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Utilizing Mnemonics to Enhance the First-Year Geodetic Engineering Students Retention of Gas Laws' Formula

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Abstract: ***Understanding gas laws requires familiarity with equations that model gas behaviour across varying conditions. Yet, many learners experience difficulty remembering and using these equations consistently. This study aims to utilize mnemonics to enhance the first-year geodetic engineering students' retention of gas laws' formulas. By incorporating mnemonic strategies, the research seeks to simplify complex concepts and improve long-term recall and application of these formulas. The researchers focused on specific research questions that serve as the basis for their study: (1) Determine the effectiveness of mnemonics as a pedagogical tool in mastering the Gas Laws' Formulas, (2) Examine the students' perception of the use of mnemonics in learning Gas Laws formulas in terms of motivation, engagement, and ease of learning, and(3) Evaluate the efficiency of utilizing mnemonic tools as a learning strategy to enhance students' mastery of Gas Laws formulas. Quantitative research design was used for this research study to formulate self- made questionnaires validated by the subject matter expert and used for gathering data. The initial week focused on questionnaire preparation and expert review, while data collection occurred in the second week through computer-assisted personal interviews (CAPI) to ensure accuracy and reliability. Data analysis utilized measures of central tendency on a four-point Likert scale. The findings indicate that the use of mnemonic devices had a positive impact on students' ability to master gas laws formulas. The researchers suggest that mnemonics enhanced the efficiency of learning and recalling gas laws' formulas among first-year geodetic engineering students.***
Keywords: Gas Laws' Formula, Geodetic Engineers, Mnemonics, and Retention

I. INTRODUCTION

All-throughout the years, memorization of certain formulas has become one of the most challenging parts of being a student. Each value and constant is required to retain in the mind of students in order to execute the correct solution in a problem. The hindrance of memorization creates a hassle for every student when it comes to assessing problem-solution based examinations due to multiple factors of struggling in studying. Gas Laws' specifically, this concept has five (5) specific formulas with different values that are needed to determine. Gas behavior is described by key laws, Boyle's Law states that pressure and volume are inversely related at constant temperature (PV = k). Charles's Law shows that volume is directly proportional to temperature at constant pressure (V/T = k). These combine into the Ideal Gas Law: PV = nRT, where n is the number of moles and R is the gas constant. Though meant for ideal gases, this law closely models real gas behaviour (Gregersen, E., 2021). Together with the other concept of chemistry that deals with complex calculations, students may encounter difficulties and hardships to remember such formulas when assessing the activities. Moreover, the amplification of memorizing capabilities is further enhanced with the introduction of the mnemonic method. A mnemonic device is a cognitive tool, strategy, or technique designed to support students in retaining and recalling information more effectively. It works by simplifying complex or abstract content and converting it into a more familiar, organized, or memorable format—often through patterns, associations, or visual aids (Lukie, M.P., 2016).

Additionally, learning as a First - Year Engineering Student comes with struggles and challenges. The hectic schedules and complex learning materials can be overwhelming as a student. The transition to university life is challenging, involving academic adaptation and social and lifestyle adjustment, so it is no surprise that attrition is at its highest in the first year of attending university (Curtis, F. & Feng, D., 2021). It is authenticated that studying in Tertiary Education is both eccentric and a struggle in the life of the students.

This study aims to develop simplified yet effective strategies to enhance students' cognitive skills, particularly in mastering the formulas associated with the Gas Laws.

By incorporating techniques such as mnemonic comprehension and improved long-term retention. The goal is not only to aid memorization but also to strengthen students' ability to apply these concepts critically in problem-solving situations, which is essential for success in higher-level chemistry courses and related scientific fields.

Furthermore, in accordance with the assistance and support on the construction of the Sustainable Development Goals (SDG's) – this study aims to provide assistance particularly on Goal 4 which discusses Quality Education. This research intends to contribute by identifying and addressing key challenges within educational systems, promoting inclusive and equitable access to learning opportunities, and fostering lifelong learning for all. Through evidence-based analysis and strategic recommendations, the study aims to support in aligning educational practices with the broader objectives of sustainable development.

II. OBJECTIVES

This study investigates the efficacy of mnemonics as a pedagogical tool for first-year geodetic engineering students in mastering Gas Laws Formulas. Specifically, it addresses the following key problems:

1) Determine the effectiveness of mnemonics as a pedagogical tool in mastering the Gas Laws' Formulas.

2) Examine the students' perception of the use of mnemonics in learning Gas Laws formulas in terms of:

- Motivation
- Engagement
- Ease of Learning

3) Evaluate the efficiency of utilizing mnemonic tools as a learning strategy to enhance students mastery of Gas Laws formula.

III. MATERIALS AND METHODS

A. Research Design

The researchers used descriptive research design to study the experiences of third-year science major students in asynchronous and synchronous learning modalities. This research design looks at the characteristics of the population and identifies the problems that exist within an organization, and allows for adequate interpretation of gathered facts using questionnaires. It was chosen because it best suited the objectives of the study.

B. Subjects of the Study

This study used first year BSGE students from the Alanginan campus of Batangas State University as respondents. Geodetic Engineering students are reliable sources of data because they directly study gas laws in their foundational courses, making them well-positioned to offer opinions regarding how mnemonic strategies affect their retention of these formulas. The distribution of respondents per campus is presented in table 1.

Table 1. Distribution of Respondents

Geodetic Engineering Students	Population of Students
BS GEODENG 1101	15
BS GEODENG 1102	15
Total	30

C. Data Gathering Instrument

A questionnaire made by the researcher was the main way that information was gathered for this study.

Questionnaire. The survey questionnaire was used to gather the students' perceptions regarding the use of mnemonic strategies in learning gas laws formulas through google forms. The questionnaire will be composed of Likert-scale items that focus on students' motivation, engagement, confidence, and how useful they find the mnemonic tools in remembering the formulas. It will also include simple questions about their study habits and how they usually remember scientific concepts.

Assessment. The assessment test was also used as part of the research instruments. This will include a pre-test and post-test to measure the level of understanding and retention of gas laws before and after using mnemonic strategies. The pre-test will check the students' initial knowledge about Boyle's Law, Charles' Law, Avogadro's Law, and the Ideal Gas Law. After the intervention, the post-test will be given to see if there is an improvement in their scores.

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Mnemonic Devices. Mnemonic tools were also utilized as the main instructional aid in this research. These mnemonics will include simple memory tricks such as acronyms, short phrases, and visual aids designed specifically for the different gas laws. The tools will help students connect key concepts and formulas in a way that is easier to remember. For example, acronyms may be used to recall formula parts, and short catchy phrases may help students remember the relationship between variables. These mnemonic tools will be introduced during lessons and practiced by the students throughout the learning period.

Scoring of Responses. The data distribution was displayed using tables and graphs. The researchers utilized descriptive analysis that focuses on summarizing and presenting data using descriptive statistics, which helps in understanding the distribution and characteristics of the overall data that is gathered (Neo, 2024). This was used to summarize the measurements and descriptions of data samples in order to describe the characteristics of data sets.

Rating Scale	Interpretation
3.21 – 4.00	Strongly Agree
2.52 – 3.20	Agree
1.76 – 2.50	Disagree
1.00 – 1.75	Strongly Disagree

D. Data Gathering Procedure

The research's initial week will be allocated for preparation, while the subsequent week will be dedicated to the actual collection of data. The researchers will create the research's questions during the preparation stage. These questionnaires will be reviewed by experts to ensure their accuracy and reliability.

The second week marks the start of the data collection phase and will last until the last week of the period. The researchers will use computer-assisted personal interview (CAPI) as the main type of data collection. Here both participants and researchers enter responses and then record them using digital systems. Researchers will guide participants in answering questions and ensure the accuracy and reliability of the data gathered. Within the available time frame, researchers shall work in two groups and gather data from two blocks of respondents simultaneously.

IV. RESULTS AND DISCUSSION

A. The Effectiveness of Mnemonics in Mastering the Gas Laws' Formulas.

The effectiveness of mnemonics as a pedagogical tool in helping first year BSGE students master the Gas Laws' formulas was assessed.

Table 2. The effectiveness of mnemonics as a pedagogical tool in mastering the Gas Laws' Formulas.

INDICATORS	MEAN	INTERPRETATION
Using mnemonics helps me remember Gas Laws formulas more easily.	3.10	Agree
I can recall Gas Laws formulas faster when I use mnemonics.	3.13	Agree
Mnemonics help me retain the formulas longer than simple memorization.	2.80	Agree
I forget Gas Laws formulas less often when I use mnemonics.	2.80	Agree
I feel more confident recalling Gas Laws formulas after using mnemonics.	3.03	Agree
OVERALL	2.97	Agree

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Table 2 presents the mean retention enhancement of the respondents on mnemonics as a pedagogical tool in mastering gas law formulas. The table shows that most of the 30 respondents agree. The first row with a mean of 3.10, which is interpreted as "agree," means that using mnemonics helped the respondents remember gas laws formulas more easily. Subsequently, the second row had a mean of 3.13, which is interpreted as "agree," meaning the respondents recalled gas law formulas faster when they used mnemonics. In addition, the third row with a mean of 2.80 that is interpreted as "agree" means mnemonics helped the respondents retain the formulas longer than simple memorization. Moreover, the fourth mean resulted in 2.80, which is interpreted as "agree," meaning that the respondents forget gas laws formulas less often when I use mnemonics. Lastly, the fifth mean corresponds to 3.03, interpreted as "agree," meaning that they felt more confident recalling gas laws formulas after using mnemonics. Overall, the total mean of the response is 2.97, which indicates the respondents generally feel the respondents on mnemonics as a pedagogical tool in mastering gas law formulas.

These results align with previous research highlighting the benefits of mnemonics in learning and motivation. Mnemonics strengthen long-term retention and improve recall, enabling students to use their working memory more efficiently for higher-order cognitive tasks such as applying, analysing, evaluating, and creating (Munusamy et al., 2025). Additionally, by helping students internalize fundamental formulas, mnemonics provide a mental framework that allows them to access and apply these concepts accurately when needed (Ng & Wan Mohamad, 2023). This suggests that mnemonics not only aid memory but also enhance students' retention of gas law formulas.

B. Students' Perception of the use of mnemonics in learning Gas Laws formulas

The students' perception of the use of mnemonics in learning Gas Laws formulas in terms of Motivation, Engagement, Ease of Learning was assessed.

1) Motivation

Table 3. the students' perception of the use of mnemonics in learning Gas Laws formulas in Motivation

INDICATORS	MEAN	INTERPRETATION
Mnemonics make learning Gas Laws more interesting	3.10	Agree
I feel more motivated to study when mnemonics are used in class.	3.10	Agree
Mnemonics make me more confident in learning difficult formulas.	3.26	Strongly Agree
I am more eager to participate in activities related to Gas Laws when mnemonics are introduced.	3.06	Agree
Mnemonics encourage me to review and study the lessons even outside class hours.	2.93	Agree
OVERALL	3.09	Agree

Table 3 presents the mean perception of the students on the use of mnemonics in learning gas law formulas in terms of their motivation. The table shows that most of the 30 respondents agree. The first row with a mean of 3.10, which is interpreted as "agree," means that mnemonics make learning gas laws more interesting for the respondents. Subsequently, the second row, with a mean of 3.10, is interpreted as "agree," meaning that the respondents felt more motivated to study when mnemonics are used in class. In addition, the third row, with a mean of 3.26, which is interpreted as "strongly agree," says that the mnemonics made them more confident in learning difficult formulas. Moreover, the fourth indicator, with a mean of 3.06, which is interpreted as "agree," suggests that they were more eager to participate in activities related to gas laws when mnemonics were introduced. Lastly, the fifth mean corresponds to 2.93, interpreted as "agree," which means that mnemonics encourage them to review and study the lessons even outside class hours. Overall, the total mean of the response is 3.09, which indicates the respondents agree that the respondents are motivated to learn when using mnemonics.

The respondents' perception of mnemonics in Table 2 is supported by previous studies highlighting its motivational benefits in learning. Most students agreed that mnemonics made learning gas law formulas more interesting, increased their confidence in handling difficult formulas, and encouraged participation and review outside class. This aligns with research indicating that mnemonic techniques foster positive attitudes toward science subjects, help students conceptualize complex problems, and promote creativity by enabling learners to generate solutions effectively (Hema, 2023). By motivating students and supporting understanding, mnemonics not only improve engagement but also enhance their ability to apply and retain scientific concepts.

2) Engagement

Table 4. the students' perception of the use of mnemonics in learning Gas Laws formulas in Engagement

INDICATORS	MEAN	INTERPRETATION
I participate more actively in lessons when mnemonics are used.	2.90	Agree
Mnemonics make the class more enjoyable and interactive.	3.33	Strongly Agree
I pay more attention during discussions that use mnemonics.	2.83	Agree
I enjoy sharing or creating my own mnemonics during class activities.	3.06	Agree
Mnemonics help me stay focused throughout the lesson.	2.80	Agree
OVERALL	2.98	Agree

Table 4 presents the mean perception of the students on the use of mnemonics in learning gas law formulas in terms of their engagement. The table shows that most of the 30 respondents agree. The first indicator, with a mean of 2.90 interpreted as "agree," says that the respondents participated more actively in lessons when mnemonics are used. In addition, the second indicator has a mean of 3.33, which is interpreted as "strongly agree," meaning that mnemonics made the class more enjoyable and interactive. Following that, the third indicator, which has a mean of 3.06, which is interpreted as "agree," suggests that they paid more attention during discussions that use mnemonics. Moreover, the fourth indicator, with a mean of 2.80, which is interpreted as "agree," suggests that they enjoyed sharing or creating their own mnemonics during class activities. Lastly, the fifth indicator, the computed mean, was 2.80, interpreted as "agree," meaning mnemonics helped them stay focused throughout the lesson. Overall, the average score of 2.98 indicates that respondents are engaged in learning and view mnemonic devices as effective tools that help sustain their engagement. The respondents' perception of mnemonics in terms of engagement is supported by previous research highlighting their role in making lessons more interactive and enjoyable. According to Olivete et al. (2025), using mnemonic devices in science education improves students' retention and sustains their interest by transforming complex concepts into memorable patterns. This aligns with the respondents' feedback that mnemonics encouraged active participation, closer attention during discussions, and enjoyment in creating or sharing their own mnemonics. These findings suggest that mnemonics not only aid memory and comprehension but also enhance student engagement, making learning more meaningful and interactive.

3) Ease of Learning

Table 5. the students' perception of the use of mnemonics in learning Gas Laws formulas in Ease of Learning

INDICATORS	MEAN	INTERPRETATION
Mnemonics make learning Gas Laws formulas easier.	2.90	Agree
I understand the formulas faster when mnemonics are used.	3.10	Agree
Mnemonics help me simplify complex formulas.	3.2	Agree
Overall, mnemonics make studying Gas Laws less stressful.	2.80	Agree
I can recall and apply Gas Laws formulas more accurately because of mnemonics.	3.03	Agree
OVERALL	3.01	Agree

Table 5 presents the mean scores on the respondents' perception of mnemonics in relation to the ease of learning Gas Laws formulas. The table shows that most of the respondents agree on the positive effects of mnemonics. The first indicator with a mean of 2.90, interpreted as Agree, suggests that mnemonics made learning Gas Laws formulas easier for the respondents. The second indicator, with a mean of 3.10 and also interpreted as Agree, implies that the respondents understood the formulas faster when mnemonics were used. The third row, which obtained a mean of 3.20, interpreted as Agree, indicates that mnemonics helped simplify complex formulas for the learners. Moreover, the fourth row with a mean of 2.80, interpreted as Agree, reveals that mnemonics reduced the stress students experienced when studying Gas Laws. Lastly, the fifth indicator with a mean of 3.03, interpreted as Agree, shows that students felt they could recall and apply formulas more accurately because of mnemonic strategies. On the whole, the average of 3.01 is the total indicator of the fact that the respondents tend to believe that mnemonic is a powerful tool that facilitates their learning of Gas Laws formulas.

The findings of the Ease of Learning section are corroborated by a number of studies which demonstrate that mnemonics create an easier to handle academic material. Abdullah and Hashim (2022) discovered that students who were taught the concepts of science with the aid of mnemonics remembered the material better and could remember the information at a quicker rate during the assessments. This aligns well with the respondents' agreement that mnemonics helped them understand Gas Laws formulas more quickly and remember them with less stress. On the same note, Udoh (2018) gave an explanation of how mnemonics reduce mental effort when using chemistry formulas, particularly those that seem complex to learn at first sight. This matches the pattern in the table, where students agreed that mnemonics helped simplify the formulas and reduced the difficulty of studying Gas Laws. In general, the literature evidences the hypothesis that mnemonics do have a positive effect on the learning process as the formulas become easier to memorize and comprehend.

C. The efficiency of utilizing mnemonic tools as a learning strategy to enhance students' mastery of Gas Laws formula

The efficiency of utilizing mnemonic tools as a learning strategy to enhance students' mastery of Gas Laws formula was assessed.

Table 6. Pre-Test and Post Test Scores

Respondents	*Pre Test Scores*	*Post Test Scores*
#1	13	15
#2	13	15
#3	13	15
#4	13	14
#5	12	13
#6	12	13
#7	12	12

#8	8	12
#9	7	12
#10	7	12
#11	7	12
#12	7	12
#13	7	12
#14	7	12
#15	6	12
#16	6	12
#17	6	11
#18	6	11
#19	6	11
#20	6	10
#21	6	10
#22	6	11
#23	6	9
#24	6	9
#25	5	9
#26	5	9
#27	3	8
#28	3	8
#29	0	7
#30	0	7

The Passing Score was 12 points out of 15 with 75% in order to determine its efficiency.

According to the table above, the pre-test results show that only 7 out of 30 respondents (23.3%) passed the assessment without using mnemonic tools, while the majority, 23 respondents (77.7%), did not qualify for passing. This low passing rate suggests the assessment was quite challenging, highlighting potential difficulties in memory retention, comprehension, or test-taking skills among the group, with over three-quarters struggling independently. Such a distribution underscores the baseline limitations without supportive aids, potentially pointing to factors like inadequate preparation or test complexity. In educational contexts, this emphasizes the value of interventions like mnemonic tools, especially if post- test data shows improvement (e.g., a rise to 16 passers). However, without additional details on the assessment's design, participant backgrounds, or statistical significance, this interpretation remains preliminary; further analysis, such as surveys on failure reasons or chi-square tests, could provide deeper insights and guide recommendations for targeted training or alternative strategies to improve outcomes.

Studies have shown that mnemonic techniques have a great effect on the memory performance and performance of students on the test involving science related subjects encouraging the observed growth in post-test scores in the current study. Olivete et al. (2025) also carried out an experimental research study to determine the effectiveness of science mnemonics on the retention ability of students in Grade VI. They found that the levels of the results of pre-test to post-test scores increased significantly and that the mean score levels of the learners who used the mnemonic tools increased significantly and had significant improvement. This is a reflection of what was found in the present study as the percentage of students passing increased to 53.3 percent compared with 23.3 percent following mnemonic intervention. The research by Olivete et al., it confirms the existence of the mnemonic-based strategies that facilitate scientific concepts in recalling when doing an assessment by enhancing the cognitive links and thus justifies the rationale that using the mnemonic-related strategies led to the greater mastery of Gas Laws formulas.

Based on the table above, the post-test results, where 16 out of 30 respondents (53.3%) passed after using mnemonic tools, indicate a substantial improvement over the pre-test's low 23.3% passing rate, suggesting that these tools effectively boosted memory retention, recall, or comprehension for more than half the group. This shift from a minority succeeding independently to a majority passing with aids highlights the tools' potential to bridge gaps in challenging assessments, possibly due to enhanced learning strategies or reduced cognitive load. In educational contexts, it underscores the value of mnemonic interventions for skill-building, though external factors like increased familiarity with the material or motivation could also play a role.

Without further details on tool specifics, test conditions, or statistical validation (e.g., effect size calculations), this remains a preliminary observation that could benefit from deeper analysis to confirm long-term efficacy.

In the same way, Lanaban et al. (2025) also showed that the mnemonic key word strategies do greatly contribute in improving the academic performance of the students in the science discipline, which supports the observed post-test performance in the current study. The quasi-experimental design that they used was a comparison of traditional instruction and enhanced teaching with the use of mnemonics among pupils in the fifth grade. The findings indicated that students who studied using mnemonic techniques scored significantly higher than those who were taught by using non-mnemonic techniques. This informs the explanation that mnemonic aids are useful in the light of minimizing cognitive load and enhancing more effective remembering of sophisticated scientific data, including Gas Laws equations. Combined with the results of both studies, it is fair to state that mnemonic aids are a powerful tool in the educational process, especially in the fields that presuppose memorization and practice of the knowledge based on formulas and ideas.

V. CONCLUSIONS

In connection with the findings of the study, the following conclusions were drawn:

1) Analysis of the results simply shows that after the implementation of mnemonic tools as a learning strategy in improving students' mastery of Gas Laws formulas, a noticeable improvement was observed. A clear change in students' ability to recall and apply Gas Laws formulas became evident, indicating a shift from limited mastery to improved understanding. Thus, the use of mnemonic tools contributed to better retention and comprehension of Gas Laws formulas among the students.

2) Furthermore, the results showed that a greater number of students achieved passing scores in the post- test compared to the pre-test. This suggests that mnemonic tools helped students recall formulas more accurately and reduced difficulty in problem solving involving Gas Laws. In addition, student responses indicated that mnemonic strategies supported motivation, engagement, and ease of learning. To sum up, the use of mnemonic tools as an instructional strategy has a meaningful impact on enhancing students' mastery of Gas Laws formulas.

VI. RECOMMENDATIONS

In light of the findings and conclusions of the study, the following recommendations are hereby presented:

1) Integrate Mnemonics into Regular Science Instruction Teachers are encouraged to consistently use mnemonic strategies when teaching Gas Laws and other formula-based lessons. Since the findings showed improved recall, motivation, and understanding, mnemonics should be included as part of the standard teaching approach.

2) Provide Training and Workshops for Teachers Science teachers may benefit from training sessions or workshops on creating effective mnemonic tools. Developing more creative and student-centered mnemonics can further enhance learning outcomes.

3) Encourage Students to Create Their Own Mnemonics Students should be encouraged to design personalized mnemonic devices. This can increase engagement, deepen understanding, and improve long- term memory of formulas.

4) Use Mnemonics Alongside Other Active Learning Strategies Schools may combine mnemonics with activities like group discussions, problem-solving exercises, and interactive learning tasks. This can help reinforce students' mastery of Gas Laws and make lessons more enjoyable.

5) Conduct Follow-Up Assessments Teachers should administer additional quizzes or activities after using mnemonics to continuously monitor learning progress and ensure that students retain the formulas over time.

6) Extend Mnemonic Use to Other Topics Since mnemonics proved effective in Gas Laws, the approach can be applied to other challenging science topics where students struggle with memorization.

7) Support Struggling Learners Additional guidance and simplified mnemonic tools may be provided to students who still find Gas Laws difficult. Tailored support can help them catch up and build confidence.

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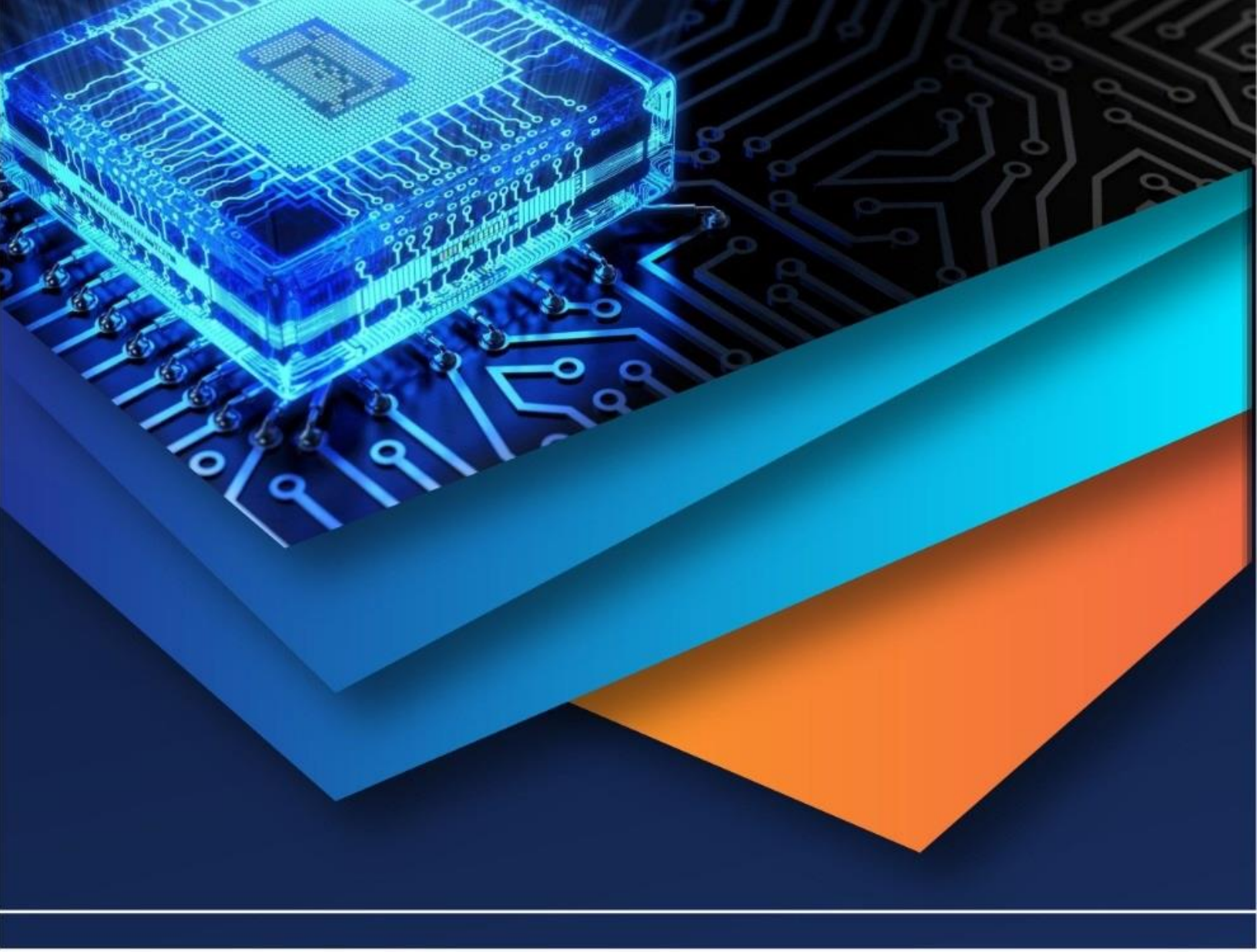

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