Cl2 Reacts With The Element Sr To Form An Ionic Compound. Based On Periodic Properties, Identify A Molecule,

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Understanding chemical reactions and the formation of compounds is fundamental in the study of chemistry. When considering the interaction between chlorine gas (Cl_2) and the element strontium (Sr), it is essential to analyze their properties based on the periodic table to determine the resulting compound. This article explores how Cl_2 reacts with Sr to form an ionic compound, utilizing periodic properties such as electronegativity, atomic radius, and typical oxidation states to identify the resulting molecule.

Introduction to the Elements: Chlorine and Strontium

Before delving into the reaction details, it is crucial to understand the characteristics of chlorine and strontium.

Chlorine (Cl)

- Position in the Periodic Table: Group 17 (Halogens), Period 3
- Atomic Number: 17
- Electronic Configuration: [Ne] $3s^2$ $3p^5$
- State at Room Temperature: Gas
- Electronegativity: 3.0 (Pauling scale)
- Common Oxidation State: -1

Strontium (Sr)

- Position in the Periodic Table: Group 2 (Alkaline Earth Metals), Period

5

- Atomic Number: 38
- Electronic Configuration: [Kr] $5s^2$
- State at Room Temperature: Solid
- Electronegativity: 0.95 (Pauling scale)
- Common Oxidation State: +2

Periodic Properties Influencing the Reaction

The reaction between Cl_2 and Sr is largely dictated by their positions on the periodic table and their inherent chemical properties.

Electronegativity and Ionic Character

- Chlorine's high electronegativity (3.0) indicates a strong tendency to attract electrons.
- Strontium's low electronegativity (0.95) suggests a propensity to lose electrons and form cations.
- These differences favor the formation of ionic bonds, with Sr donating electrons to Cl.

Oxidation States and Electron Transfer

- Strontium typically exhibits a +2 oxidation state, losing two electrons to achieve a noble gas configuration.
- Chlorine, in its elemental form (Cl_2), has an oxidation state of 0 but readily gains electrons to form Cl^- ions.
- The reaction involves Sr transferring electrons to Cl_2, resulting in Sr^{2+} and Cl^- ions.

Atomic and Ionic Radii

- Strontium's relatively large atomic radius (around 215 pm) makes it easier to lose electrons and form cations.
- Chlorine's smaller atomic radius (about 99 pm for Cl atom) complements the formation of Cl^- ions with a radius of approximately 181 pm.
- These size considerations facilitate ionic bonding, with Sr^{2+} attracting Cl^- ions in a lattice structure.

The Reaction Between Cl_2 and Sr

When strontium reacts with chlorine gas, the process involves oxidation-reduction (redox) mechanisms. The reaction can be summarized as follows:

Step 1: Oxidation of Strontium

$Sr\ (s) \rightarrow Sr^{2+}\ (aq) + 2\ e^-$

Step 2: Reduction of Chlorine

$Cl_2\ (g) + 2\ e^- \rightarrow 2\ Cl^-\ (aq)$

Overall Reaction:

$Sr\ (s) + Cl_2\ (g) \rightarrow SrCl_2\ (s)$

This reaction produces strontium chloride, an ionic compound composed of Sr^{2+} and Cl^- ions.

Identifying the Ionic Compound: Strontium Chloride ($SrCl_2$)

Based on the periodic properties and the reaction mechanism, the primary product is an ionic compound called strontium chloride with the chemical formula $SrCl_2$.

Why $SrCl_2$?

- The typical oxidation state of Sr is +2, which matches the charge on the Sr^{2+} ion.

- Chlorine, gaining electrons from Sr, forms Cl^- ions. Since each Sr atom loses two electrons, it combines with two Cl^- ions to maintain charge neutrality.
- The compound is formed as a crystalline solid with a lattice structure held together by electrostatic forces (ionic bonds).

Properties of Strontium Chloride ($SrCl_2$)

Understanding the properties of $SrCl_2$ helps confirm its identity and its ionic nature.

Physical Properties

- Appearance: White crystalline solid
- Solubility: Highly soluble in water
- Melting Point: Approximately 870°C

Chemical Properties

- Reacts with acids to produce strontium salts and hydrogen gas.
- Stable under standard conditions, but reacts with moisture in the air over time (deliquescent).

Applications and Significance of $SrCl_2$

Strontium chloride has various industrial and scientific applications, including:

- In pyrotechnics, to produce red flames due to strontium’s characteristic emission.
- As a precursor in the synthesis of other strontium compounds.

- In medical imaging, specifically in bone scans, where strontium compounds are used as tracers.

Conclusion: Periodic Properties and the Formation of Ionic Compounds

The reaction of Cl_2 with Sr exemplifies how periodic properties dictate chemical behavior. Strontium's low electronegativity and +2 oxidation state, combined with chlorine's high electronegativity and tendency to gain electrons, facilitate the formation of an ionic bond. The resulting compound, $SrCl_2$, is a crystalline ionic solid that embodies the principles of periodic trends in electronegativity, atomic size, and oxidation states.

By analyzing the periodic properties, chemists can predict the products of reactions between elements, understand their structures, and leverage these compounds for various technological and scientific purposes. The case of Cl_2 reacting with Sr highlights the importance of periodic trends in predicting chemical reactions and identifying the resulting molecules, underscoring the systematic nature of chemistry.

Summary:
- Cl_2 reacts with Sr to form an ionic compound.
- The reaction involves electron transfer from Sr to Cl_2.
- The resulting compound is $SrCl_2$, strontium chloride.
- Periodic properties like electronegativity, oxidation state, and atomic radius explain the formation and stability of $SrCl_2$.
- Understanding these properties aids in predicting and utilizing chemical reactions effectively.

Keywords for SEO:
Cl_2 reacts with Sr, ionic compound formation, periodic properties, strontium chloride, chemical reaction mechanisms, oxidation states, ionic bonding, periodic table trends, chemical properties of Sr and Cl, formation of ionic compounds, chemical prediction, chemistry of alkaline earth metals, halogen reactions, molecular identification

Frequently Asked Questions

What type of compound is formed when Cl2 reacts with Sr?

An ionic compound is formed when Cl2 reacts with Sr, specifically strontium chloride (SrCl2).

Why does strontium (Sr) tend to form ionic compounds with chlorine (Cl)?

Strontium is a metal that readily loses electrons to achieve a stable octet, while chlorine gains electrons, leading to ionic bonds due to differences in electronegativity and periodic properties.

Based on periodic properties, what is the charge of the strontium ion in SrCl2?

The charge of the strontium ion is +2, since it loses two electrons to achieve a noble gas configuration.

What is the oxidation state of chlorine in SrCl2?

The oxidation state of chlorine in SrCl2 is -1.

How do the periodic properties of Sr and Cl explain the formation of SrCl2?

Sr, a metal in group 2, readily loses electrons to form a +2 cation, while Cl, a halogen in group 17, gains electrons to form -1 anions, facilitating ionic bond formation based on their positions in the periodic table.

What is the molecular formula of the compound formed between Sr and Cl?

The molecular formula is SrCl2, indicating one strontium atom bonds with two chlorine atoms.

How does the periodic trend of electronegativity support the formation of SrCl2?

Strontium has low electronegativity, tending to lose electrons, while chlorine has high electronegativity, tending to gain electrons, which promotes ionic bond formation.

What physical properties would you expect from SrCl2 based on its ionic nature?

SrCl2 would likely be crystalline, have high melting and boiling points, and be soluble in water due to its ionic bonds.

In terms of periodic properties, why is Sr more

likely to lose electrons than gain them?

Because Sr is a metal in group 2 with a low ionization energy, making it easier for it to lose electrons and form positive ions, consistent with periodic trends.

Can you predict the type of bond in SrCl2 based on periodic properties?

Yes, the bond is ionic, formed due to the transfer of electrons from Sr to Cl, driven by differences in electronegativity and their positions in the periodic table.

Additional Resources

Cl_2 Reacts With The Element Sr To Form An Ionic Compound: An In-Depth Analytical Perspective Based on Periodic Properties

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Introduction

The interaction between halogens and alkaline earth metals is a classic exemplar of ionic compound formation, illustrating fundamental principles of periodic trends, electron transfer, and chemical bonding. In particular, the reaction between chlorine gas (Cl_2) and strontium (Sr) offers a compelling case study, elucidating how periodic properties influence reactivity, bonding, and compound stability. This article delves into the specifics of this reaction, exploring the underlying mechanisms, the nature of the resulting compound, and the broader implications rooted in periodic trends.

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1. Fundamental Periodic Properties of Chlorine and Strontium

Understanding the reactivity between Cl_2 and Sr requires a comprehensive grasp of their positions in the periodic table, their electronic configurations, and inherent properties.

1.1 Position in the Periodic Table

- Chlorine (Cl):
- Group: 17 (Halogens)
- Period: 3
- Atomic Number: 17
- Electron Configuration: [Ne] $3s^2$ $3p^5$

- Strontium (Sr):
- Group: 2 (Alkaline earth metals)

- Period: 5
- Atomic Number: 38
- Electron Configuration: [Kr] $5s^2$

1.2 Atomic and Ionic Properties

Property	Chlorine (Cl)	Strontium (Sr)
Atomic Radius	~99 pm	~195 pm
Ionization Energy	First: 1251 kJ/mol	First: 549 kJ/mol
Electronegativity (Pauling)	3.0	0.95
Typical Oxidation States	-1	+2

Implication:
Chlorine’s high electronegativity and tendency to gain electrons contrast starkly with strontium’s low electronegativity and affinity for losing electrons. These characteristics underpin their propensity to form ionic bonds, with Sr acting as a cation and Cl as an anion.

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2. Mechanism of Reaction Between Cl_2 and Sr

2.1 Electron Transfer Dynamics

The reaction involves the transfer of electrons from strontium atoms to chlorine molecules. Strontium, with its relatively low ionization energy, readily loses its two valence electrons to achieve a noble gas configuration:

$$
\mathrm{Sr} \rightarrow \mathrm{Sr}^{2+} + 2e^-
$$

Chlorine molecules (Cl_2), which are diatomic and stable, tend to gain electrons to form chloride ions:

$$
\mathrm{Cl}_2 + 2e^- \rightarrow 2\mathrm{Cl}^-
$$

The overall electron transfer process can be summarized as:

$$
\mathrm{Sr} + \mathrm{Cl}_2 \rightarrow \mathrm{Sr}^{2+} + 2\mathrm{Cl}^-
$$

This transfer results in the formation of an ionic compound where strontium cations coordinate with chloride anions.

2.2 Formation of the Ionic Compound

The ionic compound formed is strontium chloride, with the chemical formula:

$$
\mathrm{SrCl}_2
$$

The process is thermodynamically favorable due to the high lattice energy of the ionic crystal and the large difference in ionization energy versus electron affinity.

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3. Structural and Bonding Characteristics of $SrCl_2$

3.1 Crystal Structure

Strontium chloride crystallizes in a structure typical of alkaline earth halides, often adopting a cubic (rock salt) structure or similar lattice configurations depending on the phase and conditions.

- Lattice Type: Face-centered cubic (FCC) or similar close-packed arrangements
- Coordination Number: 6 for Sr^{2+} ions (octahedral coordination)
- Ionic Radii:
- Sr^{2+}: approximately 118 pm
- Cl^-: approximately 181 pm

The large size of chloride ions compared to Sr^{2+} leads to a lattice stabilized by strong electrostatic attractions.

3.2 Nature of Bonding

The bond in $SrCl_2$ is predominantly ionic, characterized by:

- Complete transfer of electrons from Sr to Cl
- Electrostatic attraction between oppositely charged ions
- Minimal covalent character due to large difference in electronegativities

The ionic bond strength is reflected in high melting points and solubility in polar solvents like water.

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4. Periodic Trends and Their Influence on Reactivity

4.1 Trends in Alkali Earth Metals (Group 2)

- Ionization Energy: Decreases down the group (from Be to Ba), making it easier for heavier alkaline earth metals like Sr to lose electrons.
- Atomic Radius: Increases down the group, leading to larger, more easily polarizable cations.

- Electronegativity: Slight decrease down the group, favoring cation formation.

Impact on Reactivity:
Strontium’s relatively low ionization energy compared to lighter alkaline earth metals explains its vigorous reactivity with halogens, especially at elevated temperatures.

4.2 Trends in Halogens (Group 17)

- Electronegativity: Decreases down the group (F > Cl > Br > I)
- Bond Dissociation Energy: Decreases down the group, making heavier halogens less reactive.
- Electron Affinity: Slightly decreases down the group.

Impact on Reactivity:
Chlorine, being more electronegative and with higher electron affinity than bromine or iodine, reacts readily with metals like Sr, forming stable ionic compounds.

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5. Practical Implications and Applications

5.1 Synthesis and Industrial Relevance

The synthesis of $SrCl_2$ through direct reaction with Cl_2 is a common method in laboratories and industries for:

- Producing pure strontium compounds
- Manufacturing materials for pyrotechnics, where Sr compounds impart red coloration
- Preparing materials for nuclear applications, where Sr isotopes are used

5.2 Material Properties and Uses

- Physicochemical Properties: $SrCl_2$ exhibits high solubility in water, making it useful in various chemical processes.
- Application in Medicine: Radioactive isotopes of Sr (like Sr-89) combined with chloride salts are used in radiotherapy for bone pain palliation.

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6. Analytical and Theoretical Considerations

6.1 Thermodynamic Aspects

The reaction's spontaneity is driven by the large lattice energy of $SrCl_2$ and the energy released during electron transfer. Gibbs free energy calculations typically confirm the exothermic nature of the process.

6.2 Kinetic Factors

Reaction rate depends on temperature, surface area of Sr, and pressure of Cl_2 gas. Elevated temperatures accelerate electron transfer by providing activation energy.

6.3 Computational Modeling

Quantum chemical calculations aid in understanding the electronic structure, predicting lattice energies, and simulating the crystal structure of $SrCl_2$.

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7. Broader Context: Periodic Trends in Ionic Compound Formation

The reaction between Cl_2 and Sr exemplifies a broader trend where metals in Group 2 form ionic halides with halogens. Similar reactions occur across the group:

- $Ba + Cl_2 \rightarrow BaCl_2$
- $Ca + Cl_2 \rightarrow CaCl_2$

Key observations:

- The reactivity increases down the group due to decreasing ionization energy.
- The halogen’s reactivity decreases down the group because of decreasing electron affinity.
- The resulting ionic compounds display properties strongly dictated by lattice energies, ionic sizes, and charge densities.

Conclusion

The reaction between chlorine gas and strontium epitomizes the principles of periodicity and ionic bonding. Rooted in the fundamental properties of elements—atomic size, ionization energy, electronegativity—it exemplifies how elements from different groups interact to form stable ionic compounds. $SrCl_2$, formed through electron transfer from Sr to Cl_2, manifests the classic features of ionic solids: high lattice energy, crystalline structure, and characteristic physical properties. This reaction not only reinforces core concepts of periodic trends but also underscores the practical and industrial importance of understanding element reactivity within the periodic table.

References

1. Atkins, P., & de Paula, J. (2014). Physical Chemistry (10th ed.). Oxford University Press.

2. Housecroft, C. E., & Sharpe, A. G. (2012). Inorganic Chemistry (4th ed.). Pearson.
3. Greenwood, N. N., & Earnshaw, A. (1997). Chemistry of the Elements. Elsevier.
4. Lide, D. R. (Ed.). (2004). CRC Handbook of Chemistry and Physics (85th ed.). CRC Press.
5. National Institute of Standards and Technology (NIST) Atomic Spectra Database.

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