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Retraction

Retracted: On Multiplicative Topological Invariants of Magnesium Iodide Structure

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] Z. Zhang, H. Ali, A. Naseem, U. Babar, X. Zhang, and P. Ali, "On Multiplicative Topological Invariants of Magnesium Iodide Structure," *Journal of Mathematics*, vol. 2022, Article ID 6466585, 15 pages, 2022.

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Research Article

On Multiplicative Topological Invariants of Magnesium Iodide Structure

Zhiqiang Zhang [1] **Haidar Ali** [2] **Asim Naseem,** [3] **Usman Babar,** [3] **Xiujun Zhang** [1] **and Parvez Ali** [4]

[1] *School of Computer Science, Chengdu University, Chengdu, China*
[2] *Department of Mathematics, Riphah International University, Faisalabad Campus, Rawalpindi, Pakistan*
[3] *Department of Mathematics, Government College University, Lahore, Pakistan*
[4] *Department of Mechanical Engineering, College of Engineering, Qassim University, Unaizah, Saudi Arabia*

Correspondence should be addressed to Haidar Ali; haidar3830@gmail.com

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In recent times, the applications of graph theory in molecular and chemical structure research have far exceeded human expectations and have grown exponentially. In this paper, we have determined the multiplicative Zagreb indices, multiplicative hyper-Zagreb indices, multiplicative universal Zagreb indices, sum and product connectivity of multiplicative indices, multiplicative atom-bond connectivity index, and multiplicative geometric-arithmetic index of a famous crystalline structure, magnesium iodide (MgI_2).

1. Introduction and Preliminary Results

In chemical graph theory, molecules can be modeled as graphs by representing atoms as vertices and atomic bonds as edges [1]. The nervous system can be thought of as a graph, where the neurons (nodes) and the edges (bonds) are between them. The nervous system can be seen as a graph, where the nodes are neurons and the edges are the connections between them.

The representation of a graph can be expressed by numbers, polynomials, and matrices. Graphs have their own characteristics that may be calculated by topological indices, and under graph automorphism, the topology of graphs remains unchanged. Degree-based topological indices are exceptionally important among different classes of indices and take on a vital role in graph theory and in particular in science [2]. Chem-informatics is a brand-new field that combines chemistry, mathematics, and information science. It investigates quantitative structure-activity (QSAR) and structure-property (QSPR) connections, which are used to predict chemical compound biological activities and qualities.

Magnesium iodide (MgI_2) is a chemical compound and has many commercial uses. It is used for manufacture of different organic compounds in large scale due to its cheapness and availability everywhere in the world. Magnesium iodide can be obtained from the reaction of hydroiodic acid with magnesium oxide, magnesium hydroxide, and magnesium carbonate.

$$\begin{aligned} 2HI + MgCO_3 &\longrightarrow MgI_2 + H_2O + CO_2 \\ 2HI + MgO &\longrightarrow MgI_2 + H_2O \\ 2HI + Mg(OH)_2 &\longrightarrow MgI_2 + 2H_2O \end{aligned} \tag{1}$$

Every heptagon in MgI_2 is connected to each other in column and row by making three C_4 within each heptagon. We will use "m" to represent the number of C_4 rows on the upper side and "n" to represent the number of C_4 on the lower side of the heptagon.

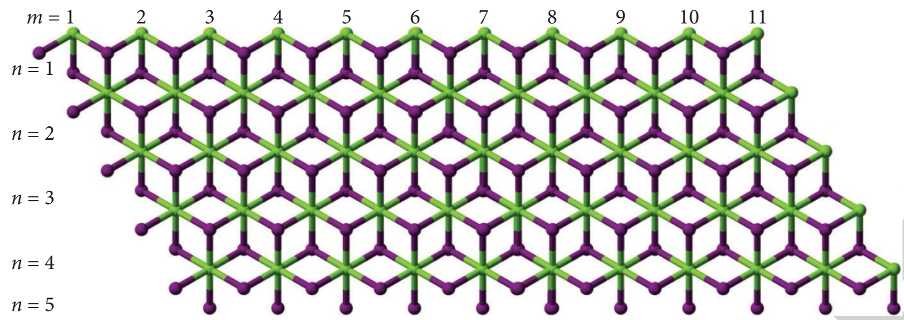

Figure 1: Graph $(\mathfrak{L}_1)$ of MgI_2 for $m = 2n + 1$.

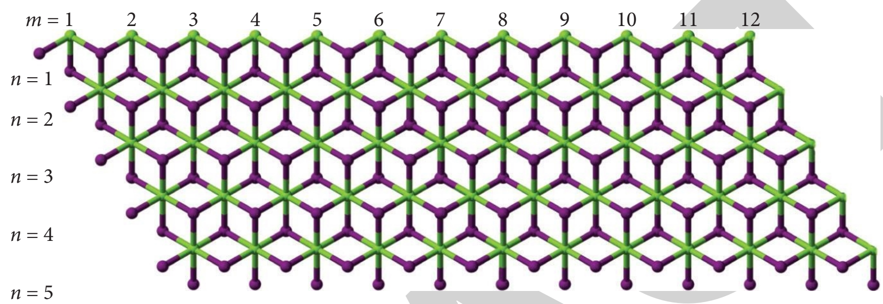

Figure 2: Graph $(\mathfrak{L}_2)$ of MgI_2 for $m = 2n + 2$.

In Figures 1 and 2, there are variables m and n, which are dependent on each other to maintain the structure of magnesium iodide. Magnesium has 2 electrons in its outermost shell, while iodide contains 7 electrons in its valence shell. As a result, to turn out to be stable, magnesium offers its electrons to iodide. To maintain the chemical structure of magnesium iodide, it depends on each other. As a result, the graph was subdivided into even and odd vertices. For the first type, the cardinality of vertices and edges of graph $(\mathfrak{L}_1)$, as shown in Figure 1, is $m = 2n + 1$, and for the second type, the cardinality of vertices and edges of graph $(\mathfrak{L}_2)$, as shown in Figure 2, is $m = 2n + 2$, where $n \in \mathbb{N}$, respectively.

In this article, "$\mathfrak{L}$" is considered a structure with a vertex set $V(\mathfrak{L})$ and edge set $E(\mathfrak{L})$, and $d(r)$ is the degree of vertex $r \in V(\mathfrak{L})$.

The "second multiplicative Zagreb index" [4] is defined as

$$\mathrm{II}_2(\mathfrak{L}) = \prod_{rs\in E(\mathfrak{L})} (d_r \times d_s), \tag{2}$$

where (r, s) is any unordered pair of vertices in $\mathfrak{L}$.

Kulli [5] further described some new and advanced topological indices, and he named them as the "first multiplicative hyper-Zagreb index" and the "second multiplicative hyper-Zagreb index" of a graph "$\mathfrak{L}$." The indices are defined as

$$\mathrm{HII}_1(\mathfrak{L}) = \prod_{rs\in E(\mathfrak{L})} (d_r + d_s)^2, \tag{3}$$

$$\mathrm{HII}_2(\mathfrak{L}) = \prod_{rs\in E(\mathfrak{L})} (d_r \times d_s)^2. \tag{4}$$

The "first multiplicative universal Zagreb index" and the "second multiplicative universal Zagreb index" were introduced by Kulli et al. [6]. These indices are defined as

$$\mathrm{MZ}_1^a(\mathfrak{L}) = \prod_{rs\in E(\mathfrak{L})} (d_r + d_s)^a, \tag{5}$$

$$\mathrm{MZ}_2^a(\mathfrak{L}) = \prod_{rs\in E(\mathfrak{L})} (d_r \times d_s)^a, \tag{6}$$

where $a \in \mathbb{N}$.

The multiplicative sum and product connectivity indices were introduced by Kulli [7], defined as

$$\mathrm{SCII}(\mathfrak{L}) = \prod_{rs\in E(\mathfrak{L})} \frac{1}{\sqrt{d_r + d_s}}, \tag{7}$$

$$\mathrm{PCII}(\mathfrak{L}) = \prod_{rs\in E(\mathfrak{L})} \frac{1}{\sqrt{d_r \times d_s}}. \tag{8}$$

"Multiplicative atom-bond connectivity index," "multiplicative geometric-arithmetic index," and "multiplicative universal geometric-arithmetic index" for a simple graph $\mathfrak{L}$ were introduced by Kulli [7], and these indices are defined as

$$\mathrm{ABCII}(\mathfrak{L}) = \prod_{rs\in E(\mathfrak{L})} \sqrt{\frac{d_r + d_s - 2}{d_r \times d_s}}, \tag{9}$$

$$\mathrm{GAII}(\mathfrak{L}) = \prod_{rs\in E(\mathfrak{L})} \frac{2\sqrt{d_r \times d_s}}{d_r + d_s}, \tag{10}$$

Table 1: Edge subdivision of $\mathfrak{L}_1$ of MgI_2 based on degree of end vertices of each edge for $m = 2n + 1$, where $n \in \mathbb{N}$.

(d_r, d_s) where $rs \in E(\mathfrak{L}_1)$	Number of edges
(1, 3)	1
(1, 4)	1
(1, 6)	$n + 5$
(2, 5)	8
(2, 6)	$2n + 8$
(3, 2)	2
(3, 3)	$3n$
(3, 4)	1
(3, 5)	12
(3, 6)	$27n - 13$
(4, 2)	2

$$\mathrm{GA}^a\mathrm{II}(\mathfrak{L}) = \left(\prod_{rs \in E(\mathfrak{L})} \frac{2\sqrt{d_r \times d_s}}{d_r + d_s}\right)^a, \qquad (11)$$

where $a \in \mathbb{N}$.

2. Main Results

Afzal et al. [8] computed the molecular description for magnesium iodide. In this article, we shall discuss the first type and second type of magnesium iodide structure and compute the exact results for topological indices like multiplicative Zagreb indices, multiplicative hyper-Zagreb indices, multiplicative universal Zagreb indices, sum and product connectivity of multiplicative indices, multiplicative atom-bond connectivity index, and multiplicative geometric-arithmetic index for the magnesium iodide structure. For further study of topological indices of various graph families, see [9–14]. For basic definitions and notations, see [15, 16].

2.1. Results for the First Type of Magnesium Iodide Structure. In this section, we compute topological indices such as multiplicative Zagreb indices, multiplicative hyper-Zagreb indices, multiplicative universal Zagreb, sum and product connectivity of multiplicative indices, multiplicative atom-bond connectivity index, and multiplicative geometric and universal geometric-arithmetic indices for the first type of magnesium iodide structure $(\mathfrak{L}_1)$, as shown in Figure 1.

Theorem 1. *Consider the magnesium iodide structure MgI_2 of first type; then, the second multiplicative Zagreb index is equal to*

$$\mathrm{II}_2(\mathfrak{L}) = 13931406950400n(n + 5)(2n + 8)(27n - 13). \qquad (12)$$

Proof. Let $\mathfrak{L}_1$ be the magnesium iodide structure MgI_2 for $m = 2n + 1, n \in \mathbb{N}$ of first type. In Table 1, there is an edge partition of $\mathfrak{L}_1$. From equation (2),

$$\mathrm{II}_2(\mathfrak{L}_1) = \prod_{rs \in E(\mathfrak{L}_1)} (d_r \times d_s). \qquad (13)$$

By applying edge partition of Table 1,

$$\begin{aligned}\mathrm{II}_2(\mathfrak{L}_1) = {} & 3|E_1(\mathfrak{L}_1)| \times 4|E_2(\mathfrak{L}_1)| \times 6|E_3(\mathfrak{L}_1)| \times 10|E_4(\mathfrak{L}_1)| \times 12|E_5(\mathfrak{L}_1)| \\ & \times 6|E_6(\mathfrak{L}_1)| \times 9|E_7(\mathfrak{L}_1)| \times 12|E_8(\mathfrak{L}_1)| \times 15|E_9(\mathfrak{L}_1)| \times 18|E_{10}(\mathfrak{L}_1)| \times 8|E_{11}(\mathfrak{L}_1)| \\ = {} & 3(1) \times 4(1) \times 6(n + 5) \times 10(8) \times 12(2n + 8) \times 6(2) \times 9(3n) \\ & \times 12(1) \times 15(12) \times 18(27n - 13) \times 8(2).\end{aligned} \qquad (14)$$

We obtain the following by making some calculations:

$$\Rightarrow \mathrm{II}_2(\mathfrak{L}_1) = 13931406950400n(n + 5)(2n + 8)(27n - 13). \qquad (15)$$

□

Theorem 2. *Consider the magnesium iodide structure MgI_2 of first type; then, the first and second multiplicative hyper-Zagreb indices are equal to*

$$\begin{aligned}\mathrm{HII}_1(\mathfrak{L}_1) &= 582761278687150080000n(n + 5)(2n + 8)(27n - 13), \\ \mathrm{HII}_2(\mathfrak{L}_1) &= 1684757809181019340800000n(n + 5)(2n + 8)(27n - 13).\end{aligned} \qquad (16)$$

Proof. Let $\mathfrak{L}_1$ be the magnesium iodide structure MgI_2 of first type. In Table 1, there is an edge partition of $\mathfrak{L}_1$. From equation (3),

$$\mathrm{HII}_1(\mathfrak{L}_1) = \prod_{rs \in E(\mathfrak{L}_1)} (d_r + d_s)^2. \qquad (17)$$

By applying edge partition of Table 1,

$$\begin{aligned}\mathrm{HII}_1(\mathfrak{L}_1) &= 16|E_1(\mathfrak{L}_1)| \times 25|E_2(\mathfrak{L}_1)| \times 49|E_3(\mathfrak{L}_1)| \times 49|E_4(\mathfrak{L}_1)| \times 64|E_5(\mathfrak{L}_1)|\\ &\quad\times 25|E_6(\mathfrak{L}_1)| \times 36|E_7(\mathfrak{L}_1)| \times 49|E_8(\mathfrak{L}_1)| \times 64|E_9(\mathfrak{L}_1)|\\ &\quad\times 81|E_{10}(\mathfrak{L}_1)| \times 36|E_{11}(\mathfrak{L}_1)|\\ &= 16(1) \times 25(1) \times 49(n+5) \times 49(8) \times 64(2n+8) \times 25(2)\\ &\quad\times 36(3n) \times 49(1) \times 64(12) \times 81(27n-13) \times 36(2).\end{aligned} \tag{18}$$

We obtain the following by making some calculations:

$$\Rightarrow \mathrm{HII}_1(\mathfrak{L}_1) = 582761278687150080000n(n+5)(2n+8)(27n-13). \tag{19}$$

From equation (4),

$$\mathrm{HII}_2(\mathfrak{L}_1) = \prod_{rs\in E(\mathfrak{L}_1)} (d_r \times d_s)^2. \tag{20}$$

By applying edge partition of Table 1,

$$\begin{aligned}\mathrm{HII}_2(\mathfrak{L}_1) &= 9|E_1(\mathfrak{L}_1)| \times 16|E_2(\mathfrak{L}_1)| \times 36|E_3(\mathfrak{L}_1)| \times 100|E_4(\mathfrak{L}_1)| \times 144|E_5(\mathfrak{L}_1)|\\ &\quad\times 36|E_6(\mathfrak{L}_1)| \times 81|E_7(\mathfrak{L}_1)| \times 144|E_8(\mathfrak{L}_1)| \times 225|E_9(\mathfrak{L}_1)|\\ &\quad\times 324|E_{10}(\mathfrak{L}_1)| \times 64|E_{11}(\mathfrak{L}_1)|\\ &= 9(1) \times 16(1) \times 36(n+5) \times 100(8) \times 144(2n+8) \times 36(2)\\ &\quad\times 81(3n) \times 144(1) \times 225(12) \times 324(27n-13) \times 64(2).\end{aligned} \tag{21}$$

We obtain the following by making some calculations:

$$\begin{aligned}\Rightarrow \mathrm{HII}_2(\mathfrak{L}_1) &= 168475780918101934080000n(n+5)\\ &\quad(2n+8)(27n-13).\end{aligned} \tag{22}$$

□

Theorem 3. *Consider the magnesium iodide structure MgI_2 of first type; then, the first and second multiplicative universal Zagreb indices are equal to*

$$\begin{aligned}\mathrm{MZ}_1^a(\mathfrak{L}_1) &= 2^{7+10a} \times 3^{2+4a} \times 5^{2a} \times 7^{3a} n(n+5)(2n+8)(27n-13),\\ \mathrm{MZ}_2^a(\mathfrak{L}_1) &= 2^{7+13a} \times 3^{2+10a} \times 5^{2a} \times n(n+5)(2n+8)(27n-13).\end{aligned} \tag{23}$$

Proof. Let $\mathfrak{L}_1$ be the magnesium iodide structure MgI_2 of first type. In Table 1, there is an edge partition of $\mathfrak{L}_1$. From equation (5),

$$\mathrm{MZ}_1^a(\mathfrak{L}_1) = \prod_{rs\in E(\mathfrak{L}_1)} (d_r + d_s)^a. \tag{24}$$

By applying edge partition of Table 1,

$$\begin{aligned}\mathrm{MZ}_1^a(\mathfrak{L}_1) &= 4^a|E_1(\mathfrak{L}_1)| \times 5^a|E_2(\mathfrak{L}_1)| \times 7^a|E_3(\mathfrak{L}_1)| \times 7^a|E_4(\mathfrak{L}_1)| \times 8^a|E_5(\mathfrak{L}_1)|\\ &\quad\times 5^a|E_6(\mathfrak{L}_1)| \times 6^a|E_7(\mathfrak{L}_1)| \times 7^a|E_8(\mathfrak{L}_1)| \times 8^a|E_9(\mathfrak{L}_1)|\\ &\quad\times 9^a|E_{10}(\mathfrak{L}_1)| \times 6^a|E_{11}(\mathfrak{L}_1)|\\ &= 4^a(1) \times 5^a(1) \times 7^a(n+5) \times 7^a(8) \times 8^a(2n+8) \times 5^a(2) \times 6^a(3n)\\ &\quad\times 7^a(1) \times 8^a(12) \times 9^a(27n-13) \times 6^a(2).\end{aligned} \tag{25}$$

We obtain the following by making some calculations:

$$\begin{aligned}\Rightarrow \mathrm{MZ}_1^a(\mathfrak{L}_1) &= 2^{7+10a} \times 3^{2+4a} \times 5^{2a} \times 7^{3a} n(n+5)\\ &\quad(2n+8)(27n-13).\end{aligned} \tag{26}$$

From equation (6),

$$\mathrm{MZ}_2^a(\mathfrak{L}_1) = \prod_{rs\in E(\mathfrak{L}_1)} (d_r \times d_s)^a. \tag{27}$$

By applying edge partition of Table 1,

$$\begin{aligned}\mathrm{MZ}_1^a(\mathfrak{L}_1) &= 3^a|E_1(\mathfrak{L}_1)| \times 4^a|E_2(\mathfrak{L}_1)| \times 6^a|E_3(\mathfrak{L}_1)| \times 10^a|E_4(\mathfrak{L}_1)| \times 12^a|E_5(\mathfrak{L}_1)| \\ &\quad \times 6^a|E_6(\mathfrak{L}_1)| \times 9^a|E_7(\mathfrak{L}_1)| \times 12^a|E_8(\mathfrak{L}_1)| \times 15^a|E_9(\mathfrak{L}_1)| \\ &\quad \times 18^a|E_{10}(\mathfrak{L}_1)| \times 8^a|E_{11}(\mathfrak{L}_1)| \\ &= 3^a(1) \times 4^a(1) \times 6^a(n+5) \times 10^a(8) \times 12^a(2n+8) \times 6^a(2) \\ &\quad \times 9^a(3n)\, 12^a(1) \times 15^a(12) \times 18^a(27n-13) \times 8^a(2).\end{aligned} \tag{28}$$

We obtain the following by making some calculations:

$$\begin{aligned}\Rightarrow \mathrm{MZ}_2^a(\mathfrak{L}_1) = 2^{7+13a} \times 3^{2+10a} \times 5^{2a} \times n(n+5) \\ (2n+8)(27n-13).\end{aligned} \tag{29}$$

□

Theorem 4. *Consider the magnesium iodide structure* MgI_2 *of first type; then, the multiplicative sum and product connectivity indices are equal to*

$$\begin{aligned}\mathrm{SCII}(\mathfrak{L}_1) &= \frac{4}{35\sqrt{7}} n(n+5)(2n+8)(27n-13), \\ \mathrm{PCII}(\mathfrak{L}_1) &= \frac{\sqrt{2}}{135} n(n+5)(2n+8)(27n-13).\end{aligned} \tag{30}$$

Proof. Let $\mathfrak{L}_1$ be the magnesium iodide structure MgI_2 of first type. In Table 1, there is an edge partition of $\mathfrak{L}_1$. From equation (7),

$$\mathrm{SCII}(\mathfrak{L}_1) = \prod_{rs \in E(\Upsilon)} \frac{1}{\sqrt{d_r + d_s}}. \tag{31}$$

By applying edge partition of Table 1,

$$\begin{aligned}\mathrm{SCII}(\mathfrak{L}_1) &= \frac{1}{\sqrt{4}}|E_1(\mathfrak{L}_1)| \times \frac{1}{\sqrt{5}}|E_2(\mathfrak{L}_1)| \times \frac{1}{\sqrt{7}}|E_3(\mathfrak{L}_1)| \times \frac{1}{\sqrt{7}}|E_4(\mathfrak{L}_1)| \\ &\quad \times \frac{1}{\sqrt{8}}|E_5(\mathfrak{L}_1)| \times \frac{1}{\sqrt{5}}|E_6(\mathfrak{L}_1)| \times \frac{1}{\sqrt{6}}|E_7(\mathfrak{L}_1)| \times \frac{1}{\sqrt{7}}|E_8(\mathfrak{L}_1)| \\ &\quad \times \frac{1}{\sqrt{8}}|E_9(\mathfrak{L}_1)| \times \frac{1}{\sqrt{9}}|E_{10}(\mathfrak{L}_1)| \times \frac{1}{\sqrt{6}}|E_{11}(\mathfrak{L}_1)| \\ &= \frac{1}{\sqrt{4}}(1) \times \frac{1}{\sqrt{5}}(1) \times \frac{1}{\sqrt{7}}(n+5) \times \frac{1}{\sqrt{7}}(8) \times \frac{1}{\sqrt{8}}(2n+8) \times \frac{1}{\sqrt{5}}(2) \\ &\quad \times \frac{1}{\sqrt{6}}(3n) \times \frac{1}{\sqrt{7}}(1) \times \frac{1}{\sqrt{8}}(12) \times \frac{1}{\sqrt{9}}(9) \times \frac{1}{\sqrt{6}}(2).\end{aligned} \tag{32}$$

We obtain the following by making some calculations:

$$\Rightarrow \mathrm{SCII}(\mathfrak{L}_1) = \frac{4}{35\sqrt{7}} n(n+5)(2n+8)(27n-13). \tag{33}$$

From equation (8),

$$\mathrm{PCII}(\mathfrak{L}_1) = \prod_{rs \in E(\mathfrak{L}_1)} \frac{1}{\sqrt{d_r \times d_s}}. \tag{34}$$

By applying edge partition of Table 1,

$$\begin{aligned}\mathrm{PCII}(\mathfrak{L}_1) &= \frac{1}{\sqrt{3}}|E_1(\mathfrak{L}_1)| \times \frac{1}{\sqrt{4}}|E_2(\mathfrak{L}_1)| \times \frac{1}{\sqrt{6}}|E_3(\mathfrak{L}_1)| \times \frac{1}{\sqrt{10}}|E_4(\mathfrak{L}_1)| \\ &\quad \times \frac{1}{\sqrt{12}}|E_5(\mathfrak{L}_1)| \times \frac{1}{\sqrt{6}}|E_6(\mathfrak{L}_1)| \times \frac{1}{\sqrt{9}}|E_7(\mathfrak{L}_1)| \times \frac{1}{\sqrt{12}}|E_8(\mathfrak{L}_1)| \\ &\quad \times \frac{1}{\sqrt{15}}|E_9(\mathfrak{L}_1)| \times \frac{1}{\sqrt{18}}|E_{10}(\mathfrak{L}_1)| \times \frac{1}{\sqrt{8}}|E_{11}(\mathfrak{L}_1)| \\ &= \frac{1}{\sqrt{3}}(1) \times \frac{1}{\sqrt{4}}(1) \times \frac{1}{\sqrt{6}}(n+5) \times \frac{1}{\sqrt{10}}(8) \times \frac{1}{\sqrt{12}}(2n+8) \times \frac{1}{\sqrt{6}}(2) \\ &\quad \times \frac{1}{\sqrt{9}}(3n) \times \frac{1}{\sqrt{12}}(1) \times \frac{1}{\sqrt{15}}(12) \times \frac{1}{\sqrt{18}}(9) \times \frac{1}{\sqrt{8}}(2).\end{aligned} \tag{35}$$

We obtain the following by making some calculations:

$$\Rightarrow \mathrm{PCII}(\mathfrak{L}_1) = \frac{\sqrt{2}}{135} n(n+5)(2n+8)(27n-13). \tag{36}$$

□

Theorem 5. *Consider the magnesium iodide structure MgI_2 of first type; then, the multiplicative atom-bond connectivity and geometric-arithmetic indices are equal to*

$$\begin{aligned}\mathrm{ABCII}(\mathfrak{L}_1) &= \frac{16\sqrt{35}}{3} n(n+5)(2n+8)(27n-13), \\ \mathrm{GAII}(\mathfrak{L}_1) &= \frac{442368\sqrt{2}}{1715} n(n+5)(2n+8)(27n-13).\end{aligned} \tag{37}$$

Proof. Let $\mathfrak{L}_1$ be the magnesium iodide structure MgI_2 of first type. In Table 1, there is an edge partition of $\mathfrak{L}_1$. From equation (9),

$$\mathrm{ABCII}(\mathfrak{L}_1) = \prod_{rs \in E\mathrm{MgI}_2} \sqrt{\frac{d_r + d_s - 2}{d_r \times d_s}}. \tag{38}$$

By applying edge partition of Table 1,

$$\begin{aligned}\mathrm{ABCII}(\mathfrak{L}_1) &= \sqrt{\frac{2}{3}}|E_1(\mathfrak{L}_1)| \times \sqrt{\frac{3}{4}}|E_2(\mathfrak{L}_1)| \times \sqrt{\frac{5}{6}}|E_3(\mathfrak{L}_1)| \times \sqrt{\frac{5}{10}}|E_4(\mathfrak{L}_1)| \\ &\quad \times \sqrt{\frac{6}{12}}|E_5(\mathfrak{L}_1)| \times \sqrt{\frac{3}{6}}|E_6(\mathfrak{L}_1)| \times \sqrt{\frac{4}{9}}|E_7(\mathfrak{L}_1)| \times \sqrt{\frac{5}{12}}|E_8(\mathfrak{L}_1)| \\ &\quad \times \sqrt{\frac{6}{15}}|E_9(\mathfrak{L}_1)| \times \sqrt{\frac{7}{18}}|E_{10}(\mathfrak{L}_1)| \times \sqrt{\frac{4}{8}}|E_{11}(\mathfrak{L}_1)| \\ &= \sqrt{\frac{2}{3}}(1) \times \sqrt{\frac{3}{4}}(1) \times \sqrt{\frac{5}{6}}(n+5) \times \sqrt{\frac{5}{10}}(8) \times \sqrt{\frac{6}{12}}(2n+8) \\ &\quad \times \sqrt{\frac{3}{6}}(2)\sqrt{\frac{4}{9}}(3n) \times (1)\sqrt{\frac{5}{12}} \times \sqrt{\frac{6}{15}}(12) \times \sqrt{\frac{7}{18}}(27n-13) \times \sqrt{\frac{4}{8}}(2).\end{aligned} \tag{39}$$

We obtain the following by making some calculations:

$$\Rightarrow \mathrm{ABCII}(\mathfrak{L}_1) = \frac{16\sqrt{35}}{3} n(n+5)(2n+8)(27n-13). \tag{40}$$

From equation (10),

$$\mathrm{GAII}(\mathfrak{L}_1) = \prod_{rs \in E(\mathfrak{L}_1)} \frac{2\sqrt{d_r \times d_s}}{d_r + d_s}. \tag{41}$$

By applying edge partition of Table 1,

$$
\begin{aligned}
\mathrm{GAII}(\mathfrak{L}_1) = {} & \frac{2\sqrt{3}}{4}\left|E_1(\mathfrak{L}_1)\right| \times \frac{2\sqrt{4}}{5}\left|E_2(\mathfrak{L}_1)\right| \times \frac{2\sqrt{6}}{7}\left|E_3(\mathfrak{L}_1)\right| \times \frac{2\sqrt{10}}{7}\left|E_4(\mathfrak{L}_1)\right| \\
& \times \frac{2\sqrt{12}}{8}\left|E_5(\mathfrak{L}_1)\right| \times \frac{2\sqrt{6}}{5}\left|E_6(\mathfrak{L}_1)\right| \frac{2\sqrt{9}}{6}\left|E_7(\mathfrak{L}_1)\right| \times \frac{2\sqrt{12}}{7}\left|E_8(\mathfrak{L}_1)\right| \\
& \times \frac{2\sqrt{15}}{8}\left|E_9(\mathfrak{L}_1)\right| \times \frac{2\sqrt{18}}{9}\left|E_{10}(\mathfrak{L}_1)\right| \times \frac{2\sqrt{8}}{6}\left|E_{11}(\mathfrak{L}_1)\right| \\
= {} & \frac{2\sqrt{3}}{4}(1) \times \frac{2\sqrt{4}}{5}(1) \times \frac{2\sqrt{6}}{7}(n+5) \times \frac{2\sqrt{10}}{7}(8) \times \frac{2\sqrt{12}}{8}(2n+8) \\
& \times \frac{2\sqrt{6}}{5}(2) \times \frac{2\sqrt{9}}{6}(3n) \times \frac{2\sqrt{12}}{7}(1) \times \frac{2\sqrt{15}}{8}(12) \times \frac{2\sqrt{18}}{9}(27n-13) \times \frac{2\sqrt{8}}{6}(2).
\end{aligned} \tag{42}
$$

We obtain the following by making some calculations:

$$
\Rightarrow \mathrm{GAII}(\mathfrak{L}_1) = \frac{442368\sqrt{2}}{1715} n(n+5)(2n+8)(27n-13). \tag{43}
$$

□

Theorem 6. *Consider the magnesium iodide structure MgI_2 of first type; then, the universal multiplicative geometric-arithmetic index is equal to*

$$
\begin{aligned}
\mathrm{GA}^a\mathrm{II}(\mathfrak{L}_1) = {} & 2^{(14+15a/2)} \times 3^{2+a} \times 5^{-a} \times 7^{-3a} n(n+5) \\
& (2n+8)(27n-13).
\end{aligned} \tag{44}
$$

Proof. Let $\mathfrak{L}_1$ be the magnesium iodide structure MgI_2 of first type. In Table 1, there is an edge partition of $\mathfrak{L}_1$. From equation (10),

$$
\mathrm{GA}^a\mathrm{II}(\mathfrak{L}_1) = \prod_{rs \in E(\mathfrak{L}_1)} \frac{2\sqrt{d_r \times d_s}^{\,a}}{d_r + d_s}. \tag{45}
$$

By applying edge partition of Table 1,

$$
\begin{aligned}
\mathrm{GA}^a\mathrm{II}(\mathfrak{L}_1) = {} & \left\{\frac{2\sqrt{3}}{4}\right\}^a \left|E_1(\mathfrak{L}_1)\right| \times \left\{\frac{2\sqrt{4}}{5}\right\}^a \left|E_2(\mathfrak{L}_1)\right| \times \left\{\frac{2\sqrt{6}}{7}\right\}^a \left|E_3(\mathfrak{L}_1)\right| \\
& \times \left\{\frac{2\sqrt{10}}{7}\right\}^a \left|E_4(\mathfrak{L}_1)\right| \times \left|E_5(\mathfrak{L}_1)\right| \left\{\frac{2\sqrt{12}}{8}\right\}^a \times \left\{\frac{2\sqrt{6}}{5}\right\}^a \left|E_6(\mathfrak{L}_1)\right| \\
& \times \left\{\frac{2\sqrt{9}}{6}\right\}^a \left|E_7(\mathfrak{L}_1)\right| \times \left\{\frac{2\sqrt{12}}{7}\right\}^a \left|E_8(\mathfrak{L}_1)\right| \times \left\{\frac{2\sqrt{15}}{8}\right\}^a \left|E_9(\mathfrak{L}_1)\right| \\
& \times \left\{\frac{2\sqrt{18}}{9}\right\}^a \left|E_{10}(\mathfrak{L}_1)\right| \times \left\{\frac{2\sqrt{8}}{6}\right\}^a \left|E_{11}(\mathfrak{L}_1)\right| \\
= {} & \left\{\frac{2\sqrt{3}}{4}\right\}^a (1) \times \left\{\frac{2\sqrt{4}}{5}(1)\right\}^a \times \left\{\frac{2\sqrt{6}}{7}\right\}^a (n+5) \times \left\{\frac{2\sqrt{10}}{7}(8)\right\}^a \\
& \times \left\{\frac{2\sqrt{12}}{8}\right\}^a (2n+8) \times \left\{\frac{2\sqrt{6}}{5}\right\}^a (2) \times \left\{\frac{2\sqrt{9}}{6}\right\}^a (3n) \times \left\{\frac{2\sqrt{12}}{7}\right\}^a (1) \\
& \times \left\{\frac{2\sqrt{15}}{8}\right\}^a (12) \times \left\{\frac{2\sqrt{18}}{9}\right\}^a (27n-13) \times \left\{\frac{2\sqrt{8}}{6}\right\}^a (2).
\end{aligned} \tag{46}
$$

We obtain the following by making some calculations:

$$\Rightarrow GA^{a}II(\mathfrak{L}_1) = 2^{(14+15a/2)} \times 3^{2+a} \times 5^{-a} \times 7^{-3a} n(n+5)(2n+8)(27n-13). \tag{47}$$

□

2.2. Results for the Second Type of Magnesium Iodide Structure. In this section, we compute topological indices such as multiplicative Zagreb indices, multiplicative hyper-Zagreb indices, multiplicative universal Zagreb indices, sum and product connectivity of multiplicative indices, multiplicative atom-bond connectivity index, and multiplicative geometric and universal geometric-arithmetic indices for the second type of magnesium iodide structure.

Theorem 7. *Consider the magnesium iodide structure MgI_2 of second type; then, the second multiplicative Zagreb index is equal to*

$$II_2(\mathfrak{L}_2) = 75582720000(n+5)(2n+8)(3n+1)(27n+7). \tag{48}$$

Table 2: Edge subdivision of $\mathfrak{L}_2 MgI_2$ based on degree of end vertices of each edge for $m = 2n+2$, where $n \in \mathbb{N}$.

(d_r, d_s) where $rs \in E(\mathfrak{L}_2)$	Number of edges
(1, 3)	1
(1, 5)	1
(1, 6)	$n+5$
(2, 2)	5
(2, 5)	2
(2, 6)	$2n+8$
(3, 2)	6
(3, 3)	$3n+1$
(3, 5)	2
(3, 6)	$27n+7$

Proof. Let $\mathfrak{L}_2$ be the magnesium iodide structure MgI_2 of second type. In Table 2, there is an edge partition of $\mathfrak{L}_2$. From equation (2),

$$II_2(\mathfrak{L}_2) = \prod_{rs\in E(\mathfrak{L}_2)} (d_r \times d_s). \tag{49}$$

By applying edge partition of Table 2,

$$\begin{aligned} II_2(\mathfrak{L}_2) &= 3|E_1(\mathfrak{L}_2)| \times 5|E_2(\mathfrak{L}_2)| \times 6|E_3(\mathfrak{L}_2)| \times 4|E_4(\mathfrak{L}_2)| \times 10|E_5(\mathfrak{L}_2)| \\ &\quad \times 12|E_6(\mathfrak{L}_2)| \times 6|E_7(\mathfrak{L}_2)| \times 9|E_8(\mathfrak{L}_2)| \times 15|E_9(\mathfrak{L}_2)| \times 18|E_{10}(\mathfrak{L}_2)| \\ &= 3(1) \times 5(1) \times 6(n+5) \times 4(5) \times 10(2) \times 12(2n+8) \times 6(6) \\ &\quad \times 9(3n+1) \times 15(2) \times 18(27n+7). \end{aligned} \tag{50}$$

We obtain the following by making some calculations:

$$\Rightarrow II_2(\mathfrak{L}_2) = 75582720000(n+5)(2n+8)(3n+1)(27n+7). \tag{51}$$

□

Theorem 8. *Consider the magnesium iodide structure MgI_2 of second type; then, the first and second multiplicative hyper-Zagreb indices are equal to*

$$\begin{aligned} HII_1(\mathfrak{L}_2) &= 792872488009728000(n+5)(2n+8)(3n+1)(27n+7), \\ HII_2(\mathfrak{L}_2) &= 47606229688320000000(n+5)(2n+8)(3n+1)(27n+7). \end{aligned} \tag{52}$$

Proof. Let $\mathfrak{L}_2$ be the magnesium iodide structure MgI_2 of second type. In Table 2, there is an edge partition of $\mathfrak{L}_2$. From equation (3),

$$HII_1(\mathfrak{L}_2) = \prod_{rs\in E(\mathfrak{L}_2)} (d_r + d_s)^2. \tag{53}$$

By applying edge partition of Table 2,

$$\begin{aligned} HII_1(\mathfrak{L}_2) &= 16|E_1(\mathfrak{L}_2)| \times 36|E_2(\mathfrak{L}_2)| \times 49|E_3(\mathfrak{L}_2)| \times 16|E_4(\mathfrak{L}_2)| \times 49|E_5(\mathfrak{L}_2)| \\ &\quad \times 64|E_6(\mathfrak{L}_2)| \times 25|E_7(\mathfrak{L}_2)| \times 36|E_8(\mathfrak{L}_2)| \times 64|E_9(\mathfrak{L}_2)| \times 81|E_{10}(\mathfrak{L}_2)| \\ &= 16(1) \times 36(1) \times 49(n+5) \times 16(5) \times 49(2) \times 64(2n+8) \times 25(6) \\ &\quad \times 36(3n+1) \times 64(2) \times 81(27n+7). \end{aligned} \tag{54}$$

Table 3: Comparison among $\mathrm{II}_2(\mathfrak{L}_1)$, $\mathrm{HII}_1(\mathfrak{L}_1)$, and $\mathrm{HII}_2(\mathfrak{L}_1)$ indices of MgI_2 for $m = 2n+1$, where $n \in \mathbb{N}$.

n	$\mathrm{II}_2(\mathfrak{L}_1)$	$\mathrm{HII}_1(\mathfrak{L}_1)$	$\mathrm{HII}_2(\mathfrak{L}_1)$
2	0.0960×10^{18}	0.0414×10^{26}	0.1160×10^{28}
3	0.3183×10^{18}	0.1331×10^{26}	0.3849×10^{28}
4	0.7623×10^{18}	0.3189×10^{26}	0.9219×10^{28}
5	1.5297×10^{18}	0.6399×10^{26}	1.8498×10^{28}
6	2.7400×10^{18}	1.1461×10^{26}	3.3136×10^{28}
7	4.5312×10^{18}	1.8954×10^{26}	5.4796×10^{28}
8	7.0589×10^{18}	2.9528×10^{26}	8.5365×10^{28}
9	10.4970×10^{18}	4.3910×10^{26}	12.6943×10^{28}
10	15.0376×10^{18}	6.2903×10^{26}	18.1853×10^{28}

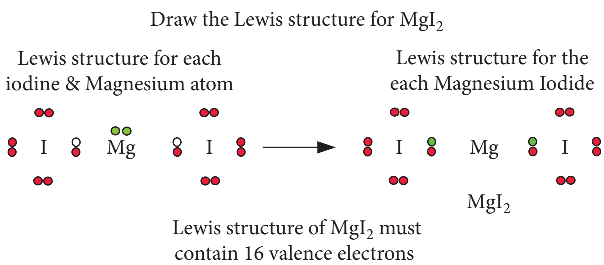

Figure 3: Lewis structure for MgI_2.

Table 4: Comparison among $\mathrm{SCII}(\mathfrak{L}_1)$, $\mathrm{PCII}(\mathfrak{L}_1)$, $\mathrm{ABCII}(\mathfrak{L}_1)$, and $\mathrm{GAII}(\mathfrak{L}_1)$ indices of MgI_2 for $m = 2n+1$, where $n \in \mathbb{N}$.

n	$\mathrm{SCII}(\mathfrak{L}_1)$	$\mathrm{PCII}(\mathfrak{L}_1)$	$\mathrm{ABCII}(\mathfrak{L}_1)$	$\mathrm{GAII}(\mathfrak{L}_1)$
2	2.9754×10^2	0.0721×10^3	0.2173×10^6	0.2512×10^7
3	9.8694×10^2	0.2393×10^3	0.7209×10^6	0.8335×10^7
4	23.6368×10^2	0.5732×10^3	1.7265×10^6	1.9960×10^7
5	47.4291×10^2	1.1502×10^3	3.4645×10^6	4.0053×10^7
6	84.9578×10^2	2.0603×10^3	6.2057×10^6	7.1745×10^7
7	140.4940×10^2	3.4071×10^3	10.2624×10^6	11.8645×10^7
8	218.8690×10^2	5.3079×10^3	15.9872×10^6	18.4831×10^7
9	325.4730×10^2	7.8932×10^3	23.7741×10^6	27.4857×10^7
10	466.2570×10^2	11.3074×10^3	34.0577×10^6	39.3747×10^7

We obtain the following by making some calculations:

$$\Rightarrow \mathrm{HII}_1(\mathfrak{L}_2) = 792872488009728000(n+5)(2n+8)(3n+1)(27n+7). \tag{55}$$

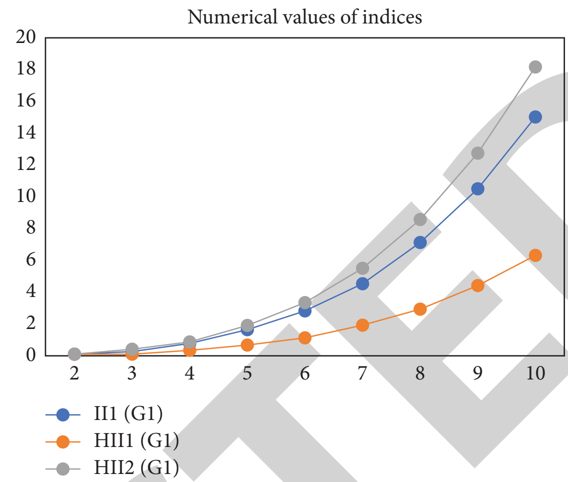

Figure 4: Graphical comparison among $\mathrm{II}_2(\mathfrak{L}_1)$, $\mathrm{HII}_1(\mathfrak{L}_1)$, and $\mathrm{HII}_2(\mathfrak{L}_1)$ indices of MgI_2 for $m = 2n+1$.

Table 5: Comparison among $\mathrm{II}_2(\mathfrak{L}_2)$, $\mathrm{HII}_1(\mathfrak{L}_2)$, and $\mathrm{HII}_2(\mathfrak{L}_2)$ indices of MgI_2 for $m = 2n+2$, where $n \in \mathbb{N}$.

n	$\mathrm{II}_2(\mathfrak{L}_2)$	$\mathrm{HII}_1(\mathfrak{L}_2)$	$\mathrm{HII}_2(\mathfrak{L}_2)$
2	0.2711×10^{16}	0.2849×10^{23}	0.1707×10^{25}
3	0.7449×10^{16}	0.7815×10^{23}	0.4692×10^{25}
4	1.6271×10^{16}	1.7069×10^{23}	1.0249×10^{25}
5	3.0910×10^{16}	3.2425×10^{23}	1.9469×10^{25}
6	5.3393×10^{16}	5.6010×10^{23}	3.3630×10^{25}
7	8.6041×10^{16}	9.0258×10^{23}	5.4193×10^{25}
8	13.1469×10^{16}	13.7912×10^{23}	8.2806×10^{25}
9	19.2585×10^{16}	20.2024×10^{23}	12.1301×10^{25}
10	27.2592×10^{16}	28.5953×10^{23}	17.1694×10^{25}

From equation (4),

$$\mathrm{HII}_2(\mathfrak{L}_2) = \prod_{rs \in E(\mathfrak{L}_2)} (d_r \times d_s)^2. \tag{56}$$

By applying edge partition of Table 2,

$$\begin{aligned} \mathrm{HII}_2(\mathfrak{L}_2) &= 9|E_1(\mathfrak{L}_2)| \times 25|E_{21}(\mathfrak{L}_2)| \times 36|E_3(\mathfrak{L}_2)| \times 16|E_4(\mathfrak{L}_2)| \times 100|E_5(\mathfrak{L}_2)| \\ &\quad \times 144|E_6(\mathfrak{L}_2)| \times 36|E_7(\mathfrak{L}_2)| \times 81|E_8(\mathfrak{L}_2)| \times 225|E_9(\mathfrak{L}_2)| \times 324|E_{10}(\mathfrak{L}_2)|, \\ &= 9(1) \times 25(1) \times 36(n+5) \times 16(5) \times 100(2) \times 144(2n+8) \times 36(6) \\ &\quad \times 81(3n+1) \times 225(2) \times 324(27n+7). \end{aligned} \tag{57}$$

We obtain the following by making some calculations:

$$\Rightarrow \mathrm{HII}_2(\mathfrak{L}_2) = 4760622968832000000(n+5)(2n+8)(3n+1)(27n+7). \tag{58}$$

□

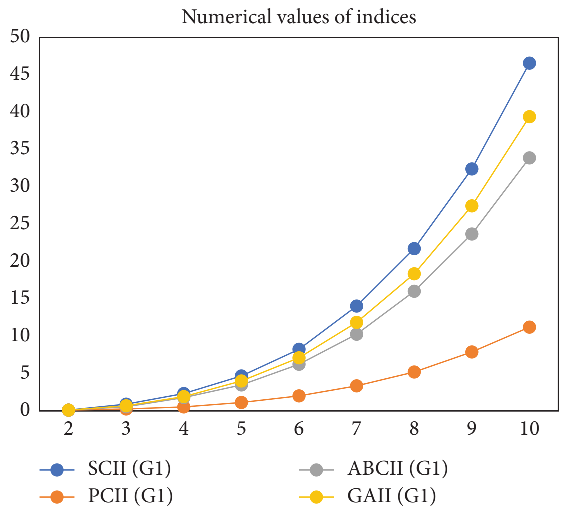

Figure 5: Graphical comparison of $\mathrm{SCII}(\mathfrak{L}_1)$, $\mathrm{PCII}(\mathfrak{L}_1)$, $\mathrm{ABCII}(\mathfrak{L}_1)$, and $\mathrm{GAII}(\mathfrak{L}_1)$ indices of MgI_2 for $m = 2n + 1$.

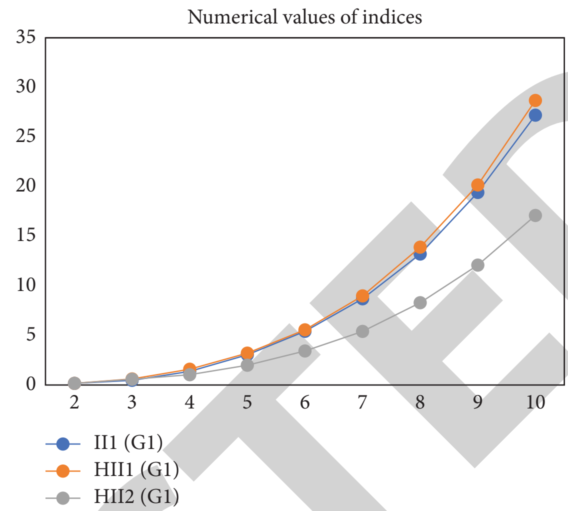

Figure 6: Graphical comparison of $\mathrm{II}_2(\mathfrak{L}_2)$, $\mathrm{HII}_1(\mathfrak{L}_2)$, and $\mathrm{HII}_2(\mathfrak{L}_2)$ indices of MgI_2 for $m = 2n + 2$.

Table 6: Comparison among $\mathrm{SCII}(\mathfrak{L}_2)$, $\mathrm{PCII}(\mathfrak{L}_2)$, $\mathrm{ABCII}(\mathfrak{L}_2)$, and $\mathrm{GAII}(\mathfrak{L}_2)$ indices of MgI_2 for $m = 2n + 2$, where $n \in \mathbb{N}$.

n	$\mathrm{SCII}(\mathfrak{L}_2)$	$\mathrm{PCII}(\mathfrak{L}_2)$	$\mathrm{ABCII}(\mathfrak{L}_2)$	$\mathrm{GAII}(\mathfrak{L}_2)$
2	0.4774×10^3	0.1715×10^3	0.1886×10^6	0.1360×10^7
3	1.3118×10^3	0.4713×10^3	0.5183×10^6	0.3739×10^7
4	2.8653×10^3	1.0293×10^3	1.1321×10^6	0.8167×10^7
5	5.4432×10^3	1.9554×10^3	2.1506×10^6	1.5515×10^7
6	9.4024×10^3	3.3777×10^3	3.7148×10^6	2.6801×10^7
7	15.1516×10^3	5.4430×10^3	5.9869×10^6	4.3189×10^7
8	23.1513×10^3	8.3168×10^3	9.1470×10^6	6.5991×10^7
9	33.9137×10^3	12.1832×10^3	13.3993×10^6	9.6669×10^7
10	48.0028×10^3	17.2445×10^3	18.9658×10^6	13.6830×10^7

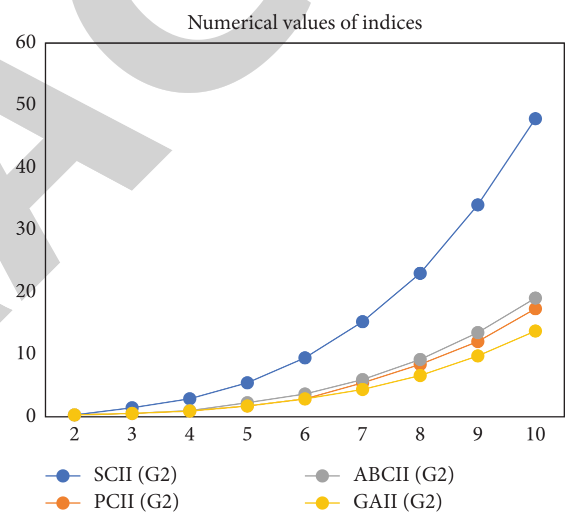

Figure 7: Graphical Comparison among $\mathrm{SCII}(\mathfrak{L}_2)$, $\mathrm{PCII}(\mathfrak{L}_2)$, $\mathrm{ABCII}(\mathfrak{L}_2)$, and $\mathrm{GAII}(\mathfrak{L}_2)$ indices of MgI_2 for $m = 2n + 2$.

Theorem 9. *Consider the magnesium iodide structure MgI_2 of second type; then, the first and second multiplicative universal Zagreb indices are equal to*

$$\begin{aligned}
\mathrm{MZ}_1^a(\mathfrak{L}_2) &= 5^{1+a} \times 7^{2a} \times 24^{1+4a}(n+5)(2n+8)(3n+1)(27n+7),\\
\mathrm{MZ}_2^a(\mathfrak{L}_2) &= 2^{3+8a} \times 3^{1+9a} \times 5^{1+3a} \times (n+5)(2n+8)(3n+1)(27n+7).
\end{aligned} \tag{59}$$

Proof. Let $\mathfrak{L}_2$ be the magnesium iodide structure MgI_2 of second type. In Table 2, there is an edge partition of $\mathfrak{L}_2$. From equation (5),

$$\mathrm{MZ}_1^a(\mathfrak{L}_2) = \prod_{rs \in E(\mathfrak{L}_2)} (d_r + d_s)^a. \tag{60}$$

By applying edge partition of Table 2,

$$\begin{aligned}
\mathrm{MZ}_1^a(\mathfrak{L}_2) &= 4^a|E_1(\mathfrak{L}_2)| \times 6^a|E_2(\mathfrak{L}_2)| \times 7^a|E_3(\mathfrak{L}_2)| \times 4^a|E_4(\mathfrak{L}_2)| \times 7^a|E_5(\mathfrak{L}_2)|\\
&\quad \times 8^a|E_6(\mathfrak{L}_2)| \times 5^a|E_7(\mathfrak{L}_2)| \times 6^a|E_8(\mathfrak{L}_2)| \times 8^a|E_9(\mathfrak{L}_2)| \times 9^a|E_{10}(\mathfrak{L}_2)|\\
&= 4^a(1) \times 6^a(1) \times 7^a(n+5) \times 4^a(5) \times 7^a(2) \times 8^a(2n+8) \times 5^a(6)\\
&\quad \times 6^a(3n+1) \times 8^a(2) \times 9^a(27n+7).
\end{aligned} \tag{61}$$

We obtain the following by making some calculations:

$$\Rightarrow MZ_1^a(\mathfrak{L}_2) = 5^{1+a} \times 7^{2a} \times 24^{1+4a}(n+5)(2n+8) \\ (3n+1)(27n+7). \tag{62}$$

From equation (6),

$$MZ_2^a(\mathfrak{L}_2) = \prod_{rs\in E(\mathfrak{L}_2)} (d_r \times d_s)^a. \tag{63}$$

By applying edge partition of Table 2,

$$\begin{aligned} MZ_2^a(\mathfrak{L}_2) &= 3^a|E_1(\mathfrak{L}_2)| \times 5^a|E_2(\mathfrak{L}_2)| \times 6^a|E_3(\mathfrak{L}_2)| \times 4^a|E_4(\mathfrak{L}_2)| \\ &\quad \times 10^a|E_5(\mathfrak{L}_2)| \times 12^a|E_6(\mathfrak{L}_2)| \times 6^a|E_7(\mathfrak{L}_2)| \times 9^a|E_8(\mathfrak{L}_2)| \\ &\quad \times 15^a|E_9(\mathfrak{L}_2)| \times 18^a|E_{10}(\mathfrak{L}_2)| \\ &= 3^a(1) \times 5^a(1) \times 6^a(n+5) \times 4^a(5) \times 10^a(2) \times 12^a(2n+8) \\ &\quad \times 6^a(6) \times 9^a(3n+1) \times 15^a(2) \times 18^a(27n+7). \end{aligned} \tag{64}$$

We obtain the following by making some calculations:

$$\Rightarrow MZ_2^a(\mathfrak{L}_2) = 2^{3+8a} \times 3^{1+9a} \times 5^{1+3a} \times (n+5)(2n+8) \\ (3n+1)(27n+7). \tag{65}$$

□

Theorem 10. *Consider the magnesium iodide structure MgI_2 of second type; then, the multiplicative sum and product connectivity indices are equal to*

$$\begin{aligned} SCII(\mathfrak{L}_2) &= \frac{1}{168\sqrt{5}}(n+5)(2n+8)(3n+1)(27n+7), \\ PCII(\mathfrak{L}_2) &= \frac{1}{54\sqrt{15}}(n+5)(2n+8)(3n+1)(27n+7). \end{aligned} \tag{66}$$

Proof. Let $\mathfrak{L}_2$ be the magnesium iodide structure MgI_2 of second type. In Table 2, there is an edge partition of $\mathfrak{L}_2$. From equation (7),

$$SCII(\mathfrak{L}_2) = \prod_{rs\in E(\mathfrak{L}_2)} \frac{1}{\sqrt{d_r + d_s}}. \tag{67}$$

By applying edge partition of Table 2,

$$\begin{aligned} SCII(\mathfrak{L}_2) &= \frac{1}{\sqrt{4}}|E_1(\mathfrak{L}_2)| \times \frac{1}{\sqrt{6}}|E_2(\mathfrak{L}_2)| \times \frac{1}{\sqrt{7}}|E_3(\mathfrak{L}_2)| \times \frac{1}{\sqrt{4}}|E_4(\mathfrak{L}_2)| \\ &\quad \times \frac{1}{\sqrt{7}}|E_5(\mathfrak{L}_2)| \times \frac{1}{\sqrt{8}}|E_6(\mathfrak{L}_2)| \times \frac{1}{\sqrt{5}}|E_7(\mathfrak{L}_2)| \times \frac{1}{\sqrt{6}}|E_8(\mathfrak{L}_2)| \\ &\quad \times \frac{1}{\sqrt{8}}|E_9(\mathfrak{L}_2)| \times \frac{1}{\sqrt{9}}|E_{10}(\mathfrak{L}_2)| \\ &= \frac{1}{\sqrt{4}}(1) \times \frac{1}{\sqrt{6}}(1) \times \frac{1}{\sqrt{7}}(n+5) \times \frac{1}{\sqrt{4}}(5) \times \frac{1}{\sqrt{7}}(2) \times \frac{1}{\sqrt{8}}(2n+8) \\ &\quad \times \frac{1}{\sqrt{5}}(6) \times \frac{1}{\sqrt{6}}(3n+1) \times \frac{1}{\sqrt{8}}(2) \times \frac{1}{\sqrt{9}}(27n+7). \end{aligned} \tag{68}$$

We obtain the following by making some calculations:

$$\Rightarrow SCII(\mathfrak{L}_2) = \frac{1}{168\sqrt{5}}(n+5)(2n+8)(3n+1)(27n+7). \tag{69}$$

From equation (8),

$$PCII(\mathfrak{L}_2) = \prod_{rs\in E(\mathfrak{L}_2)} \frac{1}{\sqrt{d_r \times d_s}}. \tag{70}$$

By applying edge partition of Table 2,

$$\begin{aligned}
\mathrm{PCII}(\mathfrak{L}_2) &= \frac{1}{\sqrt{3}}\left|E_1(\mathfrak{L}_2)\right| \times \frac{1}{\sqrt{5}}\left|E_2(\mathfrak{L}_2)\right| \times \frac{1}{\sqrt{6}}\left|E_3(\mathfrak{L}_2)\right| \times \frac{1}{\sqrt{4}}\left|E_4(\mathfrak{L}_2)\right| \\
&\quad \times \frac{1}{\sqrt{10}}\left|E_5(\mathfrak{L}_2)\right| \times \frac{1}{\sqrt{12}}\left|E_6(\mathfrak{L}_2)\right| \times \frac{1}{\sqrt{6}}\left|E_7(\mathfrak{L}_2)\right| \times \frac{1}{\sqrt{9}}\left|E_7(\mathfrak{L}_2)\right| \\
&\quad \times \frac{1}{\sqrt{15}}\left|E_9(\mathfrak{L}_2)\right| \times \frac{1}{\sqrt{18}}\left|E_{10}(\mathfrak{L}_2)\right| \\
&= \frac{1}{\sqrt{3}}(1) \times \frac{1}{\sqrt{5}}(1) \times \frac{1}{\sqrt{6}}(n+5) \times \frac{1}{\sqrt{4}}(5) \times \frac{1}{\sqrt{10}}(2) \\
&\quad \times \frac{1}{\sqrt{12}}(2n+8) \times \frac{1}{\sqrt{6}}(6) \times \frac{1}{\sqrt{9}}(3n+1) \times \frac{1}{\sqrt{15}}(2) \times \frac{1}{\sqrt{18}}(27n+7).
\end{aligned} \tag{71}$$

We obtain the following by making some calculations:

$$\Rightarrow \mathrm{PCII}(\mathfrak{L}_2) = \frac{1}{54\sqrt{15}}(n+5)(2n+8)(3n+1)(27n+7). \tag{72}$$

□

Theorem 11. *Consider the magnesium iodide structure MgI_2 of second type; then, the multiplicative atom-bond connectivity index and geometric-arithmetic index are equal to*

$$\begin{aligned}
\mathrm{ABCII}(\mathfrak{L}_2) &= \frac{8\sqrt{35}}{9}(n+5)(2n+8)(3n+1)(27n+7), \\
\mathrm{GAII}(\mathfrak{L}_2) &= \frac{480\sqrt{15}}{49}(n+5)(2n+8)(3n+1)(27n+7).
\end{aligned} \tag{73}$$

Proof. Let $\mathfrak{L}_2$ be the magnesium iodide structure MgI_2 of second type. In Table 2, there is an edge partition of $\mathfrak{L}_2$. From equation (9),

$$\mathrm{ABCII}(\mathfrak{L}_2) = \prod_{rs \in E(\mathfrak{L}_2)} \sqrt{\frac{d_r + d_s - 2}{d_r \times d_s}}. \tag{74}$$

By applying edge partition of Table 2,

$$\begin{aligned}
\mathrm{ABCII}(\mathfrak{L}_2) &= \sqrt{\frac{2}{3}}\left|E_1(\mathfrak{L}_2)\right| \times \sqrt{\frac{4}{5}}\left|E_2(\mathfrak{L}_2)\right| \times \sqrt{\frac{5}{6}}\left|E_3(\mathfrak{L}_2)\right| \times \sqrt{\frac{2}{4}}\left|E_4(\mathfrak{L}_2)\right| \\
&\quad \times \sqrt{\frac{5}{10}}\left|E_5(\mathfrak{L}_2)\right| \times \sqrt{\frac{6}{12}}\left|E_6(\mathfrak{L}_2)\right| \sqrt{\frac{3}{6}}\left|E_7(\mathfrak{L}_2)\right| \times \sqrt{\frac{4}{6}}\left|E_8(\mathfrak{L}_2)\right| \\
&\quad \times \sqrt{\frac{6}{15}}\left|E_9(\mathfrak{L}_2)\right| \times \sqrt{\frac{7}{18}}\left|E_{10}(\mathfrak{L}_2)\right| \\
&= \sqrt{\frac{2}{3}}(1) \times \sqrt{\frac{4}{5}}(1) \times \sqrt{\frac{5}{6}}(n+5) \times \sqrt{\frac{2}{4}}(5) \times \sqrt{\frac{5}{10}}(2) \\
&\quad \times \sqrt{\frac{6}{12}}(2n+8)\sqrt{\frac{3}{6}}(6) \times (3n+1)\sqrt{\frac{4}{9}} \times \sqrt{\frac{6}{15}}(2) \times \sqrt{\frac{7}{18}}(27n+7).
\end{aligned} \tag{75}$$

We obtain the following by making some calculations:

$$\Rightarrow \mathrm{ABCII}(\mathfrak{L}_2) = \frac{8\sqrt{35}}{9}(n+5)(2n+8)(3n+1)(27n+7). \tag{76}$$

From equation (9),

$$\mathrm{GAII}(\mathfrak{L}_2) = \prod_{rs \in E(\mathfrak{L}_2)} \frac{2\sqrt{d_r \times d_s}}{d_r + d_s}. \tag{77}$$

By applying edge partition of Table 2,

$$\begin{aligned}
\mathrm{GAII}(\mathfrak{L}_2) &= \frac{2\sqrt{3}}{4}|E_1(\mathfrak{L}_2)| \times \frac{2\sqrt{5}}{6}|E_2(\mathfrak{L}_2)| \times \frac{2\sqrt{6}}{7}|E_3(\mathfrak{L}_2)| \times \frac{2\sqrt{4}}{4}|E_4(\mathfrak{L}_2)| \\
&\times \frac{2\sqrt{10}}{7}|E_5(\mathfrak{L}_2)| \times \frac{2\sqrt{12}}{8}|E_6(\mathfrak{L}_2)| \times \frac{2\sqrt{6}}{5}|E_7(\mathfrak{L}_2)| \times \frac{2\sqrt{9}}{6}|E_8(\mathfrak{L}_2)| \\
&\times \frac{2\sqrt{15}}{8}|E_9(\mathfrak{L}_2)| \times \frac{2\sqrt{18}}{9}|E_{10}(\mathfrak{L}_2)| \\
&= \frac{2\sqrt{3}}{4}(1) \times \frac{2\sqrt{5}}{6}(1) \times \frac{2\sqrt{6}}{7}(n+5) \times \frac{2\sqrt{4}}{4}(5) \times \frac{2\sqrt{10}}{7}(2) \\
&\times \frac{2\sqrt{12}}{8}(2n+8)\frac{2\sqrt{6}}{5}(6) \times \frac{2\sqrt{9}}{6}(3n+1) \times \frac{2\sqrt{15}}{8}(2) \times \frac{2\sqrt{18}}{9}(27n+7).
\end{aligned} \tag{78}$$

We obtain the following by making some calculations:

$$\Rightarrow \mathrm{GAII}(\mathfrak{L}_2) = \frac{480\sqrt{15}}{49}(n+5)(2n+8)(3n+1)(27n+7). \tag{79}$$

□

Theorem 12. *Consider the magnesium iodide structure MgI_2 of second type; then, the universal multiplicative geometric-arithmetic index is equal to*

$$\begin{aligned}
\mathrm{GA}^a\mathrm{II}(\mathfrak{L}_2) &= 2^{3+2a} \times 7^{-2a} \times 15^{(2+a)/2}(n+5)(2n+8) \\
&(3n+1)(27n+7).
\end{aligned} \tag{80}$$

Proof. Let $\mathfrak{L}_2$ be the magnesium iodide structure MgI_2 of second type. In Table 2, there is an edge partition of $\mathfrak{L}_2$. From equation (10),

$$\mathrm{GA}^a\mathrm{II}(\mathfrak{L}_2) = \prod_{rs\in E(\mathfrak{L}_2)} \frac{2\sqrt{d_r \times d_s}}{d_r + d_s}^a. \tag{81}$$

By applying edge partition of Table 2,

$$\begin{aligned}
\mathrm{GA}^a\mathrm{II}(\mathfrak{L}_2) &= \left(\frac{2\sqrt{3}}{4}\right)^a |E_1(\mathfrak{L}_2)| \times \left(\frac{2\sqrt{5}}{6}\right)^a |E_2(\mathfrak{L}_2)| \times \left(\frac{2\sqrt{6}}{7}\right)^a |E_3(\mathfrak{L}_2)| \\
&\times \left(\frac{2\sqrt{4}}{4}\right)^a |E_4(\mathfrak{L}_2)| \times \left(\frac{2\sqrt{10}}{7}\right)^a |E_5(\mathfrak{L}_2)| \times \left(\frac{2\sqrt{12}}{8}\right)^a |E_6(\mathfrak{L}_2)| \\
&\times \left(\frac{2\sqrt{6}}{5}\right)^a |E_7(\mathfrak{L}_2)| \times \left(\frac{2\sqrt{9}}{6}\right)^a |E_8(\mathfrak{L}_2)| \times \left(\frac{2\sqrt{15}}{8}\right)^a |E_9(\mathfrak{L}_2)| \times \left(\frac{2\sqrt{18}}{9}\right)^a |E_{10}(\mathfrak{L}_2)| \\
&= \left(\frac{2\sqrt{3}}{4}\right)^a (1) \times \left(\frac{2\sqrt{5}}{6}\right)^a (1) \times \left(\frac{2\sqrt{6}}{7}\right)^a (n+5) \times \left(\frac{2\sqrt{4}}{4}\right)^a (5) \\
&\times \left(\frac{2\sqrt{10}}{7}\right)^a (2) \times \left(\frac{2\sqrt{12}}{8}\right)^a (2n+8)\left(\frac{2\sqrt{6}}{5}\right)^a (6) \\
&\times \left(\frac{2\sqrt{9}}{6}\right)^a (3n+1) \times \left(\frac{2\sqrt{15}}{8}\right)^a (2) \times \left(\frac{2\sqrt{18}}{9}\right)^a (27n+7).
\end{aligned} \tag{82}$$

We obtain the following by making some calculations:

$$\Rightarrow \mathrm{GA}^{a}\mathrm{II}(\mathfrak{L}_2) = 2^{3+2a} \times 7^{-2a} \times 15^{(2+a)/2}(n+5)(2n+8)(3n+1)(27n+7). \tag{83}$$

□

3. Numerical and Graphical Comparison

In this section, we compute all the indices numerically and present the result in the following tables.

(i) For the comparison of $\mathrm{II}_2(\mathfrak{L}_1)$, $\mathrm{HII}_1(\mathfrak{L}_1)$, and $\mathrm{HII}_2(\mathfrak{L}_1)$ indices of MgI_2 for $m = 2n+1$, where $n \in \mathbb{N}$, in Table 3, indices for various n values have been calculated. One can clearly see that all the indices are increasing in order for increasing values of n. Graphical representations of these topological indices are shown in Figure 3 for different values of n.

(ii) For the comparison of $\mathrm{SCII}(\mathfrak{L}_1)$, $\mathrm{PCII}(\mathfrak{L}_1)$, $\mathrm{ABCII}(\mathfrak{L}_1)$, and $\mathrm{GAII}(\mathfrak{L}_1)$ indices of MgI_2 for $m = 2n+1$, where $n \in \mathbb{N}$, numerically, we computed some indices for different values of n. In Table 4, indices for various n values have been calculated. One can clearly see that all the indices are increasing in order for increasing values of n. Graphical representations of these topological indices are shown in Figure 4 for different values of n.

(iii) For the comparison of $\mathrm{II}_2(\mathfrak{L}_2)$, $\mathrm{HII}_1(\mathfrak{L}_2)$, and $\mathrm{HII}_2(\mathfrak{L}_2)$ indices of MgI_2 for $m = 2n+2$, where $n \in \mathbb{N}$, in Table 5, indices for various n values have been calculated. One can clearly see that all the indices are increasing in order for increasing values of n. Graphical representations of these topological indices are shown in Figure 5 for different values of n.

(iv) For the comparison of $\mathrm{SCII}(\mathfrak{L}_2)$, $\mathrm{PCII}(\mathfrak{L}_2)$, $\mathrm{ABCII}(\mathfrak{L}_2)$, and $\mathrm{GAII}(\mathfrak{L}_2)$ indices of MgI_2 for $m = 2n+2$, where $n \in \mathbb{N}$, numerically, we computed some indices for different values of n. In Table 6, indices for various n values have been calculated. One can clearly see that all the indices are increasing in order for increasing values of n. Graphical representations of these topological indices are shown in Figure 6 for different values of n.

4. Discussion

Since topological indices play a vital role in various fields of science such as software engineering, medication, and pharmaceutical industry, their numerical values and graphical representations are very much important for researchers. Here, we calculate some exact values of multiplicative degree-based indices of a famous crystalline structure, magnesium iodide (MgI_2). Furthermore, we construct Tables 3–6 and Figures 4–7 to estimate the degree-based topological indices for various values of n. From tables and figures, we can see that as n increases, the degree-based indices of these networks also increase.

5. Conclusion

In this paper, we have constructed the crystalline graph of magnesium iodide with different approaches of graph theory. We subdivided the graph in even and odd vertices. We computed the multiplicative topological indices such as multiplicative Zagreb indices, multiplicative hyper-Zagreb indices, multiplicative universal Zagreb indices, sum and product connectivity of multiplicative indices, multiplicative atom-bond connectivity index, and multiplicative geometric-arithmetic index of MgI_2 structures in this research for the very first time. In addition, we have given general formulation for those indices that may be very beneficial while analyzing the underlying topologies.

In future, we are interested to design some new architectures/networks and then study their topological indices, which will be quite helpful to understand their underlying topologies.

Data Availability

No data were used to support this study.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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