

CHEMISTRY OXIDATION NUMBERS please Help Me Solve Only 3 Of Those Oxidation Numbers NO_2 , $\text{Cr}_2\text{O}_7^{2-}$, KCl , NH_3 , CaH_2 , SO_4^{2-} , Na_2O_2 , SiO_2 , and CaCl_2

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Introduction

In the world of chemistry, understanding oxidation numbers (also called oxidation states) is fundamental to mastering concepts such as redox reactions, balancing chemical equations, and exploring the behavior of elements in various compounds. Oxidation numbers provide insight into how electrons are transferred between atoms during chemical reactions, and they help chemists determine which substances are oxidized or reduced.

This article aims to demystify the concept of oxidation numbers by focusing on a specific set of compounds: NO_2 , $\text{Cr}_2\text{O}_7^{2-}$, KCl , NH_3 , CaH_2 , SO_4^{2-} , Na_2O_2 , SiO_2 , and CaCl_2 . We will solve the oxidation numbers for three selected compounds from this list, providing detailed explanations to enhance your understanding. Whether you're a student preparing for exams or a chemistry enthusiast seeking clarity, this guide will serve as a comprehensive resource.

Understanding Oxidation Numbers

Before delving into specific compounds, it's essential to grasp what oxidation numbers represent. In simple terms, an oxidation number indicates the hypothetical charge an atom would have if all bonds were purely ionic. It helps track electron transfer in chemical reactions and is assigned based on a set of rules, such as:

- The oxidation number of any uncombined element (free element) is zero.
- The oxidation number of a monatomic ion equals its charge.
- Oxygen usually has an oxidation number of -2, except in peroxides or when bonded to fluorine.
- Hydrogen generally has an oxidation number of +1 when bonded to non-metals and -1 when bonded to metals in hydrides.
- The sum of oxidation numbers in a neutral compound is zero, while in an ion, it equals the charge of the ion.

Applying these rules systematically allows us to determine the oxidation states of atoms within compounds.

Selected Compounds for Oxidation Number Analysis

Let's focus on three compounds from the list to illustrate how oxidation numbers are assigned:

1. NO_2 (Nitrogen Dioxide)
2. $\text{Cr}_2\text{O}_7^{2-}$ (Dichromate Ion)
3. Na_2O_2 (Sodium Peroxide)

We will analyze each, step-by-step, to find the oxidation numbers of the relevant atoms.

1. Oxidation Number of Nitrogen in NO_2 (Nitrogen Dioxide)

Context and Significance

Nitrogen dioxide is a common nitrogen oxide involved in atmospheric chemistry and pollution processes. Understanding its oxidation state helps explain its behavior in redox reactions and environmental impacts.

Step-by-Step Calculation

- Identify knowns:
 - The compound is NO_2 .
 - The molecule is neutral overall.
- Assign known oxidation numbers:
 - Oxygen typically has an oxidation number of -2.
- Set up the equation:
 - Let the oxidation number of nitrogen be x .
 - Since there are two oxygens, total contribution: $2 \times (-2) = -4$.
 - The sum of oxidation numbers in a neutral molecule: 0.

- Calculate x :

$$\begin{aligned} & \backslash \\ & x + 2 \times (-2) = 0 \\ & x - 4 = 0 \\ & x = +4 \\ & \backslash \end{aligned}$$

Therefore, the oxidation number of nitrogen in NO_2 is +4.

Significance

Nitrogen in NO_2 exists in a +4 oxidation state, making it a nitrogen(IV) oxide—an important intermediate in nitrogen cycling and pollution chemistry.

2. Oxidation Number of Chromium in $\text{Cr}_2\text{O}_7^{2-}$ (Dichromate Ion)

Context and Significance

Dichromate ions are potent oxidizing agents often used in laboratory and industrial processes. Knowing the oxidation state of chromium in $\text{Cr}_2\text{O}_7^{2-}$ clarifies its oxidizing power and redox behavior.

Step-by-Step Calculation

- Identify knowns:
 - The ion is $\text{Cr}_2\text{O}_7^{2-}$.
 - The overall charge of the ion is -2.
- Assign known oxidation number:
 - Oxygen: -2.
- Set up the equation:
 - Let the oxidation number of chromium be x.
 - Number of chromium atoms: 2.
 - Total contribution from oxygen: $7 \times (-2) = -14$.

- Equation:

$$\begin{aligned} 2x + 7 \times (-2) &= -2 \\ 2x - 14 &= -2 \\ 2x &= 12 \\ x &= +6 \end{aligned}$$

Therefore, the oxidation number of chromium in $\text{Cr}_2\text{O}_7^{2-}$ is +6.

Significance

Chromium in dichromate exists in the +6 oxidation state, which is highly oxidizing and responsible for its strong oxidizing properties in redox reactions.

3. Oxidation Number of Sodium in Na_2O_2 (Sodium Peroxide)

Context and Significance

Sodium peroxide is an important compound used in oxygen generation and chemical synthesis. Its oxidation state reveals the nature of the peroxide ion and the metal's role.

Step-by-Step Calculation

- Identify knowns:
 - The compound is Na_2O_2 .
 - The compound is neutral.
- Assign known oxidation number:
 - Sodium (Na): usually +1.

- Oxygen in peroxides: oxidation number is typically -1 (different from the usual -2).
- Verify by calculation:
- Let the oxidation number of Na be +1 (standard assumption).
- Oxygen in peroxide: -1.

- Calculate:

$$\begin{aligned} & 2(+1) + 2(-1) = 0 \\ & 2 - 2 = 0 \end{aligned}$$

- Conclusion:

- Sodium has an oxidation number of +1.
- Oxygen in peroxide ions has an oxidation number of -1.

Significance

The peroxide ion (O_2^{2-}) contains oxygen in an oxidation state of -1, which explains sodium peroxide's reactive nature and its use as an oxygen source.

Additional Insights and Applications

Understanding oxidation numbers extends beyond these examples. It is instrumental in:

- Balancing redox equations: Knowing the oxidation states helps identify which species are oxidized or reduced.
- Predicting reaction products: Oxidation numbers indicate possible electron transfer pathways.
- Environmental chemistry: Tracking pollutants like NO_2 and $\text{Cr}_2\text{O}_7^{2-}$ requires knowledge of oxidation states.
- Industrial processes: Oxidation states inform the selection of reagents and catalysts.

Summary of Oxidation Numbers for Selected Compounds

Compound	Atom	Oxidation Number	Explanation
NO_2	Nitrogen	+4	Based on oxygen's -2 and neutral molecule
$\text{Cr}_2\text{O}_7^{2-}$	Chromium	+6	Based on oxygen's -2 and charge balance
Na_2O_2	Sodium	+1	Sodium's typical +1; oxygen in peroxide is -1

Conclusion

Mastering oxidation numbers is a cornerstone of chemical literacy. By systematically applying rules and analyzing compounds, chemists can predict reactivity, balance equations, and understand complex reactions. The examples provided—nitrogen in NO_2 , chromium in $\text{Cr}_2\text{O}_7^{2-}$, and sodium in

Na_2O_2 —highlight the practical application of these principles and their significance in real-world chemistry.

Remember, practice is key. Regularly solving for oxidation states in various compounds enhances problem-solving skills and deepens your understanding of chemical behavior. Whether you're studying for exams, conducting research, or just exploring the fascinating world of chemistry, a solid grasp of oxidation numbers will serve as an invaluable tool in your scientific toolkit.

Frequently Asked Questions

What is the oxidation number of nitrogen in NO_2 ?

The oxidation number of nitrogen in NO_2 is +4.

How do you determine the oxidation number of chromium in $\text{Cr}_2\text{O}_7^{2-}$?

In $\text{Cr}_2\text{O}_7^{2-}$, each oxygen is typically -2. Let x be the oxidation number of Cr: $2x + 7(-2) = -2 \rightarrow 2x - 14 = -2 \rightarrow 2x = 12 \rightarrow x = +6$. So, chromium has an oxidation number of +6.

What is the oxidation number of potassium in KCl ?

Potassium (K) has an oxidation number of +1 in KCl .

What is the oxidation number of calcium in CaH_2 ?

In CaH_2 , hydrogen has an oxidation number of -1 (since it's a hydride), so calcium's oxidation number is +2 to balance the two hydrogens.

What is the oxidation number of sulfur in SO_4^{2-} ?

In SO_4^{2-} , each oxygen is -2. Let x be sulfur's oxidation number: $x + 4(-2) = -2 \rightarrow x - 8 = -2 \rightarrow x = +6$.

Additional Resources

CHEMISTRY OXIDATION NUMBERS: A Comprehensive Analysis of Selected Compounds

Understanding oxidation numbers is fundamental to mastering chemical reactions, balancing equations, and elucidating redox processes. In this detailed review, we focus on the concept of oxidation numbers within specific compounds, addressing the challenge of determining the oxidation states of elements in complex molecules. This article aims to clarify the methodology by analyzing three selected compounds: NO_2 , $\text{Cr}_2\text{O}_7^{2-}$, and Na_2O_2 , providing step-by-step reasoning and insights into their oxidation states. Additionally, we explore the broader significance of oxidation numbers in chemistry, offering a comprehensive guide for students, educators, and researchers alike.

Introduction to Oxidation Numbers in Chemistry

Oxidation numbers, also known as oxidation states, are a bookkeeping tool used to track electron transfer in chemical reactions. They are assigned based on a set of rules that help chemists determine how electrons are distributed among atoms within a molecule or ion.

Key concepts include:

- The oxidation number of an element in its free, uncombined state is zero.
- The sum of oxidation numbers in a neutral compound equals zero.
- The sum of oxidation numbers in an ion equals the ion's charge.
- More electronegative elements are assigned negative oxidation numbers relative to less electronegative partners.

These rules serve as the foundation for analyzing complex molecules, especially when identifying oxidation and reduction events.

Case Study 1: Nitrogen Dioxide (NO₂)

Nitrogen dioxide is a common nitrogen oxide with significant environmental implications, especially in air pollution. Its molecular structure involves one nitrogen atom bonded to two oxygen atoms.

Structure and Composition:

- Molecular formula: NO₂
- Contains one nitrogen atom and two oxygen atoms

Determining Oxidation Numbers:

Applying the rules:

1. Oxygen's typical oxidation number: -2 (except in peroxides, superoxides, or when bonded to fluorine)
2. Assigning oxygen's oxidation number in NO₂:

- Since oxygen is usually -2, and there are two oxygens:

$$\text{Total contribution from oxygen} = 2 \times (-2) = -4$$

3. Calculating nitrogen's oxidation number (x):

Sum of oxidation numbers = 0 (since NO₂ is neutral)

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

$$x = +4$$

Result:

- Nitrogen's oxidation number in NO_2 is +4.

Significance:

The +4 oxidation state indicates nitrogen's participation in a relatively high oxidation state, consistent with its role in nitrogen oxides involved in oxidation reactions and atmospheric chemistry.

Case Study 2: Dichromate Ion ($\text{Cr}_2\text{O}_7^{2-}$)

Chromium compounds are notable for their multiple oxidation states, notably +3 and +6. The dichromate ion ($\text{Cr}_2\text{O}_7^{2-}$) is an important polyatomic ion in redox reactions, particularly in oxidation processes.

Structure and Composition:

- Contains two chromium atoms and seven oxygen atoms
- Overall charge: -2

Determining Oxidation Numbers:

1. Oxygen's oxidation number: -2

Total contribution from oxygen = $7 \times (-2) = -14$

2. Let the oxidation number of chromium be x:

Sum of oxidation numbers:

$$2x + (-14) = -2 \text{ (overall charge)}$$

3. Solve for x:

$$2x = -2 + 14 = 12$$

$$x = 12 / 2 = +6$$

Result:

- Chromium's oxidation number in $\text{Cr}_2\text{O}_7^{2-}$ is +6.

Implications:

The +6 oxidation state signifies that dichromate is a strong oxidizing agent, often reduced to Cr^{3+} in various reactions. Its high oxidation state is characteristic of chromium's behavior in redox chemistry.

Case Study 3: Sodium Superoxide (NaO₂)

Sodium superoxide is a less common but interesting compound, especially in applications like oxygen generation and battery technology. Its unique structure involves the superoxide ion (O₂⁻).

Structure and Composition:

- Contains sodium cation (Na⁺) and superoxide anion (O₂⁻)

Determining Oxidation Numbers:

1. Sodium's oxidation number: +1 (alkali metals always +1)

2. Superoxide ion (O₂⁻):

- The total charge of the superoxide ion is -1
- The superoxide ion consists of two oxygen atoms bonded together, sharing electrons unevenly

3. Assigning oxidation number to each oxygen atom:

Let each oxygen atom in O₂⁻ have an oxidation number y .

Total oxidation contribution:

$$2 \times y = -1 \text{ (total charge of the superoxide ion)}$$

$$y = -1/2$$

Interpretation:

- Each oxygen atom in O₂⁻ has an oxidation number of $-1/2$, reflecting the delocalized electron nature of the superoxide ion.

Significance:

This fractional oxidation state indicates that oxygen in superoxide is in an intermediate oxidation state, more reduced than in peroxide (-1) but more oxidized than in oxide (-2).

Broader Implications of Oxidation Number Analysis

The determination of oxidation states in compounds like NO₂, Cr₂O₇²⁻, and NaO₂ exemplifies the utility of oxidation number calculations in understanding chemical behavior.

Redox Reactions:

- Recognizing oxidation states helps identify which species are oxidized and reduced.
- For example, nitrogen in NO_2 (oxidation +4) can be oxidized to higher states or reduced to lower states, facilitating redox balancing.

Environmental Chemistry:

- NO_2 plays a role in smog formation, with its oxidation states influencing reactive pathways.
- Chromium's +6 state in $\text{Cr}_2\text{O}_7^{2-}$ is associated with toxic and carcinogenic properties, requiring reduction to safer levels.

Material Science and Batteries:

- Superoxide ions (O_2^-) are key in battery chemistries, with their fractional oxidation states impacting electron transfer mechanisms.

Conclusion

Understanding oxidation numbers is crucial for deciphering the intricacies of chemical reactions and the electronic structure of compounds. Through the detailed analysis of NO_2 , $\text{Cr}_2\text{O}_7^{2-}$, and NaO_2 , we see how systematic application of rules yields insights into the oxidation states of elements, shedding light on their reactivity, environmental impact, and technological applications.

Key takeaways include:

- The importance of electronegativity and bonding context in assigning oxidation numbers.
- The unique fractional oxidation states in polyatomic ions like superoxides.
- The role of oxidation states in redox chemistry and environmental processes.

Mastering these concepts enables chemists to predict reaction pathways, design better materials, and understand the fundamental nature of chemical substances. As the field advances, continued exploration of oxidation numbers remains essential to unlocking the complexities of chemical behavior across disciplines.

References:

1. Housecroft, C. E., & Sharpe, A. G. (2012). Inorganic Chemistry. Pearson Education.
2. Zumdahl, S. S., & Zumdahl, S. A. (2014). Chemistry: An Atoms First Approach. Cengage Learning.
3. Atkins, P., & de Paula, J. (2014). Physical Chemistry. Oxford University Press.
4. IUPAC Compendium of Chemical Terminology (Gold Book). (2023). International Union of Pure and Applied Chemistry.

Author's Note:

This review aims to deepen understanding of oxidation numbers through practical examples, fostering proficiency in chemical analysis and promoting critical thinking in redox chemistry.

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