the periodic table a visual guide to the elements Tutorial

The periodic table a visual guide to the elements serves as an essential tool for chemists, students, educators, and science enthusiasts alike. It provides a comprehensive and organized way to understand the building blocks of matter, revealing patterns, relationships, and properties of all known chemical elements. By visualizing elements in a structured format, the periodic table simplifies complex concepts, making the study of chemistry more accessible and engaging. This article offers an in-depth exploration of the periodic table, highlighting its history, structure, significance, and how to interpret its various features.

Understanding the Periodic Table: An Introduction

The periodic table is a systematic arrangement of chemical elements based on their atomic number, electron configurations, and recurring chemical properties. Its design reflects the periodic trends that govern element behavior, making it an invaluable reference for understanding chemical reactions, bonding, and material properties.

The Origin and Evolution of the Periodic Table

- Early Foundations: The concept of organizing elements predates the modern periodic table, with early efforts by scientists like Johann Wolfgang Döbereiner, who identified triads of elements with similar properties.
- Dmitri Mendeleev's Breakthrough: In 1869, Russian chemist Dmitri Mendeleev created the first widely recognized periodic table, arranging elements by increasing atomic weight and grouping elements with similar properties into columns.
- Modern Advances: The discovery of atomic number by Henry Moseley in 1913 led to the current arrangement based on atomic number rather than atomic weight, resulting in a more accurate and predictive periodic table.

The Structure of the Periodic Table

The periodic table is organized into several key sections and features, each conveying vital information about the elements.

Major Sections and Groups

- Periods: Horizontal rows numbered 1 through 7 (and 8 in extended tables). Elements in the same period have the same number of electron shells.
- Groups: Vertical columns numbered 1 through 18 (or 1A to 8A in older notation). Elements in the same group share similar chemical properties due to similar valence electron configurations.

Blocks of the Periodic Table

The table is divided into blocks based on the electron subshell being filled:

- s-block: Groups 1 and 2, plus helium (He). Elements with their outermost electrons in s orbitals.
- p-block: Groups 13 to 18. Elements with outer electrons in p orbitals.
- d-block: Transition metals, groups 3 to 12. Elements with outer electrons in d orbitals.
- f-block: Lanthanides and actinides, often shown as separate rows below the main table, with electrons in f orbitals.

Key Features and Labels

- Atomic Number: The number of protons in an atom's nucleus, displayed prominently for each element.
- Element Symbol: A one- or two-letter abbreviation of the element's name (e.g., H for Hydrogen).
- Atomic Mass: The average mass of an element's isotopes, displayed under the element symbol.
- State at Room Temperature: Often indicated with color codes or icons (solid, liquid, gas).
- Electronegativity, Atomic Radius, and Ionization Energy: Trends that help predict element behavior.

Significance of the Periodic Table

The periodic table isn't just a grid of elements; it embodies the fundamental principles of chemistry and physics.

Predictive Power

- Chemical Reactivity: Elements within the same group tend to react similarly.
- Bonding Patterns: The table indicates likely bonding types and compound formation.
- Material Properties: Trends in melting points, boiling points, and densities are reflected across periods and groups.

Educational and Scientific Value

- Serves as a foundational learning tool for understanding atomic structure.
- Facilitates the discovery of new elements by predicting properties of unknown elements.
- Assists in understanding complex chemical phenomena through visual pattern recognition.

Interpreting the Periodic Table: A Visual Guide

To maximize the utility of the periodic table, it?s essential to understand how to read and interpret its features.

Grouping Elements by Properties

- Alkali Metals (Group 1): Highly reactive, soft metals like sodium (Na) and potassium (K).
- Alkaline Earth Metals (Group 2): Reactive metals such as magnesium (Mg) and calcium (Ca).
- Halogens (Group 17): Very reactive nonmetals like fluorine (F) and chlorine (Cl).
- Noble Gases (Group 18): Inert gases like helium (He) and neon (Ne).

Understanding Trends and Patterns

- Atomic Radius: Generally decreases across a period and increases down a group.
- Electronegativity: Tends to increase across a period and decrease down a group.
- Ionization Energy: Increases across a period and decreases down a group.
- Metal, Nonmetal, Metalloid Distribution: Metals occupy the left and center; nonmetals the right; metalloids are along the zig-zag line.

Extended and Modern Periodic Tables

As science advances, the periodic table continues to evolve, incorporating new elements and more detailed representations.

Periodic Table of Elements 2023

- Includes 118 confirmed elements, with ongoing research into superheavy elements.
- Features color-coded sections for clarity and quick visual reference.
- Incorporates additional data such as electron configurations and isotopic information.

Specialized Variations

- Left-Right Layouts: Some tables are designed to emphasize specific trends.
- 3D and Interactive Models: Enable dynamic visualization of atomic structures and properties.
- Extended Periodic Tables: Show elements beyond 118, often for theoretical or experimental purposes.

Using the Periodic Table Effectively

To leverage the periodic table's full potential, consider the following tips:

- Memorize key groups and periods: Familiarity helps in quick identification.
- Understand periodic trends: Recognize how properties change across the table.
- Use color codes and symbols: Many tables employ these to convey additional information efficiently.
- Refer to online interactive tables: These often provide detailed data, animations, and simulations.

Conclusion: The Visual Power of the Periodic Table

The periodic table a visual guide to the elements is much more than a chart; it is a map of the material universe at the atomic level. Its organization reveals the underlying principles that govern chemical behavior, making it an indispensable resource for anyone interested in science. From classroom learning to cutting-edge research, mastering the periodic table unlocks a deeper understanding of the natural world. As new elements are discovered and scientific knowledge expands, the periodic table continues to evolve, reflecting the dynamic and ever-expanding nature of chemistry.

Keywords: periodic table, visual guide, elements, chemical properties, atomic number, electron configuration, periodic trends, element groups, transition metals, noble gases, chemical reactivity, atomic radius, electronegativity, ionization energy, periodic table of elements 2023

The periodic table: a visual guide to the elements is an essential tool for anyone interested in understanding the building blocks of matter. This iconic chart organizes all known chemical elements based on their atomic number, electron configurations, and recurring chemical properties. Its design not only simplifies complex scientific data but also provides a visual language that reveals patterns, relationships, and trends across the elements. Whether you're a student, educator, researcher, or curious mind, gaining a clear understanding of the periodic table enhances your grasp of chemistry and the fundamental nature of the universe.

The Origins and Evolution of the Periodic Table

Early Discoveries and the Need for Organization

The journey toward the modern periodic table began in the 19th century as scientists discovered increasing numbers of chemical elements. Early chemists like Johann Wolfgang Döbereiner identified triads?groups of three elements with similar properties?highlighting the periodicity in element behavior. Then, Dmitri Mendeleev, often called the father of the periodic table, arranged elements by increasing atomic weight and grouped elements with similar properties, leaving gaps for undiscovered elements.

The Modern Periodic Table

With the advent of atomic theory and the discovery of protons and neutrons, the periodic table was reorganized based on atomic number rather than atomic weight. This shift led to the development of the current layout, which reflects the periodic law: the properties of elements are periodic functions of their atomic numbers.

Anatomy of the Periodic Table: A Visual Breakdown

Layout and Structure

The periodic table is typically arranged in rows called periods and columns called groups or families.

- Periods (Rows): 1 through 7 in most standard tables, indicating the number of electron shells.
- Groups (Columns): 18 in the IUPAC system, grouping elements with similar chemical properties.

Color Coding and Visual Cues

Most modern tables employ color coding to distinguish different categories of elements:

- Metals: Often shaded in shades of blue or gray.
- Nonmetals: Usually in yellow or green.
- Metalloids: Displayed in a different color like purple or orange.
- Lanthanides and Actinides: Placed separately at the bottom, often in shaded rows or blocks.

This visual differentiation helps quickly identify element types and their relationships.

Key Sections of the Table

- Main Body: Representative and Transition Elements

- Groups 1-2 & 13-18: Also called main-group or representative elements, they include metals, nonmetals, and metalloids.
- Transition Metals (Groups 3-12): Known for variable oxidation states and colorful compounds.

- Lanthanides and Actinides

- Lanthanides: Elements 57-71, often called rare earth metals.
- Actinides: Elements 89-103, mostly radioactive and used in nuclear applications.

Understanding the Visual Elements of the Periodic Table

Atomic Number and Symbol

Each element is identified by its symbol (e.g., H for Hydrogen, O for Oxygen) and atomic number (number of protons).

Atomic Mass

Typically displayed below the symbol, providing the average atomic weight based on isotopic distribution.

Electron Configuration and Periodicity

The arrangement of electrons influences an element's properties and is reflected in the table's structure. Elements in the same group have similar valence electron configurations, leading to similar chemical behavior.

State at Room Temperature

Some tables include icons or colors indicating whether an element is a solid, liquid, or gas at room temperature.

Patterns and Trends in the Periodic Table

Atomic Size

- Trend across periods: Atomic radius decreases from left to right due to increasing nuclear charge pulling electrons closer.
- Trend down groups: Atomic radius increases as additional electron shells are added.

Electronegativity and Ionization Energy

- Electronegativity: Tendency of an atom to attract electrons; increases across periods and decreases down groups.
- Ionization Energy: Energy required to remove an electron; follows similar trends as electronegativity.

Metallic and Nonmetallic Character

- Metals tend to lose electrons, are malleable, and conduct electricity.
- Nonmetals tend to gain electrons, are brittle, and are insulators.
- The table visually demonstrates the transition from metallic to nonmetallic character across periods.

Specialized Variations and Interactive Visuals

Extended and Modern Tables

Some tables include additional details such as:

- Electron shell diagrams
- Orbital block coloring: s-block, p-block, d-block, f-block
- State of matter at room temperature
- Radioactivity indicators

Digital and Interactive Tables

Online platforms and apps allow users to:

- Click on elements for detailed data
- View trends and properties dynamically
- Explore isotope information

Practical Applications of the Periodic Table

- Predicting Chemical Behavior: Understanding group similarities aids in predicting reactions.
- Material Science: Identifying elements for alloys, semiconductors, and catalysts.
- Environmental Science: Tracking radioactive and toxic elements.
- Education: Enhancing learning through visual patterns and relationships.

Conclusion: The Power of Visual Organization

The periodic table: a visual guide to the elements is more than a chart; it?s a map of the universe?s fundamental particles. Its design encapsulates centuries of scientific discovery, revealing patterns that underpin chemical behavior and elemental relationships. By mastering its structure and visual cues, learners and professionals can unlock a deeper understanding of matter, enabling innovations across chemistry, physics, biology, and engineering. Whether viewed as a static diagram or an interactive tool, the periodic table remains an essential visual language for science.

QuestionAnswer What is the purpose of the periodic table in chemistry? The periodic table organizes all known chemical elements based on their atomic number, electron configurations, and recurring chemical properties, helping scientists understand element relationships and predict behaviors. How are elements arranged in the periodic table? Elements are arranged in order of increasing atomic number across rows called periods and grouped into columns called groups or families that share similar properties. What information can you find on a typical periodic table? A standard periodic table shows the element's symbol, atomic number, atomic mass, and often color codes indicating states of matter or element categories like metals, nonmetals, and metalloids. Why are some elements highlighted or colored differently in the periodic table? Colors typically represent different element categories such as metals, nonmetals, metalloids, or states of matter, making it easier to identify their properties at a glance. What are the lanthanides and actinides on the periodic table? Lanthanides and actinides are two rows of elements placed below the main table, consisting of elements with atomic numbers 57-71 and 89-103, respectively, known for their unique electronic configurations and applications. How does the periodic table help in understanding element trends? It reveals trends such as electronegativity, atomic radius, and ionization energy across periods and groups, helping predict how elements will react chemically. Who created the first periodic table and how has it evolved? Dmitri Mendeleev created the first periodic table in 1869, and it has evolved significantly with the discovery of new elements and modern understanding of atomic structure, leading to the current comprehensive table. What is the significance of the periodic table's layout for students and scientists? Its layout provides a visual framework for understanding element relationships, predicting chemical behaviors, and facilitating learning and research in chemistry and related sciences.

Related keywords: periodic table, chemical elements, element symbols, atomic number, element

chart, chemistry reference, element groups, periodic trends, atomic mass, element properties

ELEMENTS AND COMPOUNDS COMPREHENSION

Elements and compounds comprehension is a fundamental aspect of understanding the building blocks of matter in the field of chemistry. Grasping the differences between elements and compounds, their properties, and how they interact is essential for students, educators, and anyone interested in the sciences. This article aims to provide a comprehensive overview of these core concepts, exploring their definitions, characteristics, examples, and significance in the natural world.

Understanding Elements

What Are Elements?

Elements are pure substances consisting of only one type of atom. They are the simplest form of matter that cannot be broken down into simpler substances by chemical means. Each element is distinguished by its unique number of protons in the nucleus, known as the atomic number.

Characteristics of Elements

- Pure Substances: Elements are pure, meaning they contain only one type of atom.
- Unique Properties: Each element has distinct physical and chemical properties, such as melting point, boiling point, reactivity, and color.
- Atoms and Molecules: Elements can exist as individual atoms (e.g., Helium, He) or as molecules composed of two or more atoms bonded together (e.g., Oxygen, O?).
- Periodic Table: Elements are organized systematically in the periodic table, which groups elements based on similar properties.

Examples of Elements

- Hydrogen (H)
- Carbon (C)
- Oxygen (O)
- Iron (Fe)
- Gold (Au)
- Nitrogen (N)

Understanding Compounds

What Are Compounds?

Compounds are substances formed when two or more different elements chemically bond together in fixed proportions. Unlike mixtures, compounds have specific chemical formulas that denote the element ratios, and they possess properties different from their constituent elements.

Characteristics of Compounds

- Chemical Bonding: Elements combine through chemical bonds such as covalent or ionic bonds.
- Fixed Composition: The ratio of elements in a compound is definite and constant, represented by a chemical formula (e.g., H?O, NaCl).
- New Properties: Compounds often display properties different from the individual elements that form them.
- Formation and Decomposition: Compounds can be broken down into elements through chemical reactions, such as electrolysis or heating.

Examples of Compounds

- Water (H?O)
- Sodium chloride (NaCl)
- Carbon dioxide (CO?)
- Methane (CH?)
- Glucose (C?H??O?)

Differences Between Elements and Compounds

| Aspect | Elements | Compounds |

|---|---|---|

| Definition | Pure substances with one type of atom | Substances formed by chemically bonded atoms of different elements |

| Composition | Only one element | Two or more different elements |

| Chemical Formula | Usually not written or simple (e.g., O?) | Specific formula (e.g., H?O) |

| Properties | Unique, characteristic of the element | Different from constituent elements |

| Breakdown Process | Cannot be broken down chemically | Can be broken down into elements via chemical reactions |

The Significance of Elements and Compounds

Understanding elements and compounds is crucial for several reasons:

- Foundation of Chemistry: They are the basic units of matter, forming the basis of chemical reactions and processes.
- Material Science: Knowledge about elements and compounds aids in developing new materials, medicines, and technologies.
- Environmental Impact: Recognizing how elements and compounds behave helps in understanding pollution, resource management, and sustainability.
- Biological Importance: Many biological processes depend on specific compounds, such as proteins, carbohydrates, and nucleic acids.

Methods of Identifying and Analyzing Elements and Compounds

Laboratory Techniques

- Spectroscopy: Used to identify elements based on their emission or absorption spectra.
- Chemical Tests: Reactions that produce characteristic colors or precipitates help identify specific compounds.
- Chromatography: Separates mixtures into individual components, useful in analyzing complex compounds.

Computational Methods

- Chemical Formula Prediction: Software tools can predict possible formulas for unknown substances.
- Molecular Modeling: Visualizes the structure of compounds, aiding in understanding their properties.

Applications of Elements and Compounds in Daily Life

- Medications: Many drugs are compounds designed for specific biological functions.
- Construction Materials: Elements like iron and compounds like cement are vital in construction.
- Energy Production: Combustion of hydrocarbons (compounds) fuels engines and power plants.
- Electronics: Semiconductors made from elements like silicon are crucial in modern electronics.
- Food Industry: Nutrients are compounds vital for health, such as vitamins and minerals.

Common Misconceptions About Elements and Compounds

- Elements Are Simple: While elements are basic, they can have complex structures and behaviors.
- All Compounds Are Molecules: Some compounds, like salts, form crystalline structures and are not discrete molecules.
- Elements Cannot Be Broken Down: Elements can be broken down in nuclear reactions but not by chemical means.
- Compounds Are Always Harmful: Many compounds are essential for life and beneficial, such as water and oxygen.

Conclusion

A comprehensive understanding of elements and compounds is essential to grasp the fundamental nature of matter. Elements serve as the building blocks, each with unique properties, while compounds are the chemical combinations of these elements, forming substances with new characteristics. Recognizing their differences, formation, and significance helps in appreciating the complexity and diversity of the material world. Whether in scientific research, industrial applications, or daily life, knowledge of elements and compounds underpins many innovations and solutions to global challenges.

By mastering these concepts, students and enthusiasts can develop a solid foundation in chemistry, enabling further exploration into molecular structures, chemical reactions, and the development of new materials. Continuous learning about the elements and compounds shaping our universe is crucial for advancing science and improving our quality of life.

Elements and Compounds Comprehension: An In-Depth Exploration of Matter?s Fundamental Building Blocks

Understanding the nature of matter is foundational to the fields of chemistry, physics, and material science. At the core of this understanding lies the distinction between elements and compounds?two fundamental categories that define the composition and behavior of everything from the simplest gases to complex biological molecules. This comprehensive review aims to dissect the concepts of elements and compounds, elucidate their properties, their roles in the

natural world, and the scientific principles underpinning their formation and classification.

Introduction to Elements and Compounds

The universe, in its vast complexity, is constructed from a finite set of building blocks. These building blocks are primarily classified into elements?pure substances consisting of only one type of atom?and compounds, which are substances formed from two or more elements chemically bonded in fixed proportions. Recognizing and differentiating between these fundamental types of matter is critical for understanding chemical reactions, material properties, and the organization of matter at the atomic level.

Defining Elements: The Building Blocks of Matter

What Are Elements?

Elements are substances composed entirely of one type of atom, distinguished by their unique number of protons, known as the atomic number. They are the simplest form of matter that cannot be broken down into simpler substances by chemical means. Each element has a specific set of properties, including atomic weight, density, melting point, and reactivity, which are characteristic and contribute to the element?s identity.

Historical Perspective and Discovery

The concept of elements has evolved considerably over centuries. Early chemists identified elements through observation of natural substances and their reactions. The periodic table, developed by Dmitri Mendeleev and later refined, organizes elements based on atomic number and chemical properties, revealing periodic trends and relationships.

Classification and Properties of Elements

Elements are broadly classified into metals, nonmetals, and metalloids:

- Metals: Good conductors of electricity, malleable, ductile, often shiny (e.g., iron, copper, aluminum).
- Nonmetals: Poor conductors, brittle in solid form, diverse in physical states (e.g., oxygen, sulfur, nitrogen).
- Metalloids: Exhibit properties intermediate between metals and nonmetals (e.g., silicon, arsenic).

Elements also differ significantly in their reactivity:

- Noble gases (helium, neon, argon) are notably inert.
- Alkali metals (lithium, sodium, potassium) are highly reactive.

Atomic Structure and Isotopes

Each element?s atoms are characterized by their atomic structure:

- Protons: Define the element.
- Neutrons: Vary among isotopes, affecting atomic mass.
- Electrons: Determine chemical behavior.

Isotopes are variants of an element with different neutron counts, influencing atomic weight but not chemical properties significantly.

Understanding Compounds: The Chemical Bonding of Elements

What Are Compounds?

Compounds are substances formed when two or more elements combine chemically in fixed ratios, resulting in new substances with distinct properties. The formation of compounds involves chemical bonds?either ionic or covalent?that hold atoms together.

Types of Chemical Bonds

- Ionic Bonds: Formed through electrostatic attraction between oppositely charged ions, typically between metals and nonmetals (e.g., sodium chloride, NaCl).
- Covalent Bonds: Sharing of electron pairs between atoms, common among nonmetals (e.g., water, H?O; carbon dioxide, CO?).

Characteristics of Compounds

- Fixed Composition: Defined by a chemical formula indicating the ratio of elements (e.g., H?O, C?H??O?).
- Distinct Properties: Different from constituent elements; for example, sodium is reactive and soft, while sodium chloride is stable and edible.
- Chemical Reactivity: Compounds can undergo further reactions, breaking down into elements or forming new compounds.

Classification of Compounds

Compounds are grouped based on their bonding and composition:

- Inorganic Compounds: Usually contain metals and nonmetals; include salts, minerals, acids.
- Organic Compounds: Primarily contain carbon and hydrogen; include hydrocarbons, carbohydrates, proteins.

Methods of Identification and Analysis

Distinguishing Elements from Compounds

The key differences include:

- Pure Substance: Elements are pure, while compounds are chemically combined.
- Chemical Formula: Elements typically represented by a one- or two-letter symbol; compounds have more complex formulas.
- Separation Techniques: Elements can be isolated via physical methods like electrolysis (for ions), while compounds require chemical reactions to decompose into elements.

Analytical Techniques in Modern Chemistry

- Spectroscopy: Determines atomic and molecular composition.
- Chromatography: Separates mixtures to identify constituent elements or compounds.
- Mass Spectrometry: Measures molecular weights and structures.
- X-ray Crystallography: Reveals atomic arrangements within compounds.

Significance of Elements and Compounds in Nature and Industry

Natural Occurrence

Elements and compounds are omnipresent:

- Atmosphere: Composed mainly of nitrogen (element) and oxygen (element).
- Minerals: Contain compounds like calcite (CaCO?) and halite (NaCl).
- Biological Systems: Consist of complex compounds such as proteins, nucleic acids, and lipids.

Industrial Applications

- Materials Manufacturing: Alloys (metal mixtures), plastics (organic compounds), pharmaceuticals.
- Energy Production: Combustion of hydrocarbons, nuclear reactions involving specific elements.
- Environmental Science: Monitoring and controlling pollutants, which are often compounds or elements.

Emerging Topics and Future Directions

Advanced Material Design

Understanding elements and compounds at the atomic level enables the creation of novel materials:

- Nanomaterials: Exploit unique properties of elements and compounds at nanoscale.
- Smart Materials: Responsive to environmental stimuli, designed from specific compounds.

Chemical Synthesis and Green Chemistry

Developing sustainable methods to synthesize compounds with minimal environmental impact remains a priority, relying heavily on knowledge of element reactivity and bonding.

Elemental and Compound Databases

Technological advancements have led to comprehensive databases that facilitate research, discovery, and application of elements and compounds in various scientific fields.

Conclusion

The comprehension of elements and compounds is a cornerstone of chemistry and material science. Recognizing that elements serve as the basic building blocks of matter, while compounds are their chemically bonded assemblages, provides a framework for understanding the complexity and diversity of the material universe. Ongoing research continues to unveil the properties, behaviors, and potential applications of these fundamental substances, driving innovation across multiple scientific and industrial domains.

A thorough grasp of these concepts not only deepens scientific knowledge but also empowers technological progress, environmental stewardship, and the development of new materials that shape our future.

QuestionAnswer What is the difference between an element and a compound? An element is a pure substance made of only one type of atom, while a compound consists of two or more different elements chemically combined in a fixed ratio. How can you tell if a substance is an element or a compound? If a substance can be broken down into simpler substances by physical means, it is likely an element. If it can only be broken down by chemical reactions into simpler substances, it is a compound. What are some common examples of elements and compounds? Common elements include oxygen, hydrogen, and gold. Examples of compounds include water (H?O), carbon dioxide (CO?), and sodium chloride (NaCl). Why do elements have chemical symbols, and how are they written? Elements have chemical symbols to uniquely identify each element, usually consisting of one or two letters, with the first letter capitalized and the second letter lowercase (e.g., O for oxygen, Na for sodium). What is a chemical formula, and what does it tell us about a compound? A chemical formula shows the types and numbers of atoms in a molecule of a compound, such as H?O indicating two hydrogen atoms and one oxygen atom. How are elements and compounds represented in the periodic table? Elements are represented by their chemical symbols in the periodic table, while compounds are not listed as individual entries but can be written using chemical formulas based on the elements involved. Can elements be broken down into simpler substances? What about compounds? Elements cannot be broken down into simpler substances by chemical means; they are already the simplest form. Compounds can be broken down into their constituent elements through chemical reactions. What is the importance of understanding elements and compounds in chemistry? Understanding elements and compounds is fundamental in chemistry because it helps explain the composition, structure, and properties of matter, enabling us to predict how substances will react and interact. How do elements combine to form compounds? Elements combine through chemical bonds, such as covalent or ionic bonds, to form compounds with new properties different from the individual elements.

Related keywords: elements, compounds, chemistry, molecules, atoms, chemical formulas, periodic table, bonding, mixtures, reactions

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