5. Oxidation state of O after the reaction: _____

6. Is oxygen oxidized or reduced? _____

Exit Ticket

1. What is an oxidation state?

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2. What happens to oxidation state during oxidation?

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3. What happens to oxidation state during reduction?

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4. Determine the oxidation state of sulfur in SO_3.

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5. An element changes from +4 to +2. Has it been oxidized or reduced?

Oxidation States Worksheet — Answer Key

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Part A — Multiple Choice

1. **C — 0**
2. **C — +1**
3. **A — −2**
4. **D — +1**
5. **B — increases**
6. **C — decreases**

Part B — Determine the Oxidation State

1. Na in NaCl: **+1**
2. Cl in NaCl: **−1**
3. Mg in MgO: **+2**
4. O in MgO: **−2**
5. H in H_2O: **+1**
6. O in H_2O: **−2**
7. Ca in $CaCl_2$: **+2**
8. Cl in $CaCl_2$: **−1**

Part C — Find the Unknown Oxidation State

1. CO_2

$C + 2(-2) = 0$
$C - 4 = 0$
C = +4

2. SO_2

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

3. NH_3

$N + 3(+1) = 0$
$N + 3 = 0$
N = −3

4. Fe_2O_3

$2(Fe) + 3(-2) = 0$
$2Fe - 6 = 0$
$2Fe = 6$
Fe = +3

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Part D — Polyatomic Ions

1. SO_4^{2-}

$S + 4(-2) = -2$
$S - 8 = -2$
$S = +6$

2. NO_3^-

$N + 3(-2) = -1$
$N - 6 = -1$
$N = +5$

3. NH_4^+

$N + 4(+1) = +1$
$N + 4 = +1$
$N = -3$

Part E — Oxidation or Reduction?

1. Mg: 0 → +2 — **Oxidation**
2. Cu: +2 → 0 — **Reduction**
3. Fe: +2 → +3 — **Oxidation**
4. Cl: 0 → −1 — **Reduction**

Remember:

Oxidation = oxidation state increases = electrons lost

Reduction = oxidation state decreases = electrons gained

Part F — Track the Electron Transfer

$Mg + Cu^{2+} \rightarrow Mg^{2+} + Cu$

Element	Initial Oxidation State	Final Oxidation State	Change
Mg	**0**	**+2**	**Oxidized**
Cu	**+2**	**0**	**Reduced**

1. Which element loses electrons?
Magnesium (Mg)

$Mg \rightarrow Mg^{2+} + 2e^-$

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2. Which element gains electrons?
Copper (Cu^{2+})

$Cu^{2+} + 2e^- \rightarrow Cu$

3. How many electrons are transferred?
2 electrons

Part G — Apply to a Chemical Equation

$2Mg + O_2 \rightarrow 2MgO$

1. Oxidation state of Mg before: 0

2. Oxidation state of Mg after: +2

3. Is Mg oxidized or reduced?
Oxidized

4. Oxidation state of O before: 0

5. Oxidation state of O after: −2

6. Is oxygen oxidized or reduced?
Reduced

Magnesium loses electrons while oxygen gains electrons.

Exit Ticket

1. What is an oxidation state?
A number assigned to an atom that helps represent and track electrons in compounds and reactions.

2. What happens to oxidation state during oxidation?
It **increases**.

3. What happens to oxidation state during reduction?
It **decreases**.

4. Determine the oxidation state of sulfur in SO_3.

$S + 3(-2) = 0$
$S - 6 = 0$
$S = +6$

5. An element changes from +4 to +2. Has it been oxidized or reduced?
Reduced, because its oxidation state decreased from +4 to +2.

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