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# 7. A Study of Periodic Trends and the S-Block Elements

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***Abstract:***

*The organometallic and coordination chemistry of alkali and alkaline earth metals has made great strides in recent years to meet the demands of modern life. Research into the chemistry of the crucial s-block metals is encouraged by increased ecological consciousness and global availability. Thanks to recent advances in theory and preparation methods, s-block metals are expanding their chemistry applications. The s-block elements have been shown to have a significant effect on stoichiometric and catalytic processes in recent studies. When it comes to the periodic table, the first two groups, the alkali and transition metals, are absorbed by the s-block metals from the alkaline earth, etc. By the middle of the 19th century, all of the non-radioactive elements had been discovered, marking the beginning of a profound, s-block metal-based chemistry with a lengthy history. The limited scope of their chemistry is justified by the low toxicity, and the very hazardous congeners are limited to the radioactive metals and beryllium.*

***Keywords:***

*S-block metals; periodic trends; alkali metals; alkaline earth metals.*

## 7.1 Introduction:

To better understand the size and electrical properties of an element, as well as other characteristics, periodic trends can be observed in the table of elements. Changes in electronegativity, ionization energy, electron affinity, atomic radius, melting temperature, and metallic character occur on a periodic basis and have significant periodic trends.

The periodic trends that emerge from the structure of the periodic table give chemists a powerful tool for making accurate predictions about the properties of individual elements. Both the periodic nature of the elements and the similarity of their atomic structures within their various group families explain these patterns.

Metals (to the left of the line) and non-metals (right of the line) are separated by the diagonal line in Figure 7.1 of "Summary of Periodic Trends in Atomic Properties" (to the right of the line). Because of their low electronegativity, metals readily lose electrons to other elements during chemical reactions, resulting in the formation of compounds in which the metal is in a higher oxidation state. In contrast, non-metals have high electronegativity's, therefore they gain electrons to create compounds with lower oxidation states than their initial state during chemical processes.

On the diagonal between metals and non-metals is where you'll find the semimetals. Therefore, it is not surprising that their characteristics and reactivity's fall somewhere in the middle of those of metals and non-metals. The chemistry of elements in groups 13, 14, and 15 is more complicated than would be expected from their valence electron configurations alone since they transcend the diagonal line between metals and non-metals.

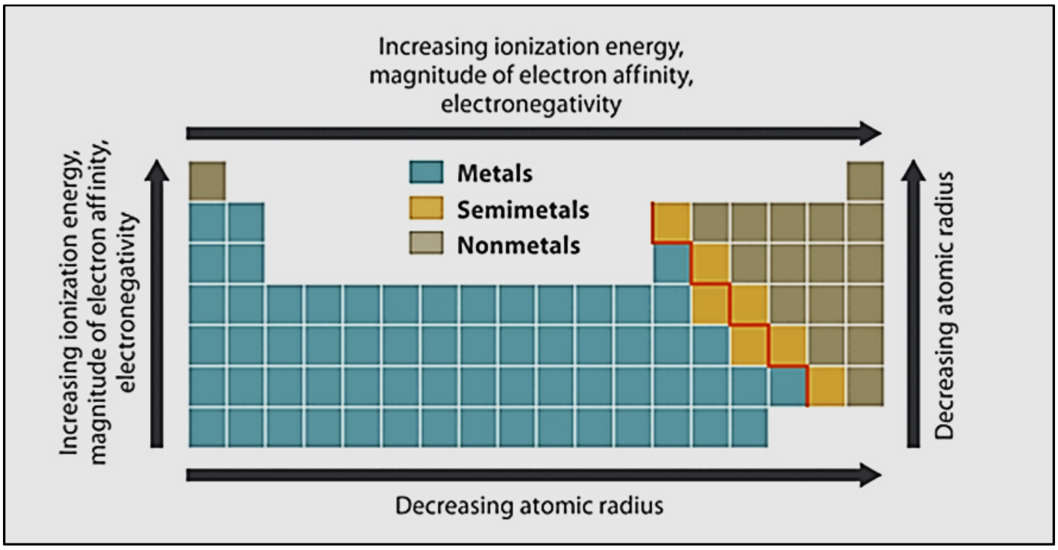


**Figure 7.1: Summary of Periodic Trends in Atomic Properties**

Energy required to cause ionization, strength of electron affinity, and electronegativity tend to rise from left to right and from bottom to top. On the other hand, atomic size decreases in both a horizontal and vertical direction.

As a result, the elements on the far right of the periodic table are the smallest and most electronegative, while the elements in the far left are the largest and least electronegative. The semimetals have intermediate qualities and can be found on the diagonal between the metals and the non-metals. [1]

## 7.2 S Block Elements:

The s-block, if the periodic table were a city, would be a small area with a lot of identical homes and businesses. The s-block, which spans the far left side of the periodic table, consists of the elements found in columns 1 and 2, plus helium, which may be found in the far right, in column 8A. (Column 18 on some versions of the periodic table). The s-block has been assigned the pink color in the periodic Table 7.2.

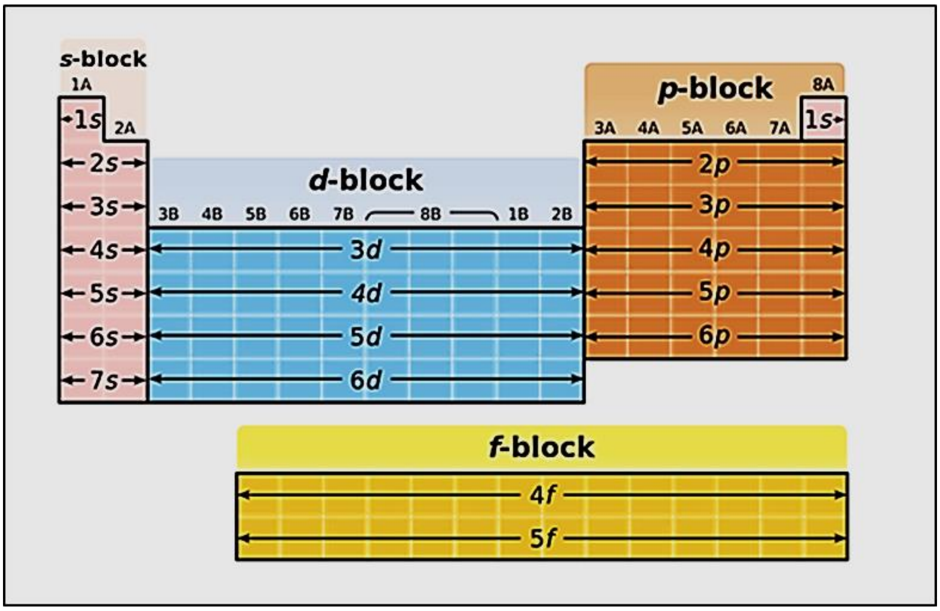


**Figure 7.2: Periodic table of s-block elements**

The 14 elements in this block are known as the s-block. The valence electrons (the most outer electrons) of all s-block elements are located in the s orbital, making up a characteristic shared by all of these elements. An atom can have a maximum of two electrons in its spherical s orbital. Elements with one s-orbital electron are found in Column 1, while those with two (plus helium) can be found in Column 2.

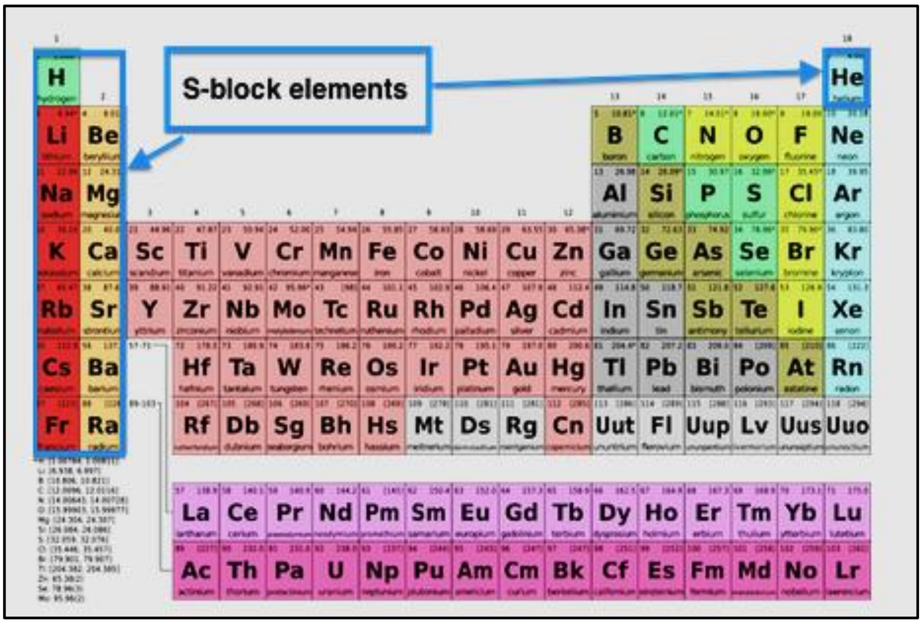


**Figure 7.3: s-block elements**

Hydrogen (H), Helium (He), Lithium (Li), Beryllium (Be), Sodium (Na), Magnesium (Mg), Potassium (K), Calcium (Ca), Rubidium (Rb), Strontium (Sr), Cesium (Cs), Barium (Ba), Francium (Fr), and Radium (Ra) make up the s-block elements (Ra). To see where in the s-block certain elements fall, consult the periodic table.

### 7.2.1 Properties of S-Block Elements:

If these elements were houses in our made-up s-block neighbourhood, they'd all look extremely similar to one another. This is in sharp contrast to the other areas on the periodic table, where dwellings come in a rainbow of color and shapes.

The s-block elements are all metallic. The majority of them have a metallic sheen and silvery color, are excellent thermal and electrical conductors, and readily give up their valence electrons. The s-block elements are notoriously reactive due to the ease with which their characteristic s orbital valence electrons are lost.

On the periodic table, groups 7.1 and 7.2 make comprise the S-block. In chemistry, elements in group 7.1 are known as alkali metals, while those in group 7.2 are known as alkaline earth metals.

**Group 7.1: Elements: Alkali Metals**

The general electronic configuration of group 7.1 element is ns1. All alkali metals have one valance electron hence form monovalent M+ ions, and are highly reactive. Group 7.1 consists of following elements.

Lithium (Li), Sodium (Na), Potassium (K), Rubidium (Rb), Cesium (S) and Francium (Fr).

**The electronic configuration of group 7.1 elements**

| Element | Symbol | Electronic configuration |
|---|---|---|
| Lithium | Li | [He]$2s^1$ |
| Sodium | Na | [Ne]$3s^1$ |
| Potassium | K | [Ar]$4s^1$ |
| Rubidium | Rb | [Kr]$5s^1$ |
| Caesium | Cs | [Xe]$6s^1$ |
| Francium | Fr | [Rn]$7s^1$ |

**Group 7.2: Elements: Alkaline Earth Metals**

The general electronic configuration of group 7.2 elements is $\mathbf{ns^2}$. All alkaline earth metals have two valance electrons, hence form divalent $M^{2+}$ ions, and are highly reactive like alkaline metals. Group 7.2 consists of following elements.

Beryllium (Be), Magnesium (Mg), Calcium (Ca), Strontium (Sr), Barium (Ba), Radium (Ra).

**The electronic configuration of group 7.2 elements**

| Elements | Symbol | Atomic Number | Electronic Configuration |
|---|---|---|---|
| Beryllium | Be | 4 | [He] $2s^2$ |
| Magnesium | Mg | 12 | [Ne] $3s^2$ |
| Calcium | Ca | 20 | [Ar] $4s^2$ |
| Strontium | Sr | 38 | [Kr] $5s^2$ |
| Barium | Ba | 56 | [Xe] $6s^2$ |
| Radium | Ra | 88 | [Rn] $7s^2$ |

## 7.2.2 Objectives:

- To know important periodic trends in several atomic properties.
- To be familiar with the roles of the *s*-block elements in chemistry.
- To describe how the alkali metals are isolated.
- To be familiar with the reactions, compounds, and complexes of the alkali metals.

## 7.2.3 Review of Literature:

Ionic bonding and the salt-like properties of their compounds characterize the organic and coordination chemistry of these highly electropositive metals. Cesium, with an Allred-Roc how electronegativity of 0.86, is the non-radioactive element with the highest electro positivity.

Magnesium (I) and calcium (I) complexes are notable outliers since they are thermally stable while still retaining their elements' +I and +II oxidation states, respectively, throughout the chemical changes.

The paradigm change in polar organometallic chemistry that has occurred in recent years has greatly increased the field's visibility and made hitherto niche activities and applications possible for these reagents [4-6].

Nobel Laureate in Chemistry in 1934 for discovering deuterium was Harold Urey (1893-1981). (2H). Urey grew up in a little town in Indiana. In 1917, Urey graduated from the University of Montana with a bachelor's degree in zoology. At Berkeley, he studied chemistry with G. and eventually earned his Ph. N. Lewis (famous for the Lewis electron structure), and he went on to collaborate with Niels Bohr in Copenhagen.

Urey oversaw the Columbia University Atomic Bomb Project during World War II as its director of war research. Later in adulthood, he decided to study how life came to be. In 1953, he and his graduate student Stanley Miller demonstrated that a mixture of substances supposed to be present in the atmosphere of early Earth could be created by running an electric discharge across the mixture, resulting in organic compounds like amino acids. [7]

Authors: Alzamly, Ahmed; Alnaqbi, Mohamed; Ahmed, Salwa; Bakiro, Maram; Kegere, James; Nguyen, Ha. (2020). S-block metal-organic frameworks: chemistry and potential uses. The A Journal of Materials Chemistry.

Metal-organic frameworks (MOFs) are crystalline porous materials that have several potential applications. In the last ten years, researchers have created a wide variety of metal-organic frameworks (MOFs) based on metal ions from the s-, p-, d-, and f-blocks. S-block MOFs are less investigated than MOFs based on transition metals and f-block metal ions, despite their abundance, low cost, and well acknowledged lack of toxicity.

Gas storage and separation, chemical delivery, catalysis, electrochemical applications, and sensing are all possible uses for s-block MOFs due to their exceptional properties (such as low density, dense Lewis active centres and open metal sites, biocompatibility, and high catalytic activity). Up-to-date developments with s-block MOFs are covered here.

First, we discuss the characteristics of s-block metal ion-based MOFs; second, we detail the chemical structures of s-block MOF constituents such as organic linkers and metal clusters; and finally, we focus on the role of crystal structures and applications of s-block MOFs in fields such as gas sorption and separation, chemical delivery, catalysis, sensing, and others. In an effort to guide the chemistry, characteristics, applications, and future directions of s-block MOFs as advanced materials for numerous purposes, we conclude by offering perspectives on how to broaden the scope of s-block MOF chemistry. [8]

The authors are Sven Krieck and Matthias Westerhausen. (2017). A round of applause for the s-block metal chemistry's renaissance. Inorganics. 5. 17. 10.3390/inorganics5010017. The organometallic and coordination chemistry of alkali and alkaline earth metals has made great strides in recent years to meet the demands of modern life. Research into the chemistry of the crucial s-block metals is encouraged by increased ecological consciousness and global availability. Thanks to recent advances in theory and preparation methods, s-block metals are expanding their chemistry applications. Many recent studies have revealed the significant role that components from the s block play in stoichiometric and catalytic reactions. [9]

### 7.2.4 Research Methodology:

To further our understanding of periodic trends and the s-block elements, we consulted a variety of secondary materials, including books, educational and development magazines, government papers, and print and online reference sites. In this investigation, we will focus on a single S-block element. The element's uses and intriguing facts are discussed, as well as the symbol on the periodic table and the characteristics that set it apart from other elements in the S-block.

The research is focused on one specific S-block constituent and highlights its unique properties. The final product is visually appealing, well-organized, and academic.

## 7.3 Result and Discussion:

### 7.3.1 S Block Elements Chemical Reactivity:

The alkali metals are highly reactive due to their large size and low ionization enthalpy [10]

**A. Reactions of S-block elements with oxygen (air):**

Alkali metals burns vigorously in oxygen to form oxides. Lithium forms monoxide ($Li_2O$) and sodium forms peroxide, ($Na_2O_2$).

$$4Li + O_2 \rightarrow 2Li_2O \quad \text{(Oxide)}$$

$$2Na + O_2 \rightarrow Na_2O_2 \quad \text{(Peroxide)}$$

The other elements form super-oxides.

$$M + O_2 \rightarrow MO_2 \quad \text{(Superoxide)}$$

(Where, M = K, Rb, Cs)

**B. Reaction of S-block elements with water:**

The alkali metals react with water to form corresponding hydroxides and evolve hydrogen gas (Dihydrogen). (M = Li, Na, K, Rb, Cs)

$$2M + 2H_2O \rightarrow 2MOH + H_2 \uparrow$$

**C. S-block elements Reaction with halogens:**

All the alkali metals react vigorously with halogen to form their respective ionic crystalline halides with general formula M+X- where M = Na, K, Rb, Cs and X = Cl, Br, I and F.

$$2M + X2 \quad \Delta \rightarrow \quad 2M+X-$$

The melting point of a substance is defined as the amount of energy needed to break its bonds and transform from its solid state into its liquid state. In general, the more energy is needed to break the connection between atoms of an element, the more stable the element is.

A high bond dissociation energy corresponds to a high temperature due to the direct relationship between the two quantities. There is no clear pattern to melting points across the periodic Table. Figure 7.7 does, however, allow for certain inferences to be made. [11]

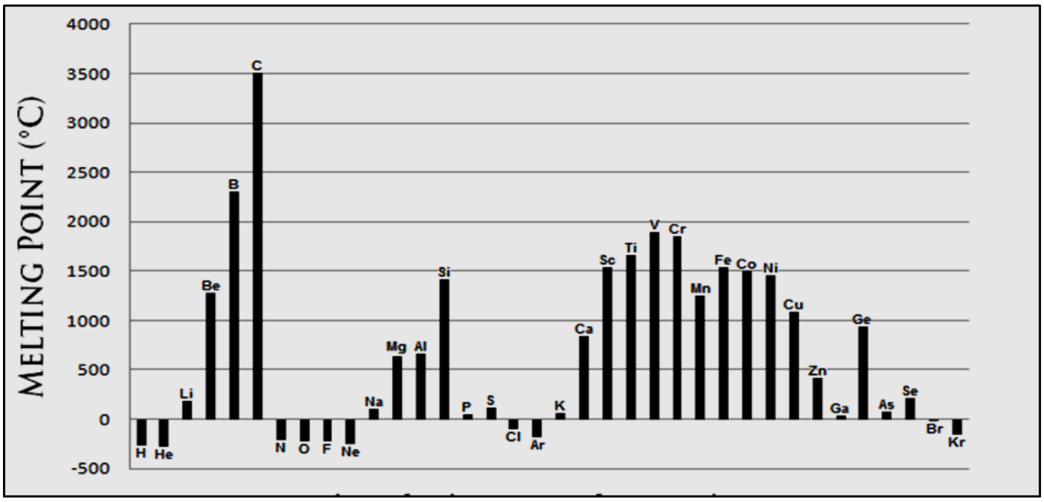


**Figure 7.7: Chart of Melting Points of Various Elements**

## 7.4 Conclusion:

Elements are classified into one of four groups based on their electrical structures. This cluster is made up of elements from Groups 7.1 and 7.2. This category contains elements from Groups 13-18. Similar patterns, based on periodic trends, can be seen in the periodic table for properties of elements like electronegativity, atomic radius, and ionizing power. According to the periodic law, when elements are categorized by their atomic numbers, there is a regular occurrence of certain properties.

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