

What Atom Is Represented By The Bohr Configuration Of 2-7-15 ?

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Understanding atomic structure is fundamental to the study of chemistry and physics. The Bohr model, introduced by Niels Bohr in 1913, provides a simplified way to visualize the arrangement of electrons within an atom. When given a configuration such as 2-7-15, it refers to the number of electrons present in successive energy levels or shells around the nucleus. Deciphering this configuration allows us to identify the specific element it represents. In this article, we will explore the details of the Bohr model, analyze the given electron configuration, and determine the corresponding atom.

Overview of the Bohr Model of the Atom

Historical Context and Significance

The Bohr model was a pioneering step in atomic theory, proposing that electrons orbit the nucleus in fixed energy levels or shells. This model explained the spectral lines of hydrogen and laid the groundwork for modern quantum mechanics.

Key Features of the Bohr Model

- Electrons occupy distinct energy levels or shells.
- Each shell can hold a specific maximum number of electrons.
- Electrons can jump between levels by absorbing or emitting energy.
- The model simplifies the complex quantum behavior into circular orbits for visualization purposes.

Electron Shells and Their Capacities

The capacities of the shells in the Bohr model are based on the formula:

- Maximum electrons in the n th shell = $2n^2$
- 1st shell ($n=1$): 2 electrons
- 2nd shell ($n=2$): 8 electrons
- 3rd shell ($n=3$): 18 electrons
- 4th shell ($n=4$): 32 electrons
- and so on...

This understanding helps us interpret electron configurations and identify the element.

Deciphering the Electron Configuration 2-7-15

Interpreting the Configuration

The configuration 2-7-15 indicates the number of electrons in successive shells:

- First shell: 2 electrons
- Second shell: 7 electrons
- Third shell: 15 electrons

Adding these:

$2 + 7 + 15 = 24$ electrons in total.

Since the number of electrons in a neutral atom equals its atomic number, this suggests the atom has an atomic number of 24.

Electron Distribution Across Shells

The distribution aligns with the typical filling order:

- 1st shell: 2 electrons (full)
- 2nd shell: 7 electrons (partially filled)
- 3rd shell: 15 electrons (partially filled)

It is consistent with the Aufbau principle, which guides the filling order of atomic orbitals.

Identifying the Element

Atomic Number and Element Name

- Atomic number (Z): 24
- Corresponding element: Chromium (Cr)

Chromium is the 24th element in the periodic table. Its atomic number confirms the total count of electrons in a neutral atom.

Electronic Configuration of Chromium

The ground-state electron configuration for chromium is typically written as:

- $[\text{Ar}] 3d^5 4s^1$

This configuration reflects electron filling beyond the noble gas argon (Z=18). However, the Bohr model simplifies the understanding by focusing on shells rather than subshells.

Matching the Configuration to Chromium

- The 2 electrons in the first shell correspond to the 1s orbital.
- The 7 electrons in the second shell correspond to the 2s and 2p orbitals.
- The 15 electrons in the third shell include the 3s, 3p, and 3d orbitals, with the remaining electrons filling higher shells.

While the detailed subshell configuration for chromium involves 3d and 4s orbitals, the total electron count matches the Bohr shell model's 2-8-14 (or 2-8-18) pattern. The given 2-7-15 indicates a simplified model, possibly representing the initial filling before electrons occupy higher subshells.

Understanding the Significance of the Configuration

Comparison with Typical Electron Shell Fillings

- The 2-8-18 pattern is typical for elements beyond calcium.
- The 2-7-15 pattern suggests an element with electrons filling the first three shells, but with a slightly abbreviated third shell filling compared to the standard 2-8-18.

Implication for the Element's Chemical Properties

Chromium exhibits variable oxidation states and complex chemistry due to its d-electrons. Its electron arrangement contributes to its ability to form various compounds, especially in oxidation states ranging from +2 to +6.

Additional Insights and Clarifications

Limitations of the Bohr Model

While the Bohr model provides a foundational understanding, it does not account for:

- Subshell and orbital shapes
- Electron spin and quantum numbers
- Electron-electron interactions

Modern quantum mechanical models offer more precise descriptions but still use the shell concept for simplicity.

Why the Electron Count Matters

Knowing the electron configuration helps predict:

- Atomic radius
- Ionization energy
- Reactivity

- Bonding behavior

For chromium, the unique electron arrangement explains its distinctive chemical properties.

Summary

- The Bohr configuration 2-7-15 indicates an atom with 24 electrons.
- The element with 24 electrons in its neutral state is Chromium (Cr).
- The configuration reflects electron distribution across the shells, aligning with the known electron structure of chromium.
- While simplified, this configuration helps understand the atom's placement in the periodic table and its chemical characteristics.

Conclusion

The Bohr configuration 2-7-15 corresponds to the element chromium. This understanding bridges the classical Bohr model with modern atomic theory, illustrating how simple electron shell arrangements can reveal the identity of an element. Recognizing such configurations enhances our comprehension of atomic structure, chemical behavior, and the periodic table's organization. Although the Bohr model has limitations, it remains a valuable educational tool for visualizing atomic electrons and their arrangements.

References

- Atkins, P., & de Paula, J. (2014). Physical Chemistry. Oxford University Press.
- Zumdahl, S. S., & Zumdahl, S. A. (2014). Chemistry. Cengage Learning.
- National Institute of Standards and Technology (NIST). Atomic Spectra Database.
- Periodic Table and Electron Configuration Resources.

Frequently Asked Questions

What element is represented by the Bohr configuration 2-7-15?

The element is Silicon (Si).

How do you determine the element from the Bohr electron configuration 2-7-15?

By adding the electrons in each shell: $2 + 7 + 15 = 24$, so the element has 24 electrons, which is Chromium (Cr).

Is the Bohr configuration 2-7-15 a complete electron configuration for any element?

Yes, it corresponds to Chromium (Cr), which has 24 electrons.

What does the electron configuration 2-7-15 tell us about the element's valence electrons?

The valence electrons are in the outermost shell, which for this configuration is 15 electrons in the third shell, indicating a complex electron arrangement characteristic of transition metals like Chromium.

Why is the 2-7-15 configuration significant in atomic structure?

It illustrates the electron distribution in a transition metal, showcasing the filling of d-orbitals beyond the s-orbital in the third shell.

How does the Bohr model help in understanding the element with configuration 2-7-15?

The Bohr model visualizes the electrons in fixed shells, allowing us to understand the distribution and properties of the element, which in this case is Chromium.

What is the atomic number of the element with Bohr configuration 2-7-15?

The atomic number is 24.

What are the properties of the element with electron configuration 2-7-15?

Chromium is a transition metal known for its hardness, high melting point, and use in stainless steel and plating.

Can the Bohr configuration 2-7-15 represent any other element besides Chromium?

No, the configuration specifically corresponds to Chromium; other elements have different electron distributions.

Additional Resources

What Atom Is Represented By The Bohr Configuration Of 2-7-15?

In the intricate world of atomic physics and chemistry, understanding the structure of an atom provides crucial insights into its properties, behavior, and how it interacts with other elements. One of the foundational models that helps visualize atomic structure is the Bohr model, which represents electrons in discrete energy levels or shells around the nucleus. When examining a configuration such as 2-7-15, it immediately sparks curiosity about the specific atom it describes and the underlying principles that define its electronic arrangement. This article delves deep into the significance of the Bohr configuration 2-7-15, unraveling what atom it corresponds to, and exploring the broader implications of electron configurations in atomic science.

Understanding the Bohr Model and Electron Configurations

The Bohr Model: A Brief Overview

Developed by Danish physicist Niels Bohr in 1913, the Bohr model was a pioneering step toward understanding atomic structure. It proposed that electrons orbit the nucleus in specific, quantized energy levels or shells, much like planets orbit the sun. These shells are designated by principal quantum numbers ($n=1, 2, 3$, etc.), and each shell can hold a limited number of electrons based on the formula $2n^2$.

Key features of the Bohr model include:

- Electrons occupy fixed energy levels.
- Electrons can transition between levels by absorbing or emitting quantized energy.
- The model successfully explained the spectral lines of hydrogen.

Although more sophisticated quantum mechanical models have since replaced Bohr's in precision, the Bohr model remains a valuable educational tool for visualizing atomic structure and electron distribution.

Electron Shells and Capacity

In the Bohr model, electrons are arranged in shells around the nucleus:

- First shell ($n=1$): holds up to 2 electrons.
- Second shell ($n=2$): holds up to 8 electrons.
- Third shell ($n=3$): holds up to 18 electrons, but often filled to 8 in many elements due to the Aufbau principle.
- Higher shells follow similar patterns, with increasing capacities.

Understanding how electrons fill these shells facilitates the determination of an atom's chemical properties and its place on the periodic table.

Deciphering the Configuration 2-7-15

What Does 2-7-15 Represent?

The sequence 2-7-15 describes the number of electrons in successive shells of an atom:

- 2 electrons in the first shell ($n=1$)
- 7 electrons in the second shell ($n=2$)
- 15 electrons in the third shell ($n=3$)

This specific distribution points towards a particular element when considering the total number of electrons, which equals the atomic number (Z).

Calculating the total:

$$2 + 7 + 15 = 24 \text{ electrons}$$

Thus, the atom with this configuration has an atomic number of 24, corresponding to the element chromium (Cr).

Implications of the Electron Distribution

Electron configurations like 2-7-15 are often associated with the ground state of an atom, depicting how electrons fill the available shells following the Aufbau principle—electrons occupy the lowest energy orbitals first before moving to higher ones.

For element 24:

- The first shell is fully filled with 2 electrons.
- The second shell is fully filled with 8 electrons.
- The third shell contains 14 electrons to reach 16 electrons in total, but here it shows 15, which indicates that the third shell is one electron short of its expected maximum in the common 3d series.

However, since the configuration explicitly given is 2-7-15, it suggests the electrons are arranged in a way consistent with the element chromium, which typically has an electron configuration of $[\text{Ar}] 3d^5 4s^1$ in its ground state. But in Bohr or simplified shell notation, the arrangement of electrons in shells can be approximated as 2-8-13 or similar.

The 2-7-15 notation simplifies the understanding of the electron distribution for this particular atom, emphasizing the occupation of the first three shells.

The Element Corresponding to 2-7-15 Configuration: Chromium (Cr)

Basic Properties of Chromium

Chromium, with an atomic number of 24, is a transition metal known for its hardness, high melting point, and remarkable corrosion resistance, especially when used in stainless steel. It belongs to group 6 of the periodic table and is characterized by a partially filled 3d subshell.

Some notable properties include:

- Atomic weight: approximately 51.996 g/mol.
- Electron configuration: $[\text{Ar}] 3d^5 4s^1$.
- Common oxidation states: +2, +3, and +6.
- Uses: stainless steel production, plating, pigments, and catalysts.

Electron Configuration and Chemical Behavior

While the Bohr configuration 2-7-15 offers a simplified shell perspective, the actual electron configuration of chromium is more nuanced. The standard notation indicates that:

- The first shell ($n=1$): 2 electrons.
- The second shell ($n=2$): 8 electrons.
- The third shell ($n=3$): 13 electrons in the 3d and 4s subshells combined.

This configuration explains chromium's unique properties:

- The half-filled $3d^5$ subshell provides extra stability due to electron exchange energy.
- The presence of a single electron in the 4s orbital ($4s^1$) influences its oxidation behavior.

The simplified 2-7-15 notation aligns with the total electrons distributed across shells but does not reflect the detailed subshell fill order. Nonetheless, it points toward the same atom—chromium.

Broader Significance of Electron Configurations in Chemistry

Periodic Table Placement and Trends

Understanding electron configurations like 2-7-15 helps chemists predict:

- An element's position on the periodic table.
- Its chemical reactivity.
- Its typical oxidation states.
- The types of bonds it can form.

For example, chromium's electron configuration explains its placement in the transition metals and its ability to exhibit multiple oxidation states.

Electronic Stability and Chemical Properties

Configurations tend to favor arrangements that maximize stability, often reflected by filled or half-filled subshells (e.g., $3d^5$). Chromium's configuration demonstrates this principle, with its half-filled 3d subshell conferring added stability and influencing its chemistry.

Real-World Applications and Technological Impact

Understanding these electron arrangements informs:

- Development of alloys with specific properties.
- Design of catalysts for industrial processes.
- Creation of pigments and corrosion-resistant materials.

Chromium's electron configuration underpins its vital industrial roles.

Conclusion: The Atom Behind the Configuration

The Bohr configuration 2-7-15 corresponds to the element chromium (Cr), with an atomic number of 24. While simplified shell diagrams provide a useful visualization, modern quantum mechanics offers a more detailed account of electron arrangements, including subshells and orbital shapes. Nonetheless, the 2-7-15 configuration encapsulates the fundamental electron distribution that defines chromium's chemical identity and properties.

Understanding such configurations is crucial for chemists and physicists alike, as they form the basis for predicting element behavior, designing new materials, and exploring the fundamental structure of matter. The case of chromium exemplifies how electron arrangements influence an element's physical and chemical characteristics, highlighting the enduring importance of atomic structure in scientific and industrial applications.

In summary, when confronted with the Bohr configuration 2-7-15, the atom it most likely represents is chromium ($Z=24$). This configuration underscores the importance of electron shell filling patterns and their profound influence on the properties and uses of elements across the periodic table.

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