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**SPATIAL RELATIONSHIPS, MOVEMENT AND
FORM AS DISCRIMINATING FACTORS IN
FORENSIC HANDWRITING ANALYSIS IN UGANDA**

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DEDICATION

I dedicate this research thesis to my brothers and sisters, my dear mum Vanice NDEBIIKA and dad Nathan KACWERA who supported me financially, emotionally and spiritually through advice and prayers. May Almighty God bless you abundantly.

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ABBREVIATIONS

DGAL : Directorate of Government Analytical Laboratory

F : Form

Lab : Laboratory

M : Movement

Q.D : Questioned Documents

S : Spatial relationships



ABSTRACT

Spatial Relationships, Movement and Form As Discriminating Factors in Forensic Handwriting Analysis in Uganda

There are many cases of questioned documents in Uganda. According to the annual crime report by Uganda Police Force, 670 cases of questioned documents were reported in 2023 and of which handwriting cases constituted 80% of the total document cases. This study is on forensic handwriting analysis and will be based on the principle of individuality that no two people have identical handwriting characteristics.

Forensic handwriting analysis is a technique that involves the examination various handwriting features to determine whether a handwriting sample is genuine or forged. Spatial relationships, movement, and form are critical factors that forensic document examiners use to differentiate between genuine and forged handwriting samples.

This research thesis investigates the importance of spatial relationships, movement, and form in forensic handwriting analysis. The study analyzes various factors that are considered in forensic handwriting analysis and highlights the importance of spatial relationships, movement, and form for differentiating between genuine handwriting and forgery. The findings indicate that consistent spatial relationships in handwriting samples, consistent movement in pen pressure, speed, and direction of pen strokes, and consistent letter slant and shape are crucial factors in determining the accuracy of forensic handwriting analysis. The study underscores the need for continued research and development in forensic handwriting analysis to improve the accuracy and reliability of handwriting analysis in forensic investigations.

In this study, 160 samples from the Directorate of Government Analytical Laboratory plus other samples and examined using visual analysis..

Overall, this research thesis provides valuable insights into the factors that determine the accuracy of forensic handwriting analysis and highlights the importance of spatial relationships, movement, and form in forensic handwriting analysis. By providing a thorough understanding of these discriminating, this research thesis seeks to strengthen forensic handwriting analysis' use in criminal investigations.

Keywords: Handwriting, Questioned Documents, Spatial relationships, Movement, Form.

ÖZET

Uganda'da Adli El Yazısı Analizinde Ayırt Edici Faktörler Olarak Mekansal İlişkiler, Hareket ve Biçim

Uganda'da çok sayıda şüpheli belge vakası var. Uganda Polis Gücünün yıllık suç raporuna göre, 2023 yılında 670 şüpheli belge vakası rapor edildi ve bunların el yazısı vakaları, toplam belge vakalarının %80'ini oluşturdu. Bu çalışma adli el yazısı analizi üzerine olup, hiçbir iki kişinin aynı el yazısı özelliklerine sahip olmaması bireysellik ilkesine dayanacaktır.

Adli el yazısı analizi, bir el yazısı örneğinin gerçek mi yoksa sahte mi olduğunu belirlemek için çeşitli el yazısı özelliklerinin incelenmesini içeren bir tekniktir. Uzaysal ilişkiler, hareket ve biçim, adli belge incelemecilerinin gerçek ve sahte el yazısı örnekleri arasında ayırım yapmak için kullandıkları kritik faktörlerdir.

Bu araştırma tezi, adli el yazısı analizinde mekansal ilişkilerin, hareketin ve biçimin önemini araştırmaktadır. Çalışma, adli el yazısı analizinde dikkate alınan çeşitli faktörleri analiz ediyor ve gerçek el yazısı ile sahtecilik arasında ayırım yapmak için mekansal ilişkilerin, hareketin ve biçimin önemini vurguluyor. Bulgular, el yazısı örneklerindeki tutarlı mekansal ilişkilerin, kalem basıncındaki tutarlı hareketin, kalem vuruşlarının hızı ve yönünün ve tutarlı harf eğimi ve şeklinin, adli el yazısı analizinin doğruluğunu belirlemede çok önemli faktörler olduğunu göstermektedir. Çalışma, adli soruşturmalarda el yazısı analizinin doğruluğunu ve güvenilirliğini artırmak için adli el yazısı analizinde sürekli araştırma ve geliştirme ihtiyacının altını çiziyor.

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Genel olarak, bu araştırma tezi, adli el yazısı analizinin doğruluğunu belirleyen faktörlere dair değerli bilgiler sağlar ve adli el yazısı analizinde mekansal ilişkilerin, hareketin ve formun önemini vurgular. Adli el yazısı analizinin cezai soruşturmalarda kullanımının güçlendirilmesi.

Anahtar Kelimeler: El Yazısı, Sorgulanan Belgeler, Mekansal ilişkiler, Hareket, Form.

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1. INTRODUCTION

Forensic handwriting analysis is a crucial tool used in crime investigation and prosecution. Forensic experts use various techniques to identify individuals based on their handwriting. However, handwriting analysis can be challenging, and the accuracy of results can depend on numerous factors. Spatial relationships, movement, and form of handwriting are among the discriminating factors that forensic experts use to distinguish the authenticity of handwriting.

These factors play a fundamental role in forensic handwriting analysis and can provide valuable evidence in legal proceedings. Therefore, this research aims to explore the significance of spatial relationships, movement, and form as discriminating factors in forensic handwriting analysis. The research seeks to provide a better understanding of these factors and their importance in accurately identifying the authorship of a document. The results of this study can have significant implications on the forensic community and contribute to the development of more accurate and reliable handwriting analysis techniques.

Forensic handwriting analysis is a crucial aspect of forensic science that uses various techniques to study and identify handwriting characteristics to solve crimes. In Uganda, forensic handwriting analysis plays a significant role in criminal investigations, and it is essential to understand the discriminating factors that influence the analysis's accuracy. This thesis focuses on three critical factors: spatial relationships, movement, and form, and their impact on forensic handwriting analysis in Uganda.

Forensic handwriting analysis is a widely used technique in criminal investigations to determine the authenticity of a handwriting sample. This technique involves the examination of various features of handwriting, such as spatial relationships between characters, movement, and form, to identify any discrepancies that may indicate forgery. Forensic handwriting analysis can be a powerful tool for investigators, but it requires skilled experts who can analyze handwriting samples accurately.

Among the various factors examined in forensic handwriting analysis, spatial relationships, movement, and form are critical discriminating factors. Spatial relationships refer to the relative position of characters in a handwriting sample, while

movement analysis involves examining the speed, direction, and pressure of pen strokes. Form analysis involves assessing the shape and slant of individual letters.

1.1. Spatial Relationships

Spatial relationships refer to the arrangement of letters and words on a page. In forensic handwriting analysis, handwriting samples are evaluated by analyzing the spatial relationships between the letters and words used. These relationships provide insights into the person's writing habits, such as the use of space and structure, which can help in identifying the author of a document. In Uganda, forensic handwriting analysts use spatial relationships as a critical factor in handwriting analysis, and they often to determine the author of a document.

1.2. Movement

Movement refers to how the writer forms each letter. In forensic handwriting analysis, movement is analyzed by studying the line quality, pressure, and overall flow of the handwriting sample. The movement of the writer can provide information on their writing style, such as how they form specific letters and how much pressure is used. This information can help in identifying the writer of a document. In Uganda, forensic handwriting analysts use the movement of the writer to identify the author of a document and build a profile of their writing habits.

1.3. Form

Form refers to the shape and style of the letters used in handwriting. In forensic handwriting analysis, form is studied by analyzing the slant, spacing, and stroke patterns of the handwriting sample. Form in handwriting analysis refers to the overall appearance of the handwriting. Forensic handwriting experts use form as a discriminating factor by examining the shape and size of the letters, as well as their consistency. These factors provide valuable evidence for or against the authenticity of a document.

2. PROBLEM STATEMENT

Despite the numerous techniques used in forensic handwriting analysis, accurately identifying the authorship of a document can be a challenging task. Handwriting analysis experts use various discriminating factors to distinguish the authenticity of handwriting, including spatial relationships, movement, and form. However, there is a need to investigate the significance of these factors further in forensic handwriting analysis. It is crucial to understand how the different discriminating factors are interconnected and the importance of each factor in accurately identifying the authorship of a document. Therefore, this research aims to explore the significance of spatial relationships, movement, and form as discriminating factors in forensic handwriting analysis and provide insights that can help improve the accuracy and reliability of handwriting analysis techniques.

3. MAIN OBJECTIVE

The main objective of this research is to investigate the significance of spatial relationships, movement, and form as discriminating factors in forensic handwriting analysis. The study aims to provide a better understanding of how these factors contribute to accurately identifying the authorship of a document. The research seeks to explore the relationship between spatial relationships, movement, and form and provide insights into how these factors can be used to improve the accuracy and reliability of handwriting analysis techniques. The study also aims to examine how the reliance on the expertise of the examiner in evaluating these factors can potentially lead to inaccuracies in the results. By achieving these objectives, this research hopes to contribute to the development of more accurate and reliable handwriting analysis techniques that can be widely adopted in the forensic community.

4. SPECIFIC OBJECTIVES

- To examine the relationship between spatial relationships in handwriting and the accuracy of handwriting analysis.
- To investigate the significance of movement as a discriminating factor in forensic handwriting analysis.
- To explore the importance of form in accurately identifying the authorship of a document.
- To examine the interconnectivity between spatial relationships, movement, and form in forensic handwriting analysis.
- To identify the potential sources of inaccuracies in the results of handwriting analysis techniques that rely on the expertise of the examiner in evaluating these factors.
- To provide recommendations on how forensic experts can integrate spatial relationships, movement, and form to improve the accuracy and reliability of handwriting analysis techniques.

5. RESEARCH QUESTIONS

- What are the evaluation criteria used for handwriting analysis in Uganda, and how do they incorporate the use of spatial relationships, movement, and form?
- To what extent do spatial relationships, movement, and form contribute to the accuracy and reliability of forensic handwriting analysis in Uganda?
- What are the limitations and challenges of using spatial relationships, movement, and form as discriminating factors in forensic handwriting analysis in Uganda, and how can these be addressed?
- What are the recommendations for improving the accuracy and reliability of forensic handwriting analysis in Uganda, with a focus on the use of spatial relationships, movement, and form?
- What are the potential future research directions for forensic handwriting analysis in Uganda, particularly with respect to improving the use of spatial relationships, movement, and form?

6. SIGNIFICANCE OF THE STUDY

The significance of this study lies in its contribution to the forensic community's knowledge of the significance of spatial relationships, movement, and form as discriminating factors in handwriting analysis. The study aims to improve the accuracy and reliability of forensic handwriting analysis techniques by providing a better understanding of the interconnectivity between these factors and their importance in accurately identifying the authorship of a document. The study's findings will provide valuable insights into how forensic experts can integrate spatial relationships, movement, and form into their analysis to improve the accuracy of their results. Furthermore, the study will identify potential sources of inaccuracies in the results and provide recommendations to avoid them, which can help increase the confidence in the validity of the results.

7. HYPOTHESIS

The use of spatial relationships, movement, and form as discriminating factors in forensic handwriting analysis in Uganda has the potential to significantly improve the accuracy and reliability of handwriting analysis, leading to better outcomes in criminal investigations. Specifically, it is hypothesized that the study of spatial relationships, movement, and form in handwriting can be used to determine authorship. Therefore, by incorporating the use of spatial relationships, movement, and form into the existing techniques and tools used for forensic handwriting analysis in Uganda, it is expected that the accuracy and reliability of the analysis can be improved and lead to more successful outcomes in criminal investigations.

8. THEORETICAL FRAMEWORK

The theoretical framework for the thesis on the research topic will be based on the following theories and concepts:

Gestalt theory: This theory argues that humans naturally perceive objects as organized and whole entities, rather than as isolated parts. This theory can be applied to handwriting analysis, as it suggests that spatial relationships between letters and words can provide important insights into an individual's writing style.

Motor control theory: This theory describes the cognitive and neural processes involved in movement planning and execution. It can be applied to handwriting analysis, as it suggests that subtle differences in an individual's handwriting movement trajectories can be used to provide unique insights into their identity.

Linguistic theory: This theory explores the structural and functional aspects of language, including grammar, syntax, and semantics. It can be applied to handwriting analysis, as it suggests that the form of letters and words can provide clues about the author's educational background, occupation, and age.

Forensic psychology: This field explores the intersection of psychology and the law and focuses on various aspects of legal proceedings, including criminal investigations. It can be applied to handwriting analysis, as it provides a theoretical basis for understanding the human behavior and cognitive processes involved in the creation of written documents.

The application of these theories and concepts provided a theoretical framework for the thesis to explore the use of spatial relationships, movement, and form as discriminating factors in forensic handwriting analysis in Uganda. The framework helped to develop a better understanding of the underlying cognitive and neural processes involved in handwriting analysis and how they relate to the specific factors being studied. It also helped to identify potential areas for further research and development in the field of forensic handwriting analysis.

9. LITERATURE REVIEW

9.1. Overview

Writing grew out of pictures; cave drawings being the first recorded record of humans. These paintings, called petroglyphs or petrograms, are believed to have developed between 20,000 and 10,000 BC . Gradually, pictures came to represent words. Word pictures known as ideographs were used by Sumerians, Chinese, Aztecs, Mayas, and Egyptians. Most notable are the Egyptian word pictures, hieroglyphics. Pictures were modified into symbols, symbols represented syllables, and symbols used to represent a sound or a syllable is known as a phonograph. This developed into simplified phonetic symbols called the phonetic alpha-bet. The Sumerians assigned a symbol to each sound and are generally credited with the development of the first alphabet. The Phoenicians spread this alphabet throughout the known world between 1700 and 1500 BC. (Koppenhaver , 2007)

Handwriting is identifiable to an individual writer . Several treatises have been devoted to proving this fact. Whereas DNA cannot distinguish between identical twins, the examination of their handwriting can identify them individually. Studies by (Boot 1998), (Gamble 1980), and (Beacom 1960) have established that identical twins who were raised in the same family, attended the same schools, and were taught to write under the same handwriting systems do not have identical handwriting. Quite the contrary, these twins have individually identifiable handwriting characteristics that distinguish them one from the other. Just like everyone else, these twins have handwriting that is unique and identifiable to them individually. (Koppenhaver , 2007)

Forensic handwriting analysis has been in practice for over a century, and it remains a critical tool in criminal investigations. Handwriting analysis involves the examination of various features of handwriting to determine whether a handwriting sample is genuine or forged. The examination of spatial relationships, movement, and form in handwriting samples is particularly important in forensic handwriting analysis. This literature review examines the existing research on the role of spatial relationships, movement, and form as discriminating factors in forensic handwriting analysis.

Spatial Relationships:

Spatial relationships refer to the relative position of characters in a handwriting sample. Experts in forensic handwriting analysis utilize spatial relationships to differentiate between similar-looking characters, such as lowercase letters 'a' and 'u,' or uppercase letters 'E' and 'F.' Inaccurate spatial relationships between these characters can be indicative of forgery. Osborn (1910) was one of the first scholars to recognize the importance of spatial relationships in forensic handwriting analysis. Since then, numerous studies have reiterated the importance of spatial relationships in differentiating between genuine handwriting and forgery (Huber & Headrick, 1999; Hilton, 1992; Parikh & Srihari, 2009).

Various studies have been conducted to explore the significance of these in analysis. A study by Osborn and Osborn (1993) on the significance of spatial relationships in handwriting analysis found that the accuracy of handwriting analysis is dependent on the examiner's ability to identify and evaluate differences in spatial relationships.

Movement:

The examination of movement in handwriting samples is also an important factor in forensic handwriting analysis. The speed, direction, and pressure of pen strokes can provide important clues regarding the authenticity of the handwriting sample. Genuine handwriting samples typically exhibit more consistent strokes, while forgeries often have inconsistent movements due to the writer's hesitation or lack of familiarity with the handwriting style. Almog and Cohen (2005) noted that movement analysis is becoming increasingly important in forensic handwriting analysis, and they stressed the need for continued research in this area.

Furthermore, studies such as the one conducted by Breski and colleagues (2017) on the use of movement analysis in identifying forgeries found that handwriting movement analysis can be a valuable tool in distinguishing genuine from forged documents.

Form:

The analysis of form in handwriting samples is also an essential aspect of forensic handwriting analysis. Form refers to the shape and slant of individual letters,

and experts in forensic handwriting analysis use form to differentiate between genuine and forged handwriting samples. Consistency in letter slant and shape is indicative of genuine handwriting, while inconsistencies are indicative of forgery. The importance of form in forensic handwriting analysis was also noted by Roper (2017), who emphasized the role of form in differentiating between genuine and forged handwriting samples.

Handwriting is unique and identifiable – (Srihari et al 2002).

Each writer has innate powers of observation, a capacity for graphic expression, and technical execution. It takes many years of practice to develop skills and proficiency in writing. Graphic maturity is reached when the motor skills of the writer are fully developed, and the writer no longer has to focus attention on the act of writing. At this point, the writer concentrates on the content and lets his or her subconscious handle the execution of the writing act until writing becomes a habit. The method of construction of various letter combinations and words is set.

No two people write exactly alike. The principles of handwriting identification are based on basic scientific truths about handwriting. The use of a signature in legal and financial transactions is possible because unique characteristics in an individual's handwriting distinguish it from every other handwriting. This principle enables document examiners to differentiate genuine and non-genuine writing and to identify the author of a sample of handwriting. The second basic scientific truth about handwriting is all writing contains natural variation so that no two writing samples by the same writer will be the same. There are slight deviations in all handwriting characteristics. The document examiner must learn to distinguish between natural variation and a different writer. Writing is a complex act and highly developed skill. Many influences affect the development of each person's writing ability, resulting in the unique style of each writer. (Koppenhaver , 2007)

Handwriting is a product of the motor system's control over the movements of the arm and fingers. The information required to produce these complex movements stems from generalized motor programs or motor memories within the brain. During the comparison of handwriting samples, the examiner is effectively studying the product of motor memories executed by the writer/s in authoring a sample. For the comparison

process to proceed, the same characters and forms of characters are required to be present. (Bird, C, 2016).

The characteristics to be considered include slant, line quality, alignment, pen pressure, internal proportion of letters, external proportion of letters, spacing, baseline habits, connecting of letters, t-crossings and i-dots, pen lifts, embellishments, retracing of letters, loops, freedom of execution, method of construction of letters among others.

9.2. Spatial relationships

Spatial relationships include size; proportions; spacing between letters, words, and lines of writing; and utilization of space. Utilization of space includes arrangement and alignment of the writing. Arrangement is based on the space available, and alignment refers to the baseline, real or imaginary.

9.2.1. Size

Penmanship systems dictate normal size of writing. Young children are taught to write using larger strokes with lower case letters 0.25-inches in height. By the time they master the basic letter forms, the students are expected to reduce the writing size to half of the original size. Size of writing will vary under different circumstances.

9.2.2. Proportions

Proportions usually are consistent in writing regardless of the size of the writing. When writers change the size of their writing, their letters remain proportional. Horizontal expansion also plays a part in establishing the identity of the writer and is considered part of spacing. Penmanship systems dictate the proper proportions. Upper looped letters are twice as high as middle zone letters, and capitals can run as high as three times the middle zone letters.

9.2.3. Utilization of space

Writers are given unlimited space they will proceed to write in a size that is comfortable for them. Writing may be small or large. It may also be variable. A writer's utilization of space is affected by the parameters of the writing environment. The writer must adjust the size of his or her writing to fit into a specific area. Some writers plan accurately and space their work evenly in the space available, where as others miscalculate and must compress some of their writing to fit it in a tight space. How the writer adjusts the size to accommodate the available space is an identifying factor.

9.2.4. Spacing

Writers are taught to space their letters uniformly with connecting strokes that are the same size between each letter. Writers are taught to space their letters evenly on a horizontal plane. The rules of writing dictate two letter spaces between words. Sufficient space must be left between the lines to prevent intermingling of upper and lower loops.

9.3. Movement

Movement includes direction, slant, rhythm, pressure patterns, line quality, and speed. The direction of writing is dictated by rules of penmanship, but not everyone adheres to the rules. It is necessary to know the normal progress of writing across the page to determine deviations from that norm. Slant is part of the direction of writing but is measured separately. Speed and rhythm are affected by the direction of writing. Pressure is also related to movement.

9.3.1. Direction

Rules of penmanship dictate that writing progresses from left to right on a horizontal plane. Each line is placed below the preceding one from the top to the bottom of the page. Letters return to an imaginary baseline in a rhythmic motion. Most alphabets begin their letter formations at the baseline and move upward and to the right. Some letters begin in the mid-zone and move left such as a, c, d, g and o.

9.3.2. Slant

Slant refers to the direction in which the writing leans. It may lean to the right or the left, or it may be vertical. Slant may also be variable. Slant is sometimes called slope. When a writer tries to disguise his or her handwriting, that individual will change the slant because that will change the pictorial effect of the writing.

9.3.3. Rythm

Rythm refers to the writer's consistency of the slant combined with the even return to the baseline. Skilled writers produce more rhythmic writing than unskilled writers. Writing rhythm can have a consistent or variable slant and an even or erratic return to the baseline. It mostly falls somewhere in between. Rythm is usually disrupted when a writer attempts to copy another's handwriting and may be one of the most significant factors in the identification of a forgery. Rhythm is also an indicator of skill level. The writer who has a well-developed rhythm consistent with an even return to the baseline is a more highly skilled writer than one whose rythm is poorly developed.

9.3.4. Pressure

There are two types of pressure in handwriting: grip pressure which refers to the hand's grasp on the writing instrument, and the amount of pressure used to push the pen across the paper. It varies for different writers from light to heavy. The writing instrument will not function properly if the pressure is too heavy or too light. Most writers apply lighter pressure on upstrokes when they are pushing the pen away and heavier pressure on downstrokes when they bring the pen towards them.

9.3.5. Line Quality

The smoothness of the line of writing represents the line quality or line value. The skill of the writer determines whether the line quality represents high or low quality. Speed is generally the most important determinant when measuring line quality. Slow writing is tremulous and lacks good line quality. Slow writing is the result

of lack of skill or of copying another's style. It can be an important consideration in identification of a writer. Fast is smoother and more fluid. There are numerous indicators of speed in writing of which the line quality is a principle one.

9.4. Form

Form is not limited to the shape of the letters but includes the method of constructing and connecting the letters, including the initial and terminal strokes.

9.4.1. Letter Designs

The writing strokes consist of lines and curves in various directions, forming individual letter shapes. Lines can be vertical, horizontal or diagonal. Curves are loops, circles or parts of the circles. Letter designs are the most identifiable feature of handwriting. Forgers copy letter designs while disregarding other characteristics of the writing. Each letter has a distinguishing element and makes it unique.

9.4.2. Method of Construction

Forgers will imitate letter forms, but they fail to follow the same method of construction of letters and words when they do so. Writers develop consistent habits regarding the construction of letter forms. They start their letters in approximately the same place whether on the baseline, above or below it. They move the writing instrument in the same direction and join strokes at a similar location each time.

9.4.3. Initial Strokes

Significant aspects of letter forms are the lead-in and terminal strokes that people devise to begin and end their letters. These are highly personalized strokes that have a high value in identifying a writer. Lead-in strokes are found at the beginning of letters and words. They may be straight, curved or hooked, long or short. The initial

placement of the pen to begin each letter form is also a strong factor in identification because of the highly individualized nature of this placement.

9.4.4. Terminal strokes

Terminal strokes are ending strokes on letters and words. They also may be straight, curved or hooked, long or short and are consistent with writers. These are also overhooked by forgers unless the terminal stroke is very distinctive.

9.4.5. Medial strokes

Medial strokes are found between the initial and terminal strokes. They include the letter forms and strokes used to connect the letters in a word in cursive writing.

9.4.6. Connecting strokes

Connecting strokes join the letters in words. They are also called ligatures. Letters in a word may be connected or disconnected. Connectors can consist of arches, garlands, angles or thread connections.

9.4.7. Embellishments

Embellishments were once considered an important part of the letter forms, but modern penmanship systems do not use embellishments. Calligraphers will embellish their letters with flourishes but the average writer does not. Therefore, flourishes that appear in handwriting assist in the identification process. Flourishes are extra strokes added to letters to improve their appearance. These flourishes are curved and wavy lines added to the beginning or ending of the letters. Hooks are little strokes made with an immediate change of direction executed subconsciously by a writer.

9.5. Standards

In handwriting analysis, a standard refers to a sample of a person's known handwriting that is used as a reference for comparison. Standards are collected from various sources, such as signed documents, letters, or notes, and they provide a basis for evaluating and analyzing other handwriting samples.

The purpose of using standards in handwriting analysis is to establish a baseline for comparison. By examining the unique characteristics, habits, and style of a person's known handwriting, experts can identify consistent patterns and features that can be used to differentiate and identify handwriting from other individuals.

Standards are crucial in determining the authenticity or authorship of questioned documents. When a questioned document, such as a suspicious signature or an anonymous letter, needs to be analyzed, the standards are compared with the specimen in order to identify similarities or discrepancies.

It is important to collect a sufficient number of diverse and representative standards to ensure accuracy in handwriting analysis. The more comprehensive the collection of standards, the more reliable and confident the conclusions from the analysis will be.

9.5.1. Types of standards

Exemplars: These are samples of a person's known handwriting that serve as a reference for comparison. Exemplars can be collected from various sources, such as signed documents, letters, or even notes taken by the individual.

Questioned Documents: These are samples of handwriting that are being examined to determine authenticity or authorship. Questioned documents can include signatures on contested documents, anonymous letters, or forged checks etc.

Known Standards: These are samples of the suspect's writing that are obtained specifically for comparison purposes. Known standards are often collected through writing samples taken under controlled conditions, such as in station or during handwriting analysis session.

Specimen: This refers to any writing sample that is being analyzed, whether it is an exemplar or a questioned document. Specimens can provide valuable clues about the writer's characteristics, habits, and style.

Comparison Standards: These are samples of known individuals handwriting that are used to compare against document. Comparison standards can include samples from potential suspects or individuals who may have had access to the document in question.

It's worth noting that the quality and quantity of standards and samples play a crucial role in the accuracy and reliability of handwriting analysis. The more diverse and representative the samples, the more confident the conclusions drawn from the analysis.

In conclusion, the analysis of spatial relationships, movement, and form is crucial in forensic handwriting analysis. The examination of spatial relationships is necessary to ensure consistency in handwriting patterns between characters, while movement analysis provides valuable clues regarding the authenticity of the handwriting sample. Form analysis is also a critical aspect of forensic handwriting analysis, and consistency in letter slant and shape is indicative of genuine handwriting. Overall, the existing literature underscores the importance of spatial relationships, movement, and form as discriminating factors in forensic handwriting analysis. There is a need for continued research and development in this field to improve the accuracy and reliability of handwriting analysis in forensic investigations.

10. MATERIALS AND METHODS

10.1. Materials:

Handwriting samples: Collect a diverse range of handwriting samples from individuals with known authorship. These samples included forensic cases and other cases.

Instruments: Provide a variety of writing instruments, such as pens, pencils, and markers, to ensure a range of writing styles and characteristics.

Rulers and measurement devices: Rulers and measurement devices were used to accurately measure the spatial relationships between letters, words, and lines in the handwriting samples.

10.2. Methods

10.2.1. Data Collection

100 Samples were collected and had known authorship and obtained as pairs for analysis.

The comparison of these samples were done in pairs (50 pairs) to identify the features.

The images of the samples were captured which involved notes to be used during the analysis.

10.2.2. Comparison

The questioned document and the known document are compared for all the similarities and dissimilarities in the characteristics. The comparison will aim at identifying all the peculiarities in the questioned and the exemplar using the standard operating procedures.

10.2.3. Evaluation

The questioned documents will be examined and evaluated critically based on all the characteristics then, determine if there is a sufficient quantity of writing. If there

is not a sufficient amount of questioned writing, known writing, or both; request more writing and repeat the above steps to the extent possible.

10.2.4. Identification or Elimination

Identification

This involves making a conclusion of identity after the examination. The examiner has no reservations whatever, and although prohibited from using the word “Fact” the examiner is certain based on evidence contained in the handwriting, that the writer of the known material actually wrote the writing in question.

Elimination

This denotes no doubt in his opinion about the handwriting that the questioned and known writings were not written by the same individual. This is after comparison between the questioned documents and known documents.

Inconclusive result

This result is obtained when the results obtained cannot identify or eliminate the writer basing on the observations.

10.2.5. Data Analysis.

In this study, a thematic analysis of the samples was conducted , focusing on the identified themes related to spatial relationships, movement, and form as discriminating factors.

Samples were analysed to gain a comprehensive understanding of the handwriting features.

10.2.6. Analysis Reporting.

This step consisted of a summary of the key findings related to the role of spatial relationships, movement, and form as discriminating factors in forensic handwriting analysis.

The findings were presented in a clear and organized manner, including relevant quotes or examples from the analysis sessions to support the analysis reports.

These materials and methods provided a systematic approach to investigate the role of spatial relationships, movement, and form as discriminating factors in forensic handwriting analysis. This enabled the collection and analysis of data from experienced forensic handwriting analysts, offering valuable insights into the techniques and considerations involved in this field.



11. ETHICAL CONSIDERATIONS

The study was conducted by the declaration of Cukurova University and the guidelines for research. Ethical approval was obtained from the College of Veterinary Medicine, Animal Resources & Biosecurity (CoVAB.MSC4.2023) of Makerere University before conducting the study. The data collected was strictly for this study and not for any other purpose. All information was to be kept private and treated with the confidentiality it deserved.



12. FINDINGS

Samples collected were examined using visual analysis and the handwriting features and the arrangement of the samples is done in pairs. The images of the samples examined are shown for clarity of reporting the examinations. Out of 100 specimens examined, below is a representation of the analyses. The images of the rest of the samples done is readily available and can be accessed when needed.

Figure 1: handwriting Sample (Questioned)

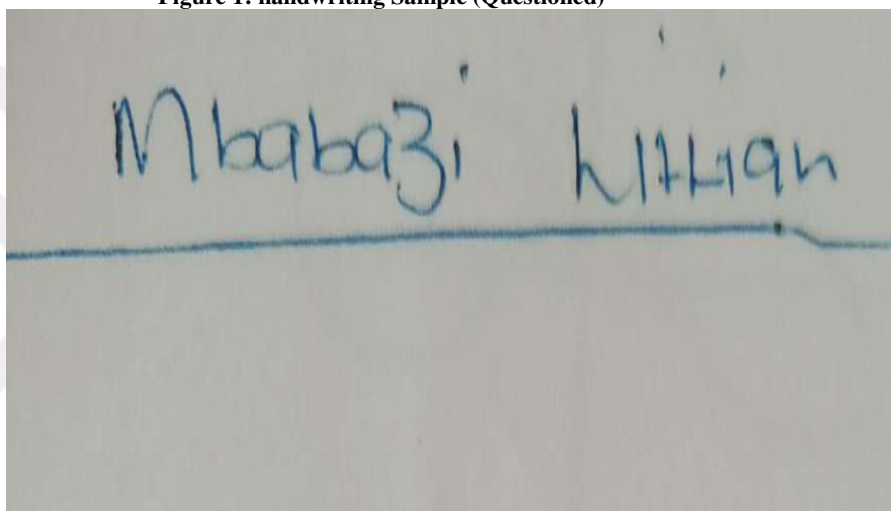
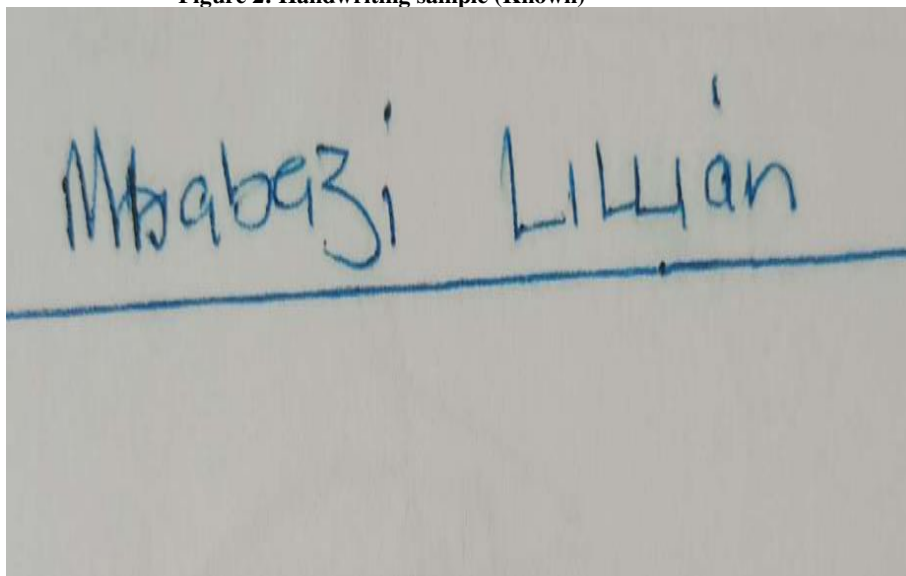


Figure 2: Handwriting sample (Known)



Similarities

- Method of construction of “z” [F]
- Nature of the i-dottings [F]
- Slant of “a” is vertical [M]
- Loop for “l” is horizontal [F]
- Spacing between the words [S]
- Alignment of “n” [S]
- Less pen pressure [M]

Differences

- i-dotting is missing on “Lillian” of Figure 2.
- Connecting strokes of “b” and “a” missing in the word “Mbabazi” in Figure

Conclusion: The questioned sample and the known specimen are all written by the sample author (identified).

Differences

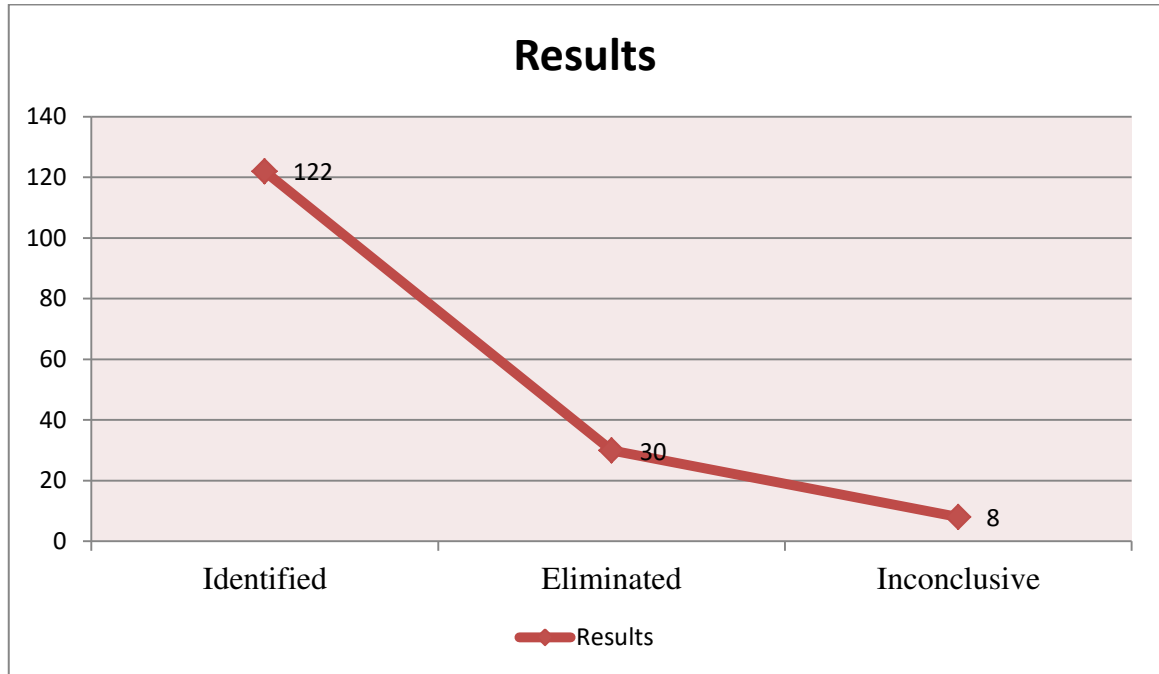
- Initial stroke for the questioned is curved differently.[F]
- Connecting strokes of the questioned signature are abit loose and the strokes for the known are so close.[M]
- Medial strokes are wide compared to the known signatures.[S]
- The slant of the loop of the medial strokes for the questioned signature is towards the right while the known signature is vertical. [M]
- The proportion of the loops in questioned signature is larger than that in the known signature. [S]
- Presence of pen lifts and hesitation in the questioned documents. [M]

Similarities

- The terminal stroke is vertical [F]
- The alignment of the terminal stroke is similar.[S]

Conclusion: The known signature and the questioned were not written by the same author(eliminated).

13. DISCUSSION OF RESULTS



Out of 160 samples analysed, the authors of 122 samples were identified, then the authors 30 were eliminated and 8 of them were inconclusive based on the handwriting characteristics.

14. LIMITATIONS OF THE STUDY

- Cannot determine sex, race, age or handedness of the writer, the intentions of the writer.
- Limited sample size: The study's findings may be limited by the number of handwriting samples analyzed, which may not reflect the characteristics of a larger population accurately.
- Subjectivity of handwriting analysis: Handwriting analysis, by its nature, is subjective and can involve a considerable degree of examiner interpretation, which may limit the generalizability of the findings.
- Lack of standardization: There is a lack of standardization in forensic handwriting analysis techniques, which may lead to differences in the results obtained by different examiners.

15. RECOMMENDATIONS ON FUTURE RESEARCH

Based on the findings of the thesis on the research topic "Spatial relationships, movement, and form as discriminating factors in Forensic Handwriting analysis in Uganda," the following recommendations can be made for future research:

- Investigating the potential use of machine learning algorithms in handwriting analysis: As technology improves, there is an opportunity to use machine learning algorithms to analyze handwriting patterns. Further research could investigate the potential of machine learning to analyze spatial relationships, movement, and form in handwriting and how this technology can improve the accuracy and reliability of forensic handwriting analysis.
- Exploring cultural differences in handwriting: Given the diversity of cultures and languages in Uganda, it would be interesting to investigate how cultural differences impact the spatial relationships, movement, and form in handwriting. Future research could explore the differences in handwriting patterns across different cultural groups in Uganda and how these differences can be used to identify the author of a document.
- Improving the standardization of evaluation criteria: While there are well-established techniques and methods used in forensic handwriting analysis, there is a need to improve the standardization of evaluation criteria. More research is needed to develop a standardized approach to evaluating the spatial relationships, movement, and form in handwriting across different forensic handwriting analysts.
- Investigating the impact of aging on handwriting: As individuals age, their handwriting may change due to various factors such as health, illness, or medication. Future research could investigate how the spatial relationships, movement, and form in handwriting change as individuals age and how this can impact the accuracy and reliability of forensic handwriting analysis.
- Examining the impact of environmental factors on handwriting: Handwriting can be influenced by various environmental factors, such as

temperature, humidity, and lighting. Further research could examine how these environmental factors impact the spatial relationships, movement, and form in handwriting and how this can be taken into account during forensic handwriting analysis.



16. CONCLUSION

In conclusion, this thesis has explored the use of spatial relationships, movement, and form as discriminating factors in forensic handwriting analysis in Uganda. The study reviewed the literature on the topic and conducted the analysis of handwriting samples from a diverse range of authors in Uganda. The results of the analysis show that the spatial relationships, movement, and form of handwriting samples can provide important insights into an individual's writing style and can be used to identify the author of a document.

The findings of this thesis suggest that the use of spatial relationships, movement, and form in forensic handwriting analysis in Uganda can significantly improve the accuracy and reliability of the analysis and lead to better outcomes in criminal investigations. The study identified some limitations and challenges in using these factors in handwriting analysis, such as the need for improved standardization of evaluation criteria and the potential impact of environmental and cultural factors on handwriting patterns.

Therefore, this thesis recommends that future research in this area should focus on improving the standardization of evaluation criteria, exploring cultural and environmental influences on handwriting, investigating the potential of machine learning algorithms in handwriting analysis, and examining the impact of aging on handwriting. The findings of this research can be used to enhance the techniques and tools used for forensic handwriting analysis in Uganda and improve the accuracy and reliability of the analysis, leading to better outcomes in criminal investigations.

This research will have a great positive contribution to the forensic sector most especially in document examination (questioned documents) in Uganda and the world at large. The forensic analysis and examination will be based on spatial relationships, movement and form of the handwriting. The conclusion will depend on diameter, circumference, area, length, slant angle and other features when subjected to different light sources of fluorescence. Documents with alterations, insertions, obliterations, overwriting, erasures, and forgery will also be examined based on the handwriting characteristics.

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APPENDICES

Appendix 1. Ethical clearance from Makerere University (CoVAB) Research Ethics Committee.

MAKERERE P.O. Box 7062 Kampala, Uganda Website: www.mak.ac.ug		UNIVERSITY Tel: +256 - 392 - 554685 Email: principal.covab@mak.ac.ug Website: www.covab.mak.ac.ug
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COLLEGE OF VETERINARY MEDICINE, ANIMAL RESOURCES & BIOSECURITY (CoVAB)
OFFICE OF THE PRINCIPAL

Ref. COVAB.MSC4.2023 Date 02/03/2023

HIGHER DEGREES RESEARCH COMMITTEE ENDORSEMENT

The Higher Degrees Research Committee only accepts for review and approval, research proposals that have been found both scientifically and ethically acceptable in accordance with the guidelines from Directorate of Research and Graduate Training.

The **Higher Degrees Research Committee** established by
COLLEGE OF VETERINARY MEDICINE, ANIMAL RESOURCES AND BIOSECURITY

do certify that we have reviewed the research proposal (COVAB.MSC4.2023) entitled:

Spatial relationships, movement, and form as discriminating factors in Forensic handwriting analysis in Uganda

submitted by

Mr. Nuwamanya Henry

We attest to the scientific and ethical merit of this study and competency of the investigator(s) to conduct the research and hereby approve and recommend the proposal.

SIGNATURES

	Name		Date
Ethics Committee Representative	Assoc. Prof. Clovice Kankya		02/03/2023
Head of Ethics Committee	Prof. Frank N. Mwiine		02/03/2023

OFFICIAL STAMP OF INSTITUTION

cc. Prof. Dr. Behnan Alper
Anabilim Dali Baskani





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YEARS
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In future correspondence please quote the reference number above

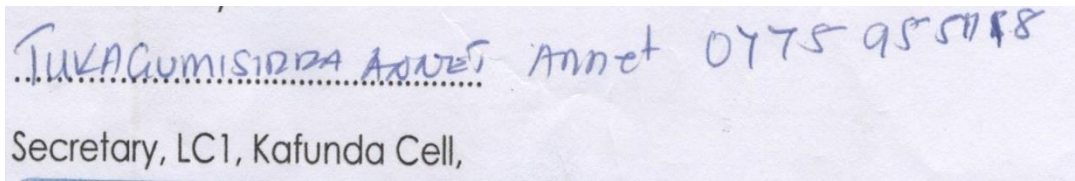
4

Appendix 2. Approval from Directorate of Government Analytical Laboratory.

In any Correspondence on this subject please quote No.....GAL/ADM/14/23 14th June, 2023 Institute of Addiction and Forensic Sciences, Cukurova University- ADANA TURKEY <i>Attn; Prof. Dr. Necmi Cekin</i>	 THE REPUBLIC OF UGANDA	MINISTRY OF INTERNAL AFFAIRS DIRECTORATE OF GOVERNMENT ANALYTICAL LABORATORY Plot No. 2 Lourdel Road Wandegeya, P.O.BOX 2174 Kampala - Uganda
RESEARCH AT THE DIRECTORATE OF GOVERNMENT ANALYTICAL LABORATORY, MINISTRY OF INTERNAL AFFAIRS. Please refer to yours to E-57861215-100-610456, dated 11th January 2023. This is to confirm that Nuwamanya Henry had his internship at the Directorate under the Questioned Document Laboratory from 13th Feb, 2023 to 12th May, 2023 during which period he was permitted to carry out research as per his topic 'Spatial relationships Movement and Form as Discriminating Factors in Forensics Handwriting		
<i>"Go Scientific for a Safe and Just Society"</i>		

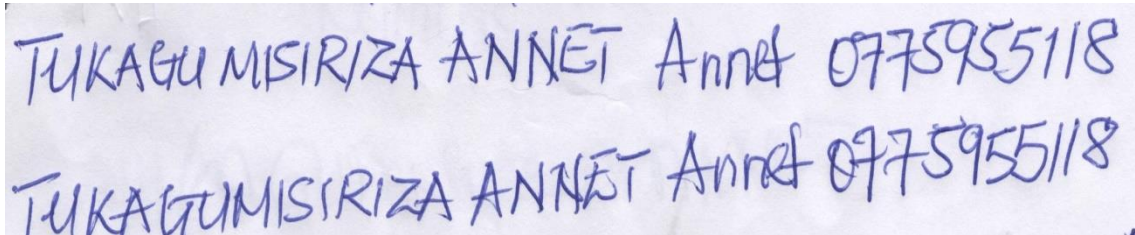
Appendix 3. Samples Analyzed Questioned signature

Questioned handwriting



TUKAGUMISIRIZA ANNET Annet 0775 955118
Secretary, LC1, Kafunda Cell,

Known handwriting



TUKAGUMISIRIZA ANNET Annet 0775955118
TUKAGUMISIRIZA ANNET Annet 0775955118

Differences

- Handwriting is cursive in 'A1' while the one in 'A5' is not cursive [F]
- The alignment of N [S]
- The size of the letters [S]
- Method of construction of M, R and K is different [F]

The similarities include:-

- The slant of figure 8. [M]
- Nature of the t-crossings [F]

CONCLUSION: ELIMINATED

Questioned

Known signature

Differences

- The direction and slant of the letters [M]
- Connecting strokes of (g-l, o-u) [F]
- Pen lifts observed in the undisputed signatures which are absent in disputed signature [M]
- Method of construction of (a, m, u, r,s) [F]
- Fluency in the writing [M]
- Relative spacing between the letters [S]
- The nature of the g loops [F]

The similarities include :-

- Starting stroke of m [F]
- Method of construction of letter m [F]

CONCLUSION: ELIMINATED

Questioned signature

Known signature

I observed the following similarities in the handwriting features.

- Connecting strokes of (S-o, m-u) [F]
- Method of construction of (s, , m, n) [F]
- The forward slant of letter 'm' [M]
- The relative spacing between the two names in the signature [S]
- Presence of tremor in the writing [M]
- Internal proportion of letter n [S]
- Nature of the i-dottings [F]

The differences include ;

- The last stroke of the signature [F]
- The shape of letter 'a' on exhibit 'A' [F]

CONCLUSION: IDENTIFIED

Questioned signature

Known signature

Similarities

- The method of construction of the strokes [F]
- External proportion of the strokes marked letter y-a [S]
- The skill of execution [M]
- The connectivity of stroke marked p to letter y [F]
- The method of construction of the a-like feature [F]
- The baseline habits of letter y [M]
- The nature of the introductory stroke of the signature [M]
- Internal proportion of letter [S]

CONCLUSION: IDENTIFIED

Questioned signature



Known signature



I observed the following differences in the handwriting features.

- The nature of starting stroke of the signature [F]
- Position of the h-like feature in questioned signatures [S]
- The nature of the ending stroke of the signature [F]
- Letter 'M' observed in the starting stroke on the specimen signature and not present in the questioned signature [F]
- The shape of the b-like feature [F]
- The shape of stroke marked y [F]

The similarities include;

- All the signatures are non-legible

CONCLUSION: ELIMINATED

Questioned signature

Known signature

I observed the following similarities in the handwriting features.

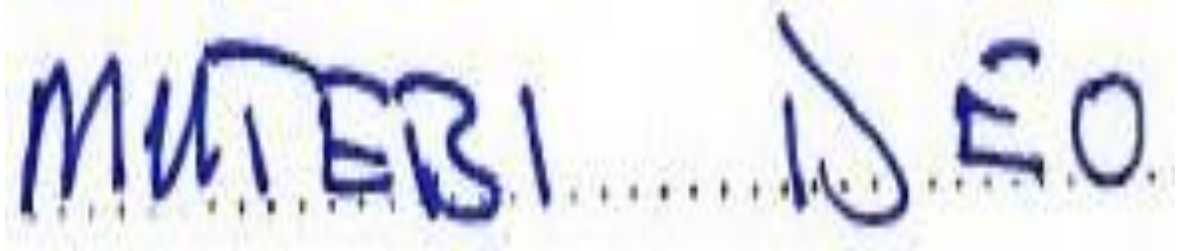
- All the signatures are fully legible in form of his name 'NEN Sebugwawo' [F]
- Method of construction of the letters (E, a, b) [F]
- Connectivity of the letters (S-e, b-u, a-w) [F]
- The skill of execution [M]
- The relative spacing between the words between NEN-Sebugwawo [S]
- The nature of the introductory stroke of letter 'S' [F]

The differences include;

- Internal proportion of the letters (g, u, s, w, e) [S]
- The slant of the letters N-E-N is different [M]
- Baseline habits of the signature [M]

CONCLUSION: IDENTIFIED

Questioned signature

A photograph of a handwritten signature in blue ink on a white background. The signature is written in a cursive style and appears to read "MUTEBI DEO". The letters are somewhat slanted and connected, with a dotted line visible beneath the text.

Known signature

A photograph of a handwritten signature in blue ink on a white background. The signature is written in a cursive style and appears to read "MUTEBI DEO". The letters are more upright and distinct than in the questioned signature, with a dotted line visible beneath the text.

I observed the following similarities in the handwriting features.

- The introductory stroke of letter m [F]
- Method of construction of the letter 'u' [F]
- Connectivity of the letters (S-e, b-u, a-w) [F]
- The relative spacing between the letters D-E-O [S]

The differences include;

- Internal proportion of the letters (E, B, D) [S]
- The nature of the T-crossings [F]
- The skill of execution [M]

CONCLUSION: INCONCLUSIVE

Questioned

Known



I observed the following similarities in the handwriting features.

- The internal proportion of the letters (d, R) [S]
- Method of construction of the letters (R, d, e) [F]
- External proportion of the letters (d-e, N-R) [S]
- Connectivity of the letters (d-e) [F]
- The skill of execution [M]
- Baseline habits of the signature [M]
- The relative spacing between the letters (N-d) [S]
- Method of construction of letter 'N' particularly the introductory part of its first stroke [F]
- Presence of the embellishments (dots) below the horizontal stroke connecting 'N-d' [F]

The differences include;

- Internal proportion of the letter 'e' [S]
- Method of construction of letter 'N' [F]

CONCLUSION: IDENTIFIED

Questioned

Known signature



I observed the following differences in the handwriting features.

- The internal proportion of the letter 'B' [S]
- The signatures on exhibit 'I' are in the form "Bcunohwa" while the known signatures are in the form "Bkunobwa" [M]
- The speed of writing is faster on the known signatures compared to the one on 'I' [M]
- The nature and shape of letter 'B' [F]
- The skill of execution [M]

The similarities include;

- Ascending alignment of the stroke connecting the letters (o-b) [S]
- Method of construction of letter 'o' [F]

CONCLUSION: ELIMINATED

Questioned

Known

Differences

- Baseline habits of the signature [M]
- The shape of the g-like feature [F]
- Nature of the starting stroke of the signature [F]
- The shape of the terminal stroke of the signature [F]
- The skill of execution [M]
- Presence of pen lifts in the contested signatures [M]
- The alignment of the signature is downward for the known signatures and horizontal for contested signatures [S]
- The nature of the embellishment above the g-like and u-like feature [F]

The similarities include;

- Relative spacing between the Z-like feature and letter 'a' [S]
- Method of construction of letter 'a' [F]
- Connectivity of (letter 'a' to the g-like feature, g-like feature to u-like feature) [F]

External proportion of (Z-like feature to letter 'a', g-like feature to u-like feature) [S]

CONCLUSION: ELIMINATED

Questioned

Known

Differences

- The internal proportion of the letters (l , g, y, d) [S]
- Method of construction of the letters (S, t, k, h) [F]
- The writing skill [M]
- External proportion of the letters (k, g, y, S, G, t, l, h, f) [S]
- The shape of letters (S, g, y) [F]

The similarities

- The relative spacing between the words [S]

CONCLUSION : ELIMINATED

Questioned

Known

I observed the following consistent similarities in the handwriting features.

- External proportion of the letter (M, g) [S]
- Method of construction of the letters (M, H,) [F]
- The skill of execution [M]
- The relative spacing between the letters (M-H, m-g) [S]
- Internal proportion of the letters (a, g, h) [S]
- Connectivity of the letters (H-h, m-m) [F]

The differences include;

- Connectivity of the letters (h-a) [F]
- Nature of the ending stroke [F]
- Presence of an embellishment of the letters (mm) [F]

CONCLUSION: IDENTIFIED

Questioned handwriting

Known handwriting

Similarities

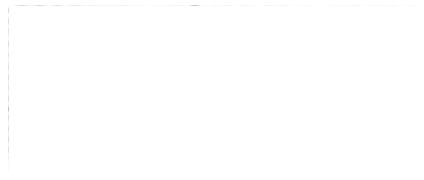
- Method of construction of the letters (A, g, n) [F]
- Internal proportion of the letter(s, M) [S]
- External proportion of letters (g, y) with the rest of the letters [S]
- The writing skill [M]
- The relative spacing between the letters [S]

The differences include;

- The shape of letter 'y' [F]
- The nature of the i-dottings [F]

CONCLUSION: IDENTIFIED

Questioned



Known



I observed the following similarities in the handwriting features.

- The skill of execution [M]
- The connectivity between the strokes in the signature [F]
- External proportion of the circular/uppermost stroke [S]
- The direction of movement of the strokes in the signature [M]

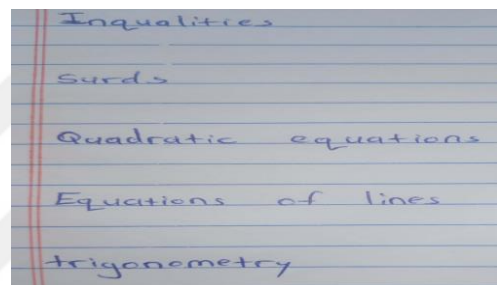
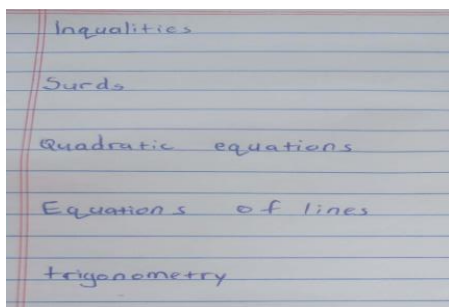
- Method of construction of the ending stroke [F]

The differences include;

- The shape of the A-like feature on exhibits 'N' and 'O'.
- Internal proportion of the starting stroke
- Absence of the y-like feature for the signature on exhibit 'N'

CONCLUSION: IDENTIFIED

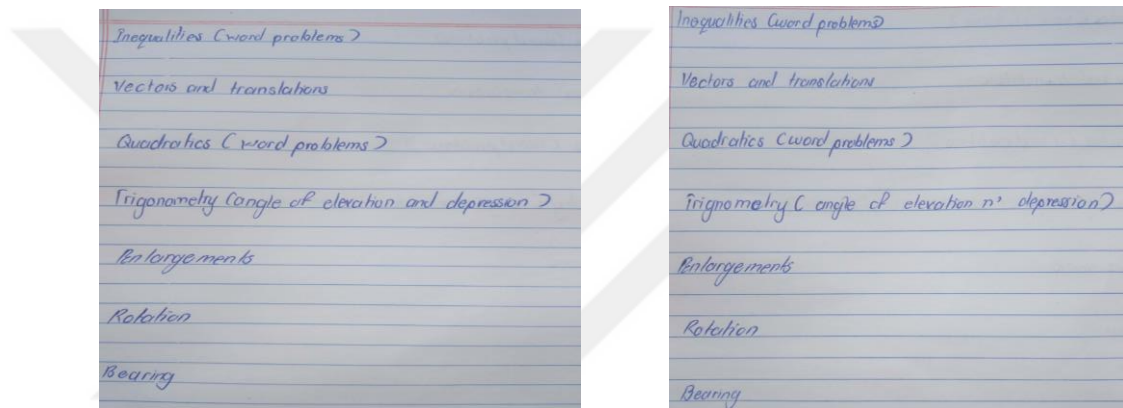
Questioned



Similarities

- Letter formation of “q” [F]
- Slant of the words to the right [M]
- Baseline habits of g [M]
- i-dottings and t crossings [F]
- Method of construction of “r” [F]
- Spacing of the words [S]

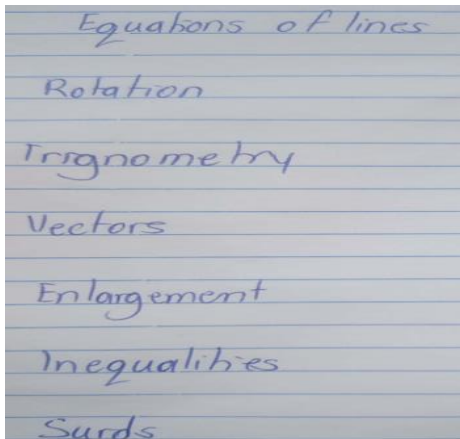
CONCLUSION: IDENTIFIED



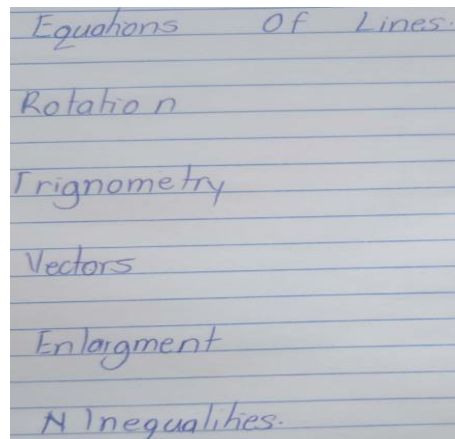
Similarities

- Slant of the letters to right [M]
- Embellishment on “E” [F]
- Method of construction of “f” [F]
- Connecting strokes of “t and a” [F]
- Baseline habits of “g” [M]
- External proportion of “d” [S]

CONCLUSION: IDENTIFIED



Equations of lines
Rotation
Trigonometry
Vectors
Enlargement
Inequalities
Surds

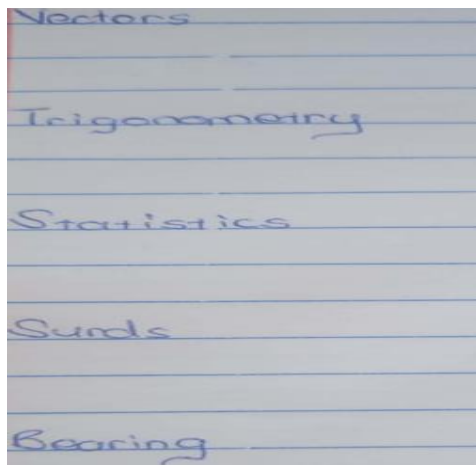


Equations Of Lines.
Rotation
Trigonometry
Vectors
Enlargement
Inequalities.

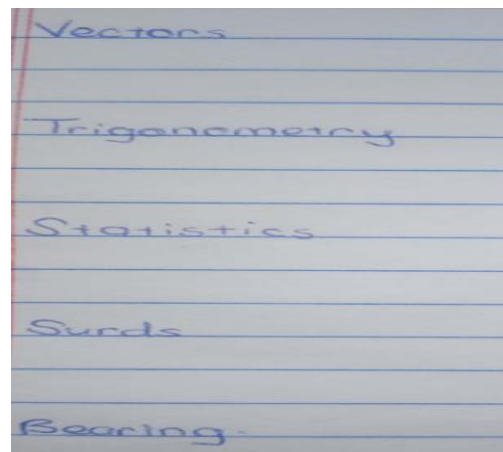
Similarities

- Connecting stroke of “t and i” [F]
- t- crossings [F]
- baseline habits of “g” [M]
- spacing between the letters [S]
- method of construction of “f” [F]

CONCLUSION: IDENTIFIED



Vectors
Trigonometry
Statistics
Surds
Bearing

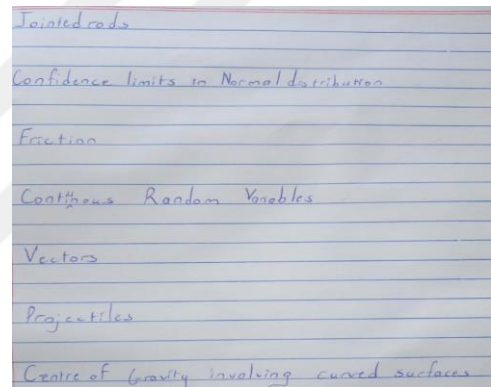
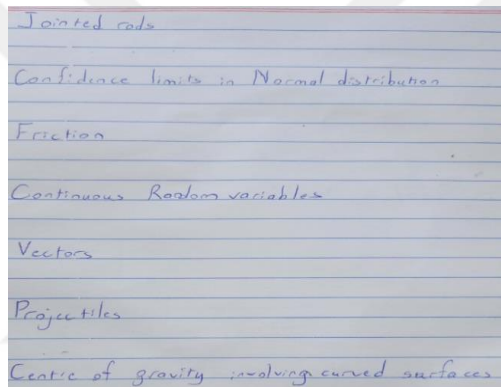


Vectors
Trigonometry
Statistics
Surds
Bearing.

Similarities

- Spacing of the letters [S]
- Low pen pressure [M]
- i-dottings [F]
- baseline habits of “ g” and “y” [M]
- High pen pressure [M]
- Method of construction of “ r ” [F]
- Slant of the letters is vertical [M]

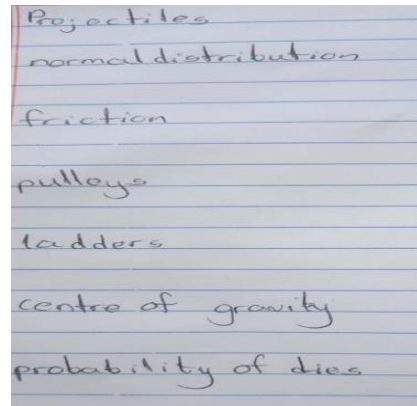
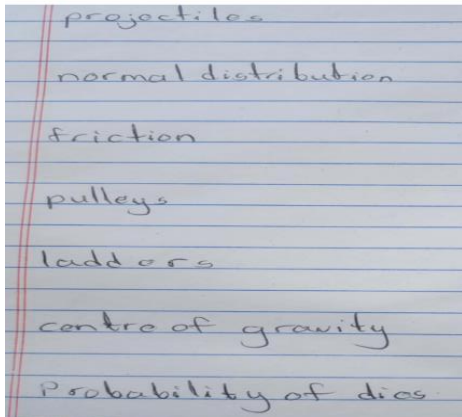
CONCLUSION: IDENTIFIED



Similarities

- External proportion of the starting letters [S]
- Baseline habits of “ j ” [M]
- Word and letter spacing [S]
- Method of construction of “ f ” [F]
- t-crossings [F]

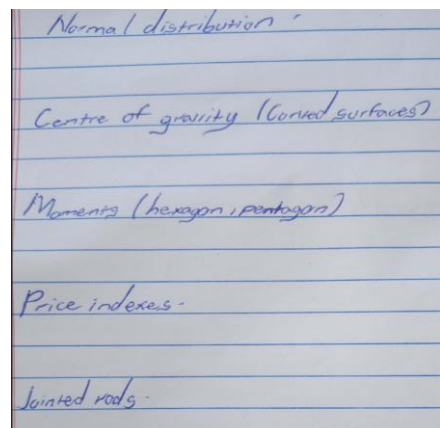
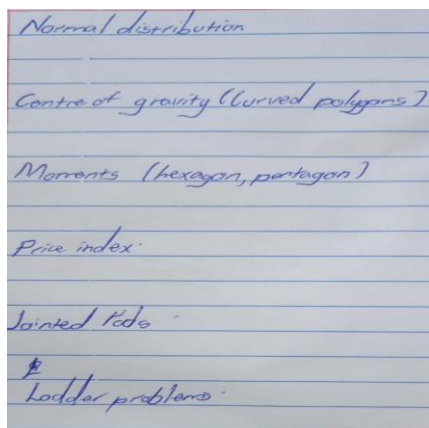
CONCLUSION: IDENTIFIED



Similarities

- high pen pressure [M]
- method of construction of “d” [F]
- connecting strokes between “v and a” [F]
- slant of the letters to the left [M]

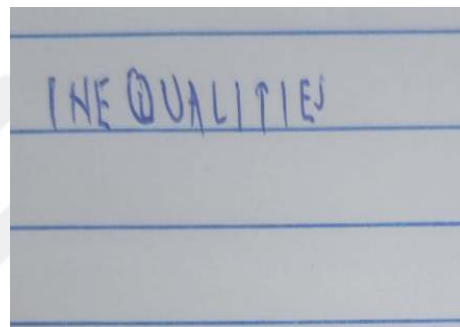
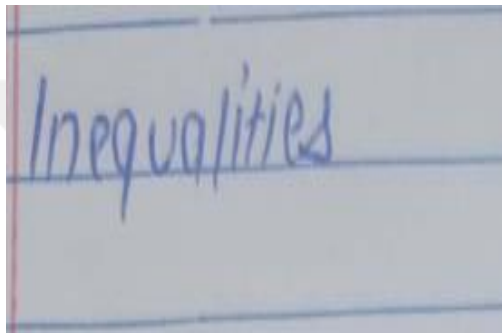
CONCLUSION: IDENTIFIED



Similarities

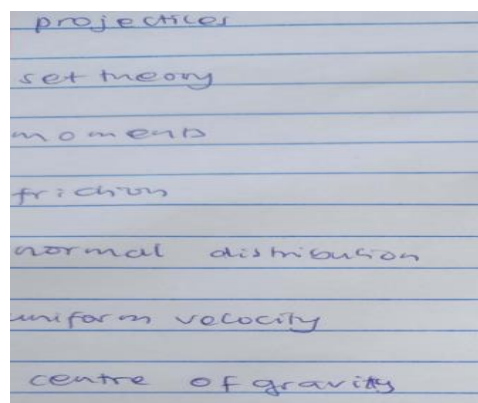
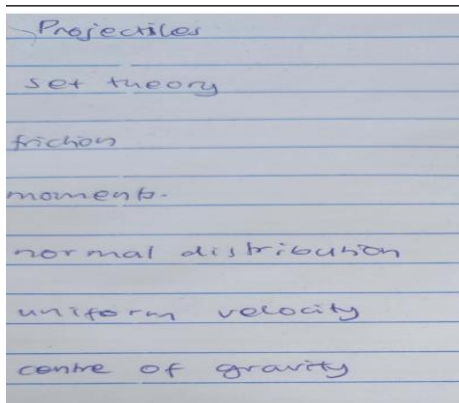
- Slant of the letters to the right [M]
- Embellishment on “g” [F]
- Baseline habits of “g” and “y” [F]
- Handwriting is cursive [F]
- Embellishments on “r” [F]
- Method of construction of “s” [F]

CONCLUSION: IDENTIFIED



One sample is written in lower case and the other in upper case.

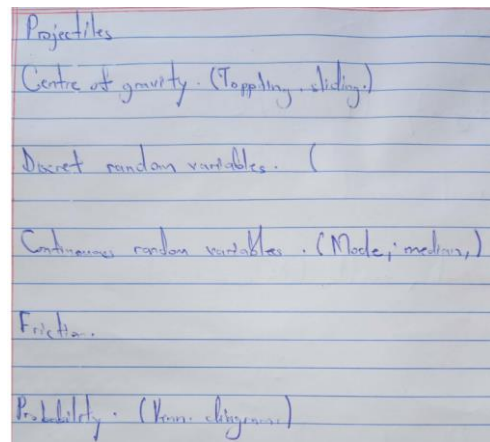
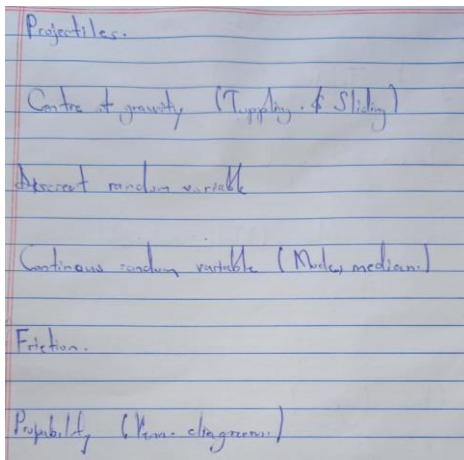
CONCLUSION : INCONCLUSIVE



Similarities

- Handwriting is cursive [F]
- Connecting strokes for “g” and “r” [F]
- Spacing of the letters [S]
- Method of construction of “th” [F]

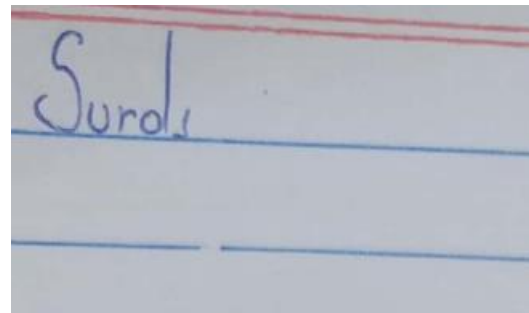
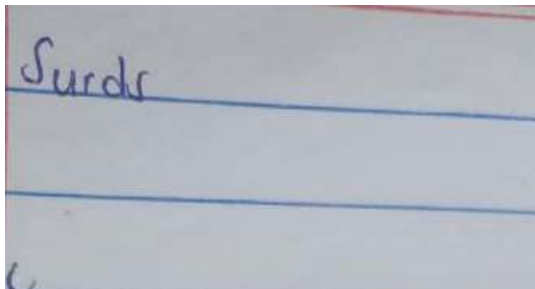
CONCLUSION: IDENTIFIED



Similarities

- Baseline habits of “g” , “p” , “y” [F]
- Connecting strokes of “ bl ” [F]
- The alignment of the letters [S]
- t-crossings [F]

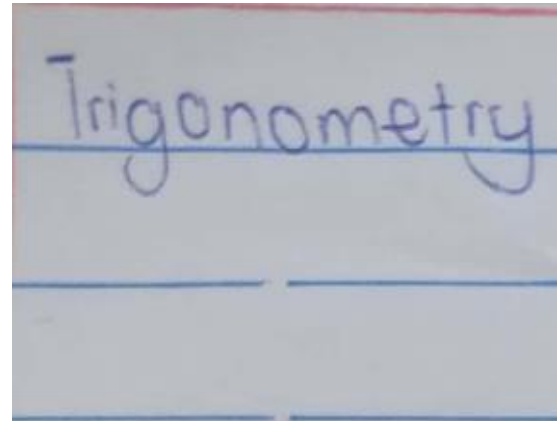
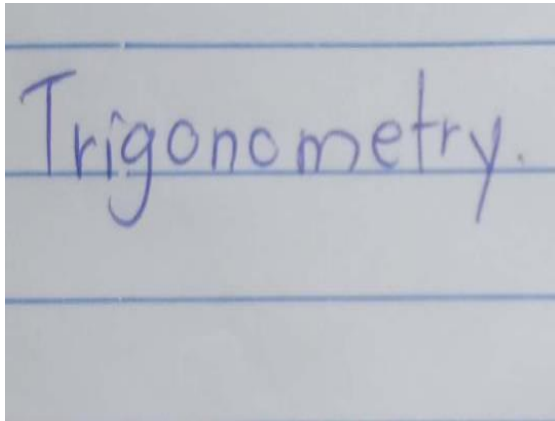
CONCLUSION: IDENTIFIED



Differences

- External proportion of “S” [S]
- Internal proportion of “d” [S]
- Method of construction of “u” [F]

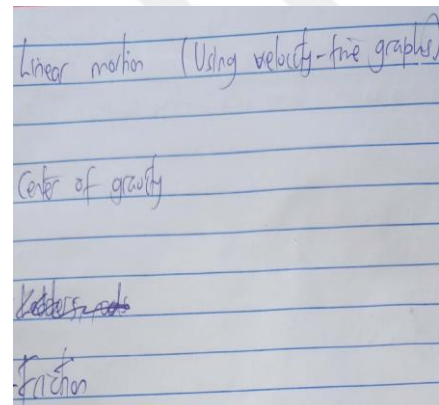
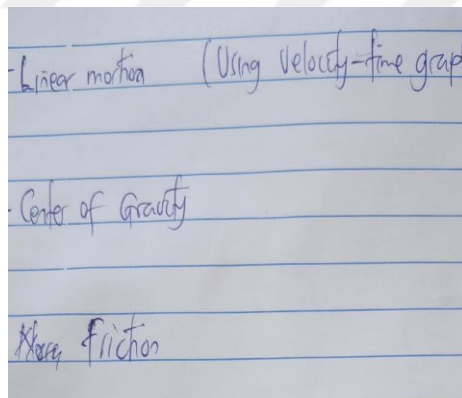
CONCLUSION: ELIMINATED



Differences

- Nature of the i-dottings [F]
- Method of construction of “y” [F]
- Nature of g-loops [M]
- The alignment of “r” [S]

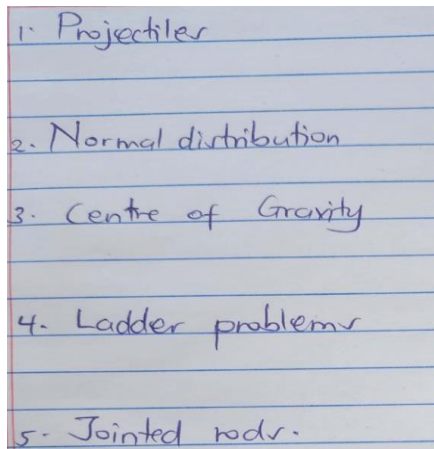
CONCLUSION: ELIMINATED



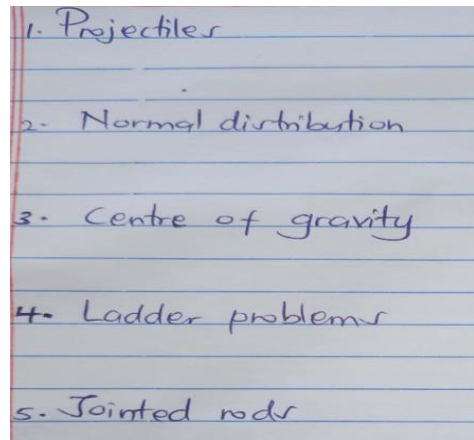
Similarities

- connecting strokes of “t” and “y” [F]
- handwriting is cursive [M]
- embellishment on “t” [F]
- method of construction of “F” [F]
- spacing of the words [S]

CONCLUSION: IDENTIFIED



1. Projectiles
2. Normal distribution
3. Centre of Gravity
4. Ladder problems
5. Jointed rods.

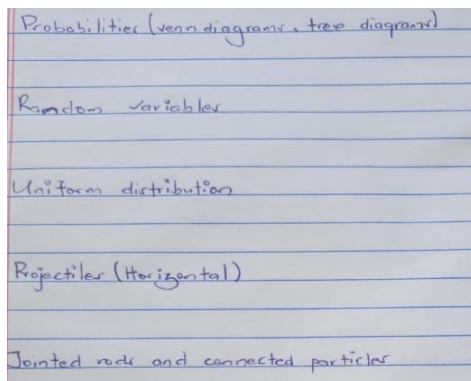


1. Projectiles
2. Normal distribution
3. Centre of gravity
4. Ladder problems
5. Jointed rods

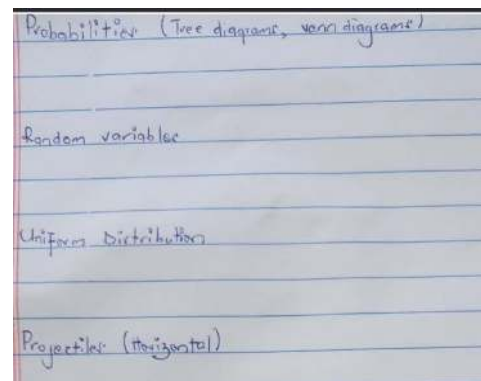
Similarities

- Method of construction of “J” [F]
- Connecting strokes of “t” and “r” [F]
- Line quality is very fluent. [M]
- Alignment of “m” [S]
- Higher pen pressure [M]

CONCLUSION: IDENTIFIED



Probabilities (Venn diagrams, tree diagrams)
Random variables
Uniform distribution
Projectiles (Horizontal)
Jointed rods and connected particles

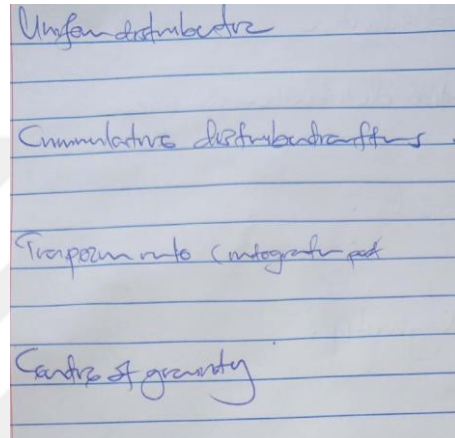
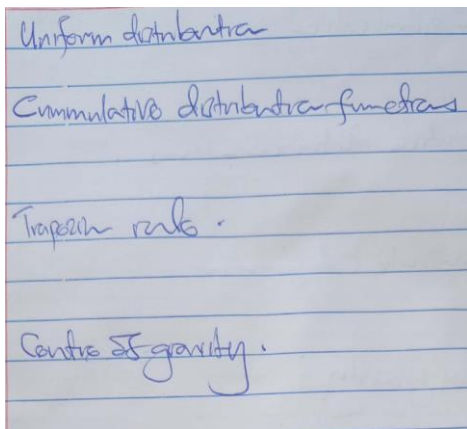


Probabilities (Tree diagrams, Venn diagrams)
Random variables
Uniform distribution
Projectiles (Horizontal)

Similarities

- i-dots are circular [F]
- method of construction of “ z ” [F]
- slant of “ v ” [M]
- g-loops are uniform [M]
- baseline habits of “ f ” [M]

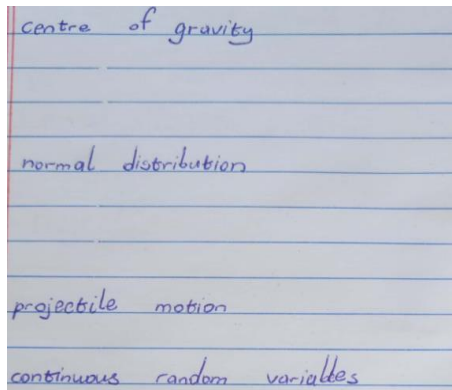
CONCLUSION : IDENTIFIED



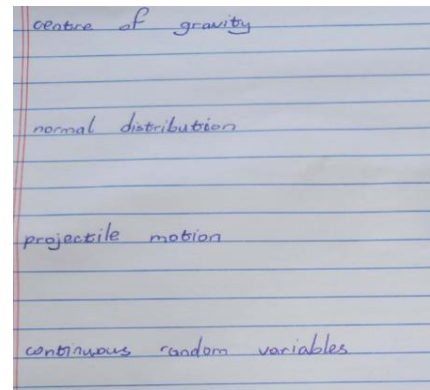
Similarities Handwriting is cursive [M]

- Method of construction of “ z ” [F]
- Loops of “g” and “y” [F]
- Embellishment on “e” [F]
- Alignment of “f” [S]

IDENTIFIED: IDENTIFIED



centre of gravity
normal distribution
projectile motion
continuous random variables

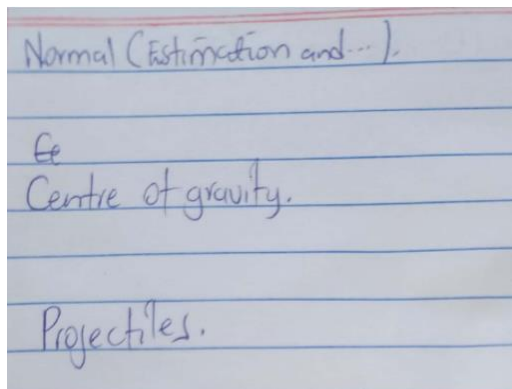


centre of gravity
normal distribution
projectile motion
continuous random variables

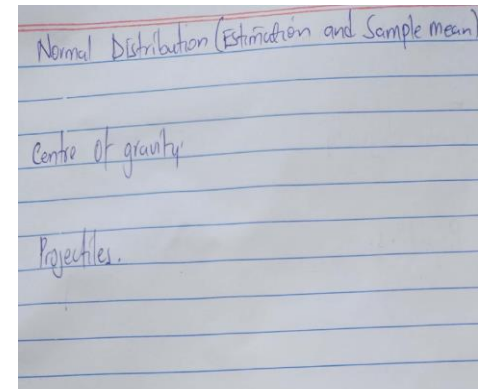
Similarities between S1 and S2

- Method of construction of “l” [F]
- Embellishment on “t” [F]
- Size of the letters is small [S]
- Connecting strokes of “u” and “s” [F]

CONCLUSION: IDENTIFIED



Normal (Estimation and...)
Centre of gravity.
Projectiles.

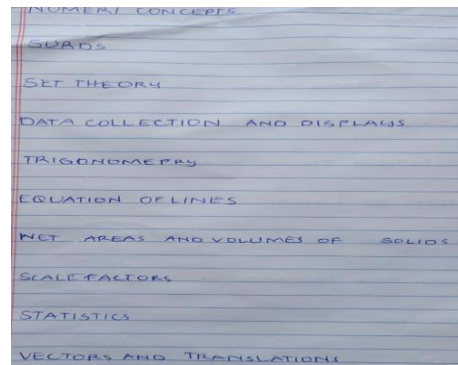
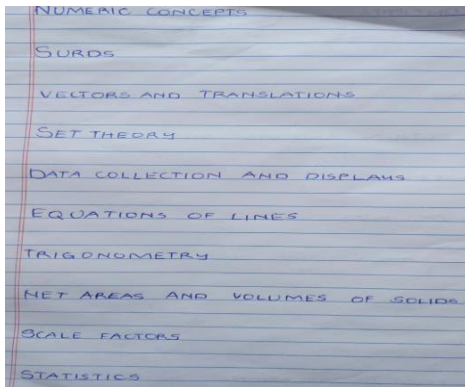


Normal Distribution (Estimation and Sample mean)
Centre of gravity
Projectiles.

Similarities

- Method of construction of “s” [F]
- Connecting strokes of “ion” [F]
- External proportion of “j” [S]
- Alignment of “E” [S]

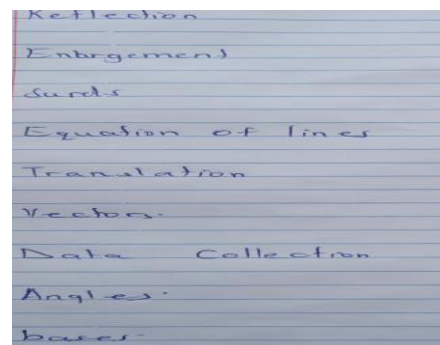
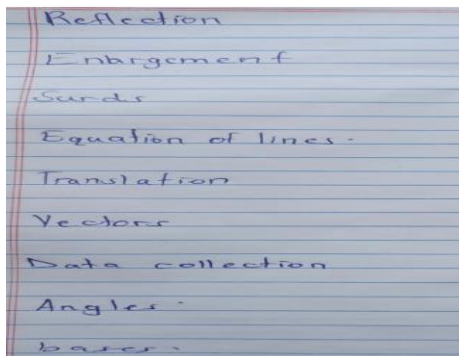
CONCLUSION: IDENTIFIED



Similarities

- Method of construction of “Y” [F]
- T-crossings [F]
- Spacing of the words [S]
- Alignment of “S” [S]

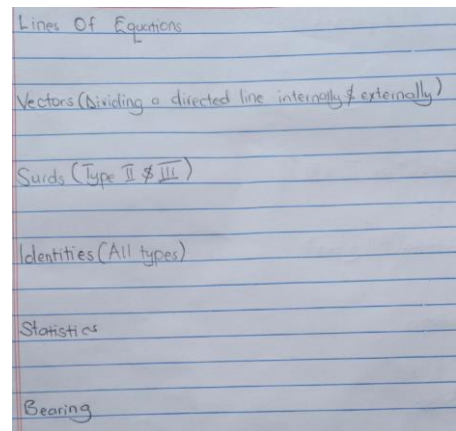
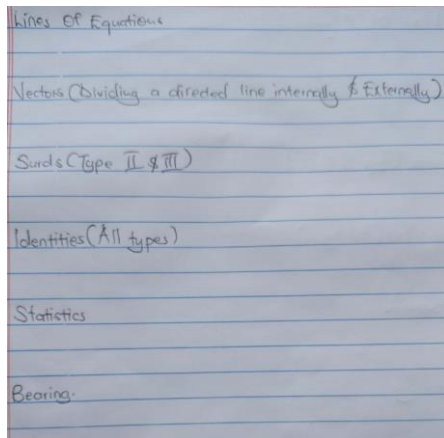
CONCLUSION: IDENTIFIED



Similarities

- g - loops are short [M]
- method of construction of “f” [F]
- i-dottings [F]
- connecting strokes of “s” and “e” [F]
- Baseline habits [M]

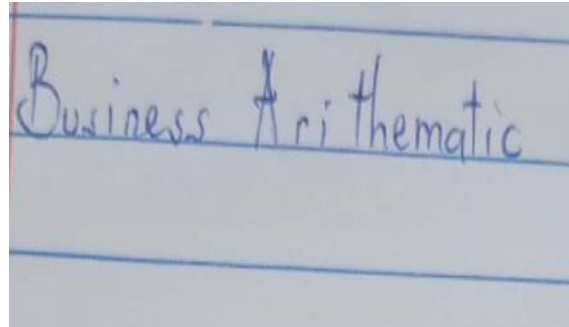
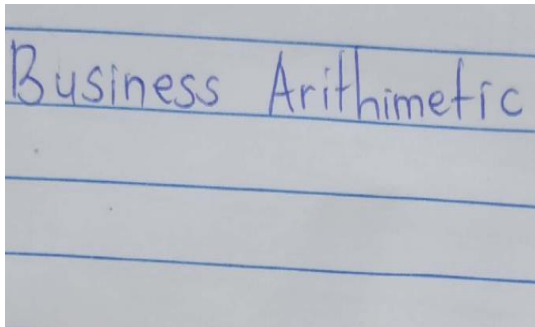
CONCLUSION: IDENTIFIED



Similarities

- Slant of the letters is vertical [M]
- Method of construction of the numerals [F]
- Loops of “y” and “g” [M]
- Spacing of the letters [S]

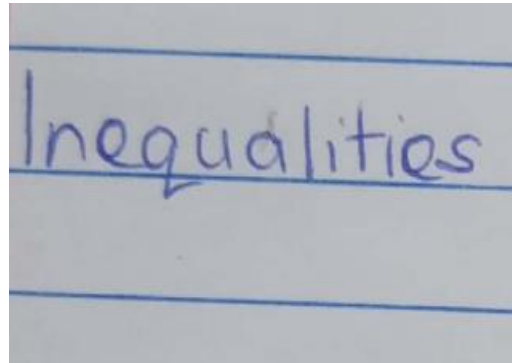
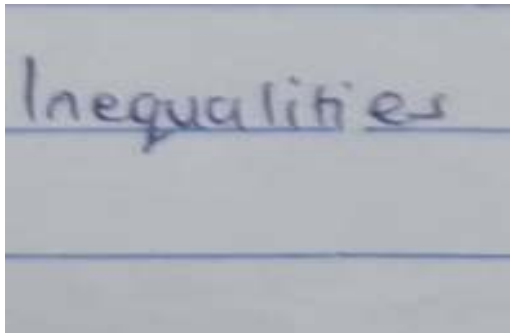
CONCLUSION: IDENTIFIED



Differences

- Rhythm of the handwriting is different [M]
- Nature of the t-crossings [F]
- Method of construction of B [F]
- Position of the i-dottings [F]

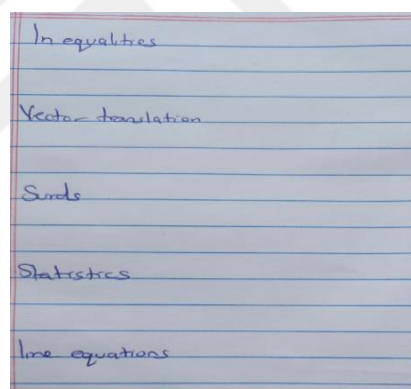
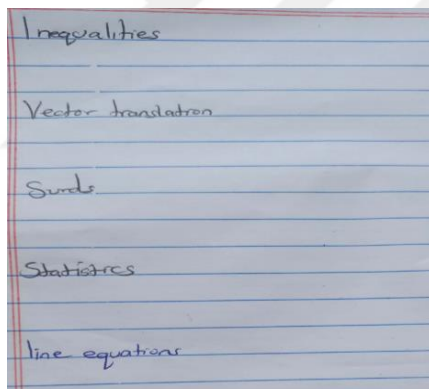
CONCLUSION: ELIMINATED



Differences

- Baseline habits of “q” [M]
- Rhythm of the style [M]
- Connecting strokes of t and l [F]
- Slant of t-crossings [M]

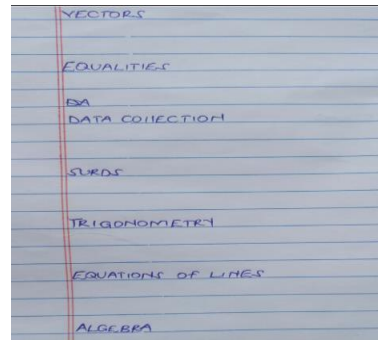
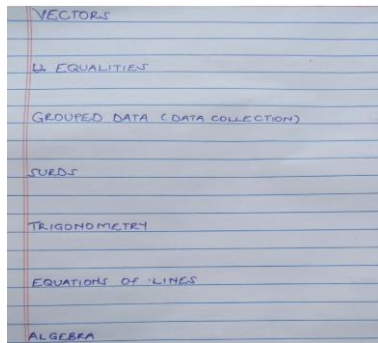
CONCLUSION: ELIMINATED



Similarities

- Connecting strokes of “u” and “r” [F]
- Handwriting is cursive [M]
- Method of construction of “q” [F]
- t-crossings [F]
- i-dottings [F]

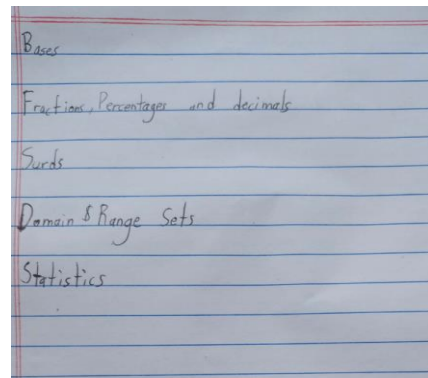
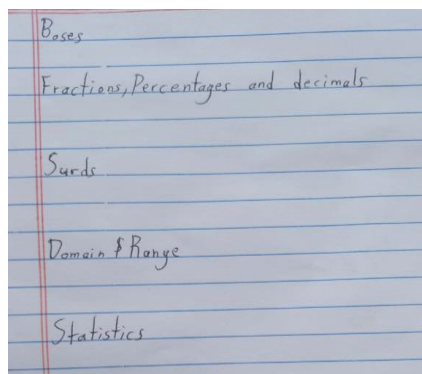
CONCLUSION: IDENTIFIED



Similarities

- handwriting is not cursive [M]
- method of construction of “s” [F]
- alignment of “E” [S]
- slant of “V” [M]
- line quality is fluent [S]

CONCLUSION: IDENTIFIED

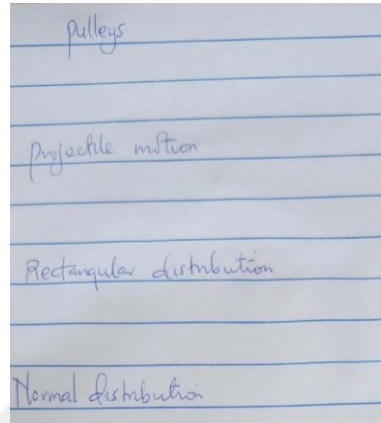
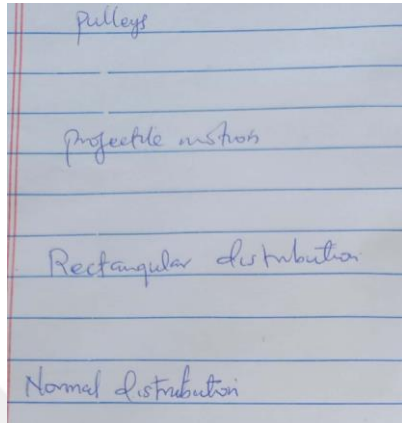


Similarities

- method of construction of “f” [F]
- slope of “S” [M]
- g-loops are long [M]
- external proportion of the starting letters for each word. [S]

- Alignment of “c” [S]

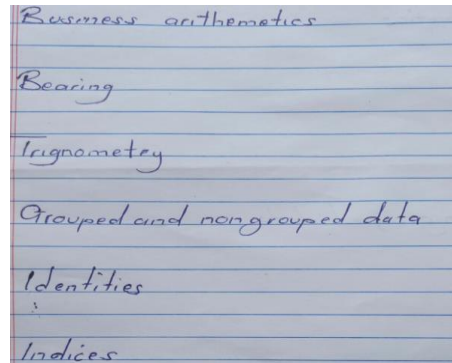
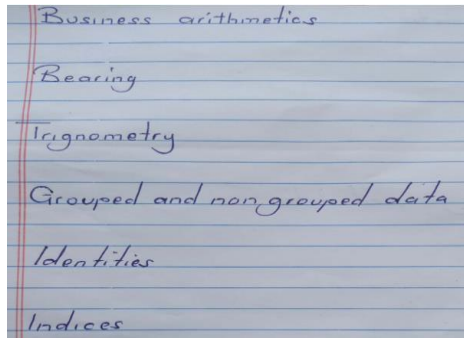
CONCLUSION: IDENTIFIED



Similarities

- Connecting strokes of “t” and “o” [F]
- Embellishment on “j” [F]
- Method of construction of “d” [F]
- Handwriting is cursive [M]
- Slant of the words to the left [M]

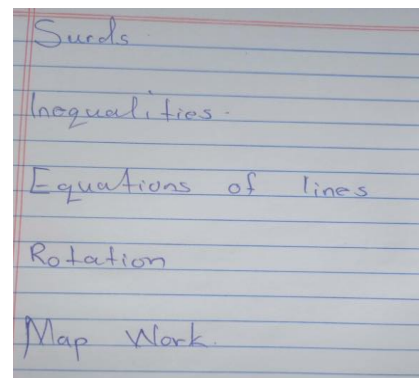
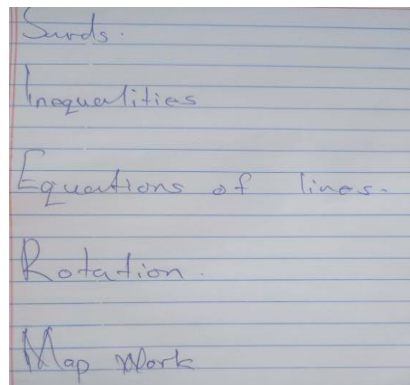
CONCLUSION: IDENTIFIED



Similarities

- T-crossings [F]
- method of construction of “I” [F]
- g-loops [M]
- pen pressure is high [M]
- alignment of the letters [S]

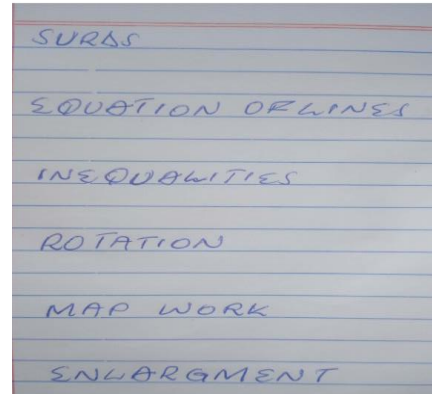
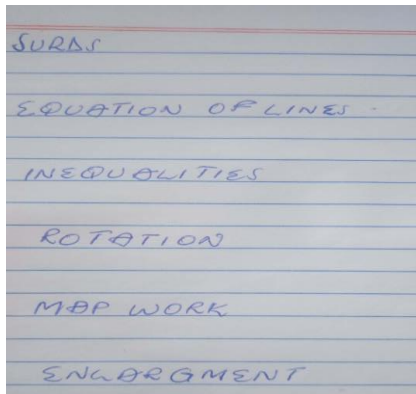
CONCLUSION: IDENTIFIED



Similarities

- Handwriting is cursive [M]
- Connecting strokes of “a” and “l” [F]
- Method of construction of “M” [F]
- External proportion of the starting letters for each word [S]
- t-crossings are horizontal [F]

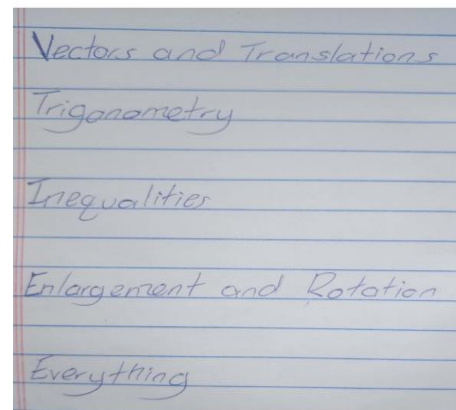
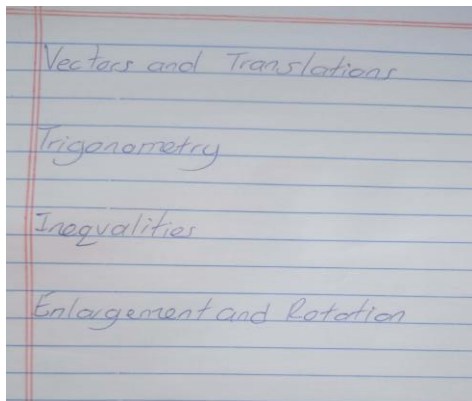
CONCLUSION: IDENTIFIED



Similarities

- T-crossings are tilted in the same way [F]
- method of construction of “E” [F]
- slope of the letters to the left [M]
- embellishment on “L” [F]

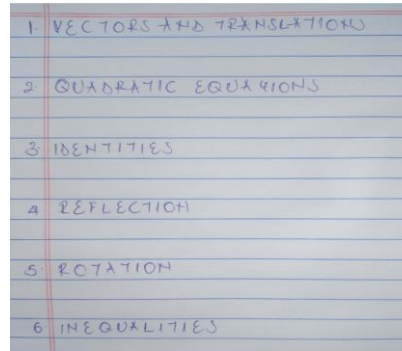
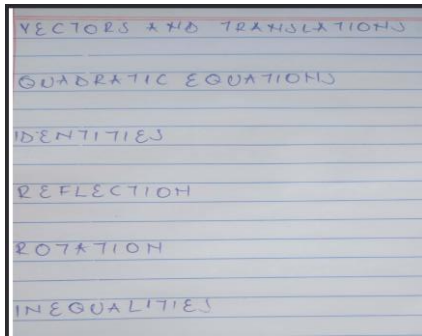
CONCLUSION: IDENTIFIED



Similarities

- baseline habits of “y” and “g” [M]
- slant of the letters to the left [M]
- position of the i-dottings [F]
- T-crossings upwards [F]

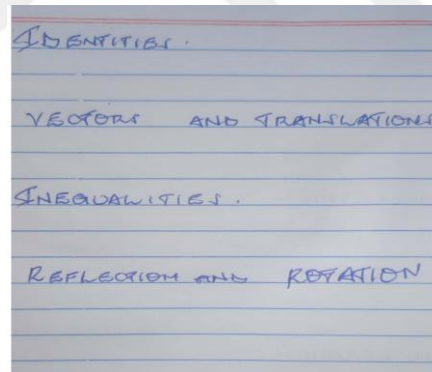
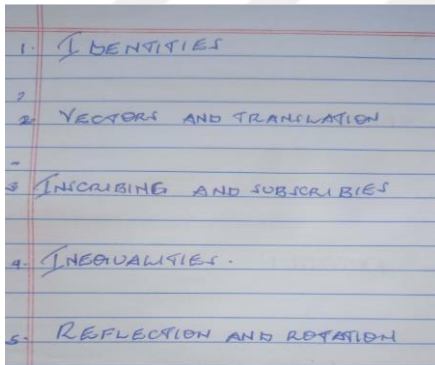
CONCLUSION: IDENTIFIED



Similarities

- t-crossings are short [F]
- method of construction of “E” [F]
- Alignment of “S” [S]
- Internal proportion of the letters [S]

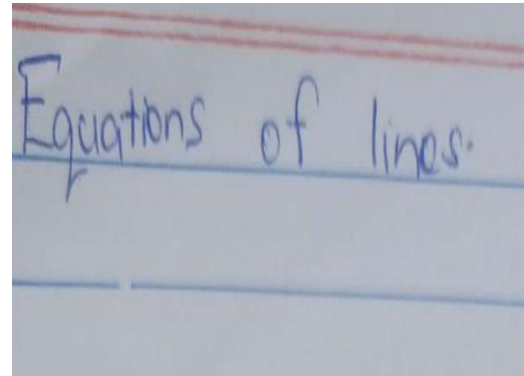
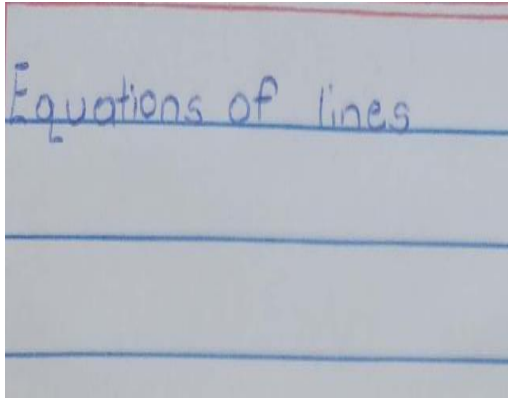
CONCLUSION: IDENTIFIED



Similarities

- Method of construction of “T” [F]
- Embellishment on “T” [F]
- Connecting strokes of “O” and “N” [F]
- Slant of “F” [M]

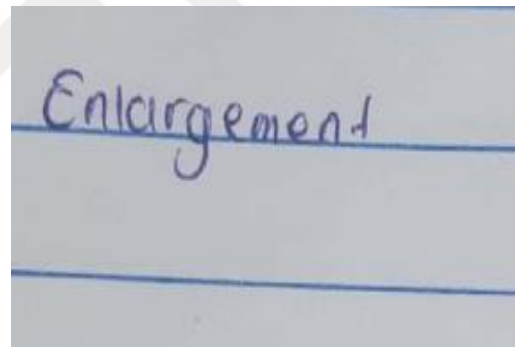
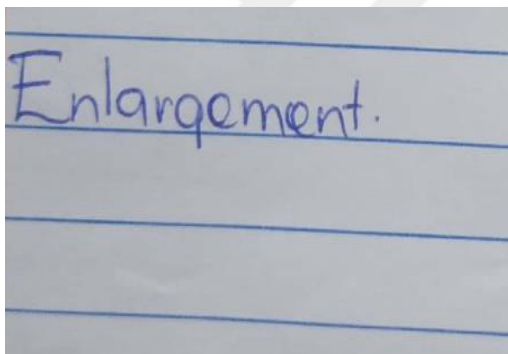
CONCLUSION: IDENTIFIED



Differences

- Method of construction of "E" [F]
- Spacing of the letters [S]
- Embellishment on "E" [F]
- The baseline habits of "q" [M]

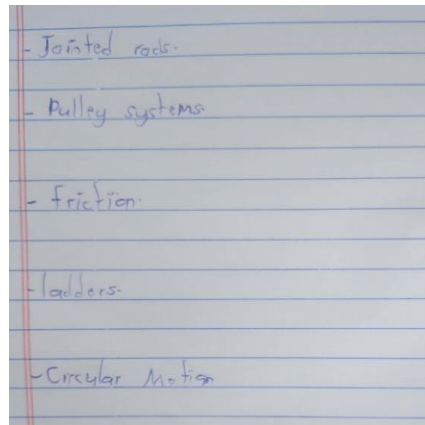
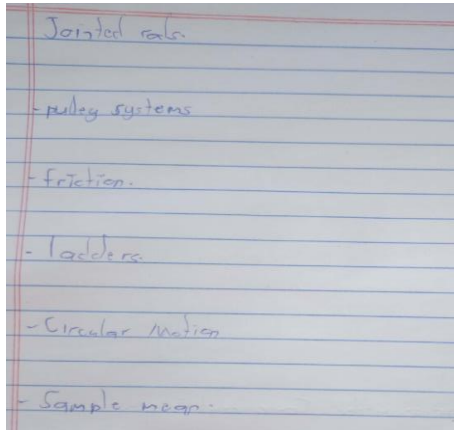
CONCLUSION: ELIMINATED



Differences

- Method of construction of "E" [F]
- The length of the g-loops [M]
- Rhythm of the handwriting style [M]

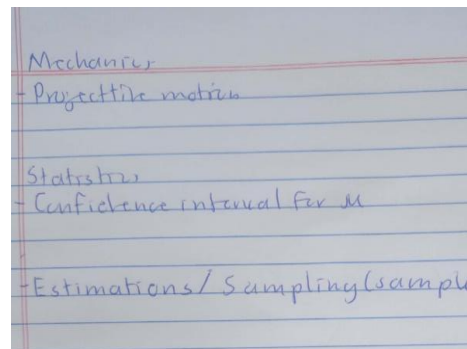
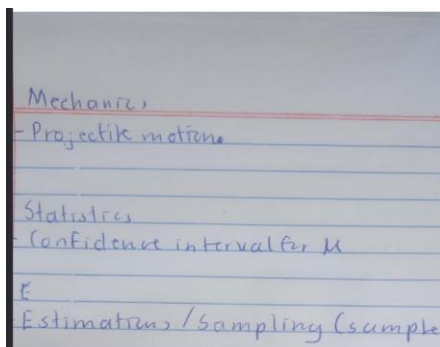
CONCLUSION: ELIMINATED



Similarities

- Spacing of the letters is uniform [S]
- i-dottings [F]
- method of construction of “F” [F]
- baseline habits of “y” [M]

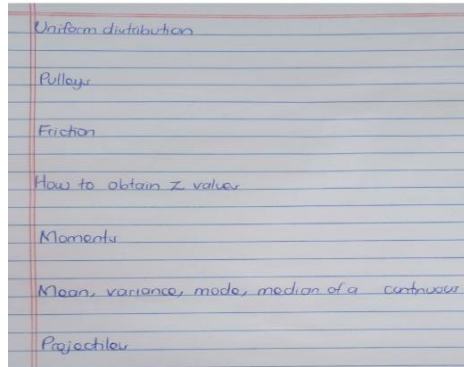
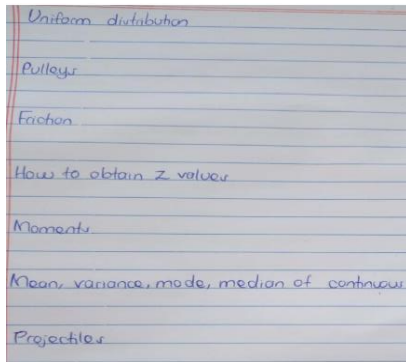
CONCLUSION: IDENTIFIED



Similarities

- Connecting strokes of “ion” [F]
- Method of construction of “g” [F]
- Alignment of “a” [S]
- i-dottings [F]

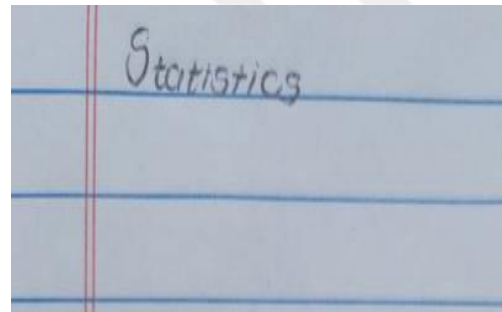
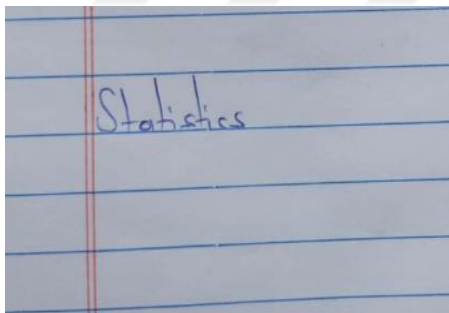
CONCLUSION: IDENTIFIED



Similarities

- loops of “j ” are short [F]
- method of construction of “P” [F]
- spacing of the letters in a word [S]
- pen pressure is high [M]

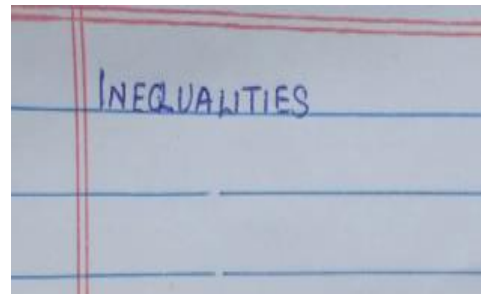
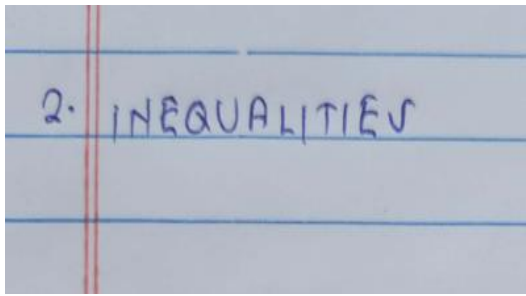
CONCLUSION: IDENTIFIED



Differences

- nature of the t-crossings [F]
- external proportion of S [S]
- method of construction of “t” [F]
- nature of the i-dottings [F]

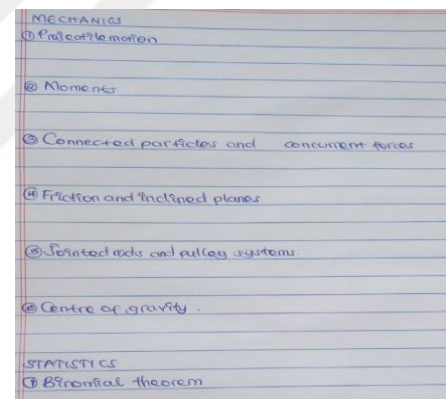
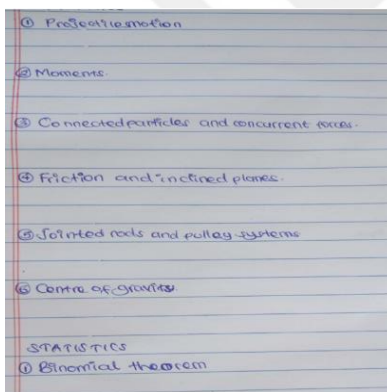
CONCLUSION: ELIMINATED



Differences

- method of construction of E [F]
- Slant of the t-crossings [M]
- External proportion of "I" [S]
- Alignment of L [S]

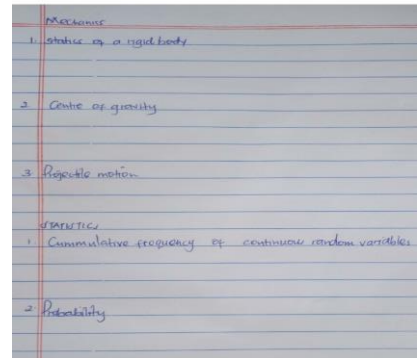
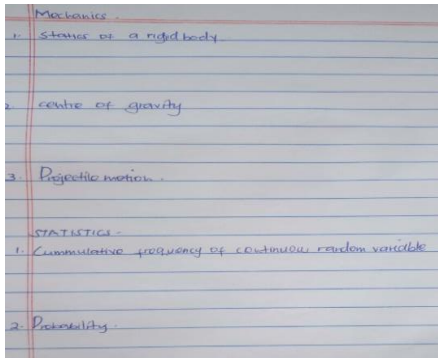
CONCLUSION: ELIMINATED



Similarities

- i-dottings are circular [F]
- loops of "g" and "y" don't cross the base lines [F]
- fluency in the handwriting [M]
- spacing of the words [S]

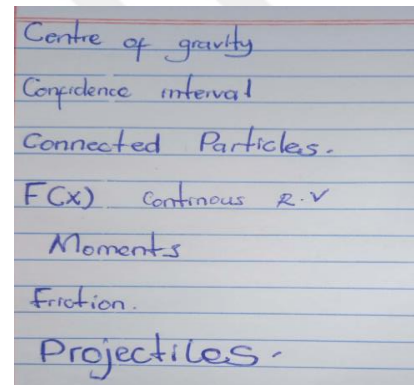
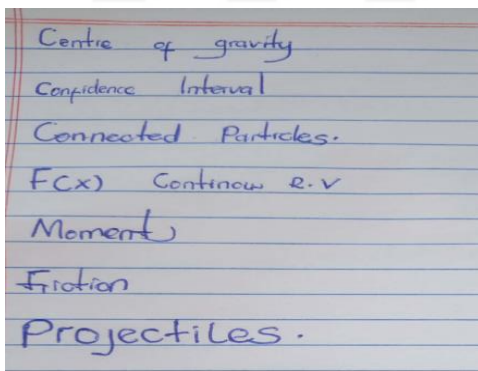
CONCLUSION: IDENTIFIED



Similarities

- connecting strokes of “t” and “y” [F]
- method of construction of “M” [F]
- external proportion of “P” [S]
- Alignment of the letters is uniform [S]

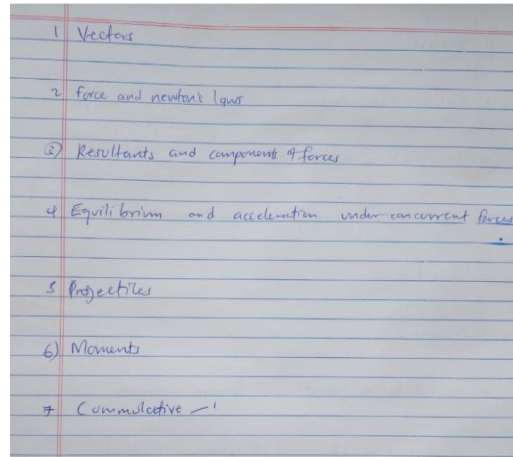
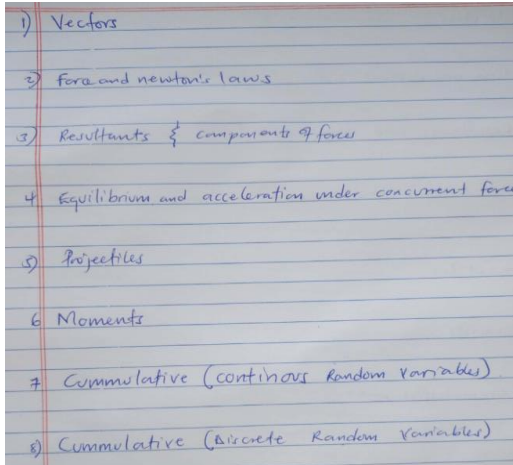
CONCLUSION: IDENTIFIED



Similarities

- Baseline habits of “f” [M]
- Connecting strokes of “r” and “t” [F]
- Loops of “g” are identical [F]
- The slant of “l” [M]

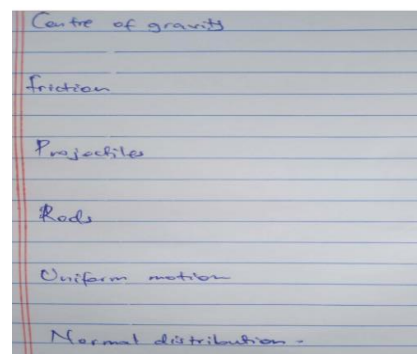
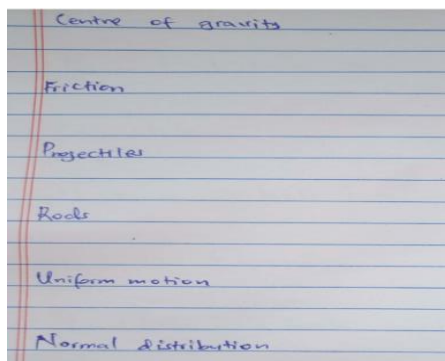
CONCLUSION: IDENTIFIED



Similarities

- handwriting is cursive [M]
- method of construction of “M” [F]
- connecting strokes of “t” and “s” [F]
- baseline habits of “q” [M]

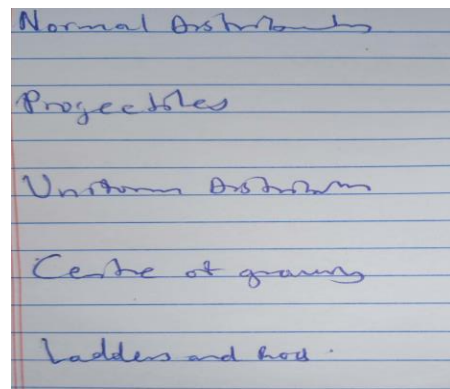
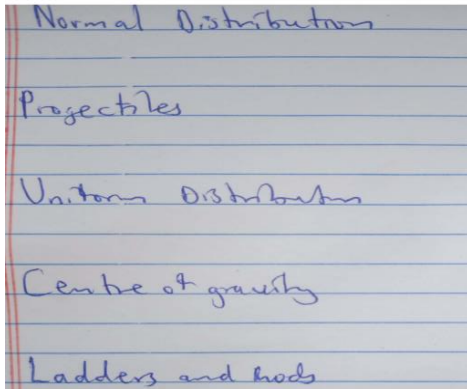
CONCLUSION: IDENTIFIED



Similarities

- connecting strokes of “t” and “y” [F]
- method of construction of “R” [F]
- slant of “f” [M]
- spacing of the letters [S]

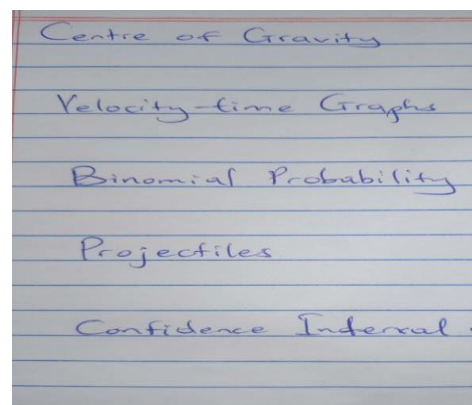
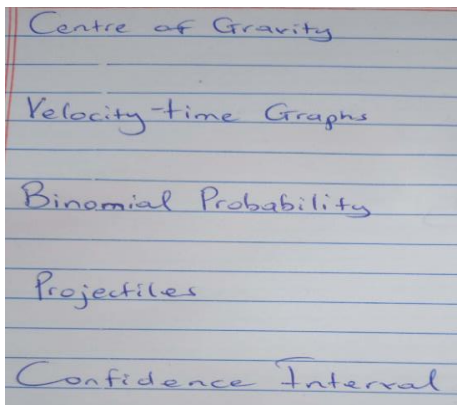
CONCLUSION: IDENTIFIED



Similarities

- handwriting is cursive [M]
- medial strokes are similar [F]
- loops of “j” [F]
- method of construction of “U” [F]

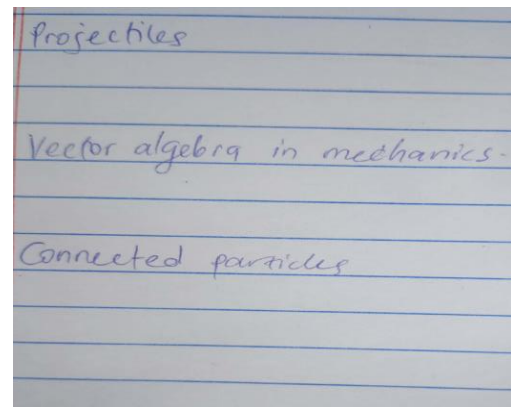
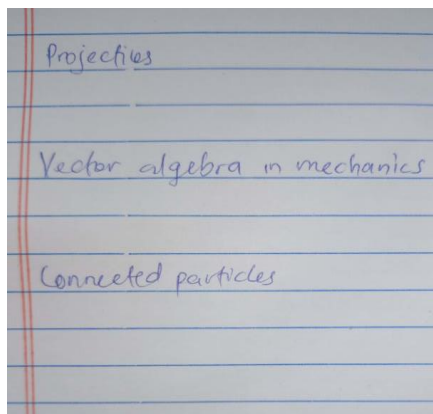
CONCLUSION: IDENTIFIED



Similarities

- baseline habits of “p’ [M]
- method of construction of “I” [F]
- Slant of “m” [M]
- External proportion of the starting letters for each word. [S]

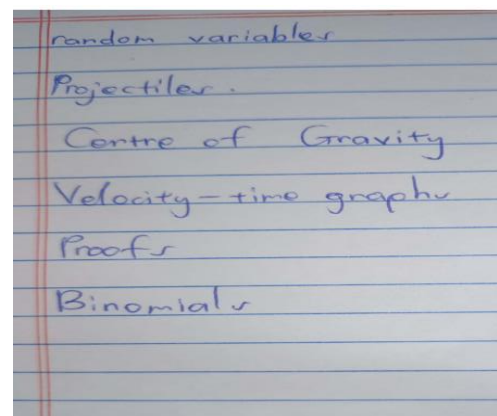
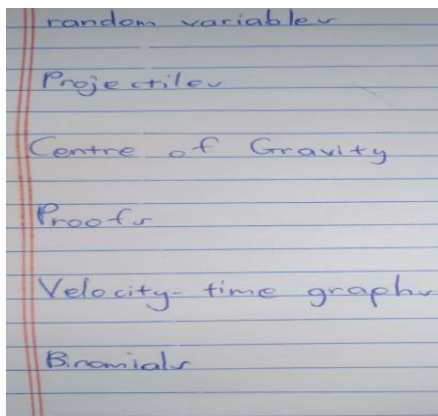
CONCLUSION: IDENTIFIED



Similarities

- handwriting is cursive [M]
- medial strokes of the letters in each word [F]
- loops of "g" [F]
- baseline habits of "g" [M]

CONCLUSION: IDENTIFIED



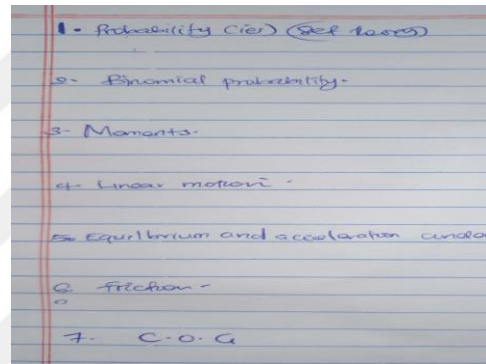
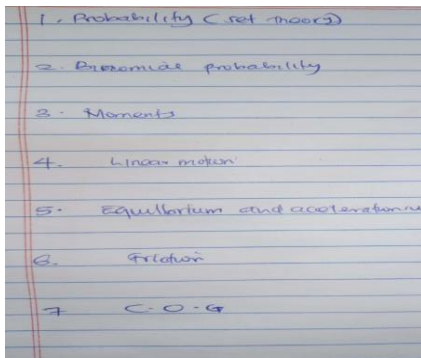
Similarities

- external proportion of “G” [S]
- slant of “p” to the right [M]
- method of construction of “f” [F]
- connecting strokes of “t” and “r” [F]

Differences

- Margin habits of the handwriting

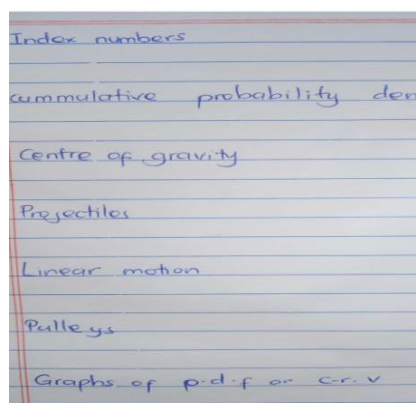
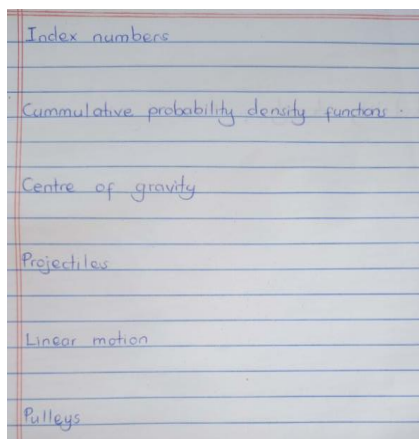
CONCLUSION: IDENTIFIED



Similarities

- method of construction of “M” [F]
- baseline habits of “q” [M]
- connecting strokes of “t” and “s” [F]
- crossings of “F” [F]

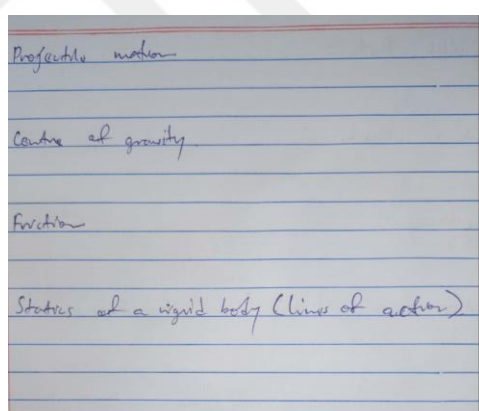
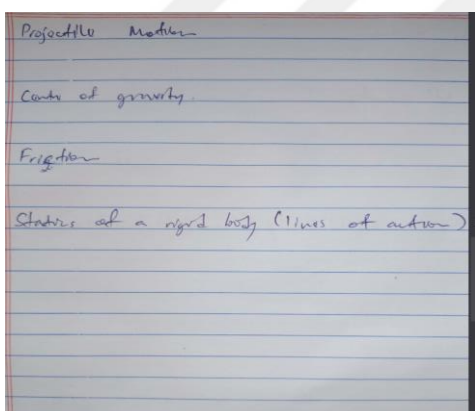
CONCLUSION: IDENTIFIED



Similarities

- loops of “g” and “y” [F]
- baseline habits of “f” [M]
- i-dottings [F]
- spacing of the words [S]

CONCLUSION: IDENTIFIED



Similarities

- handwriting is cursive [M]
- connecting strokes of “g” and “i” [F]
- pen pressure is low [M]
- method of construction of “f” [F]

CONCLUSION: IDENTIFIED

Centre Of Gravity
Moments
Ladder problems
Probabilities (Tree diagrams)
Normal Distribution

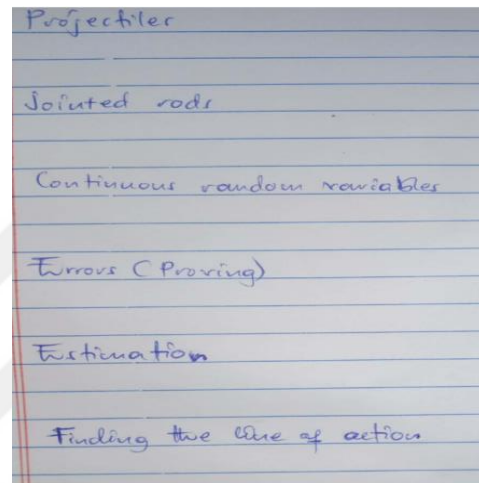
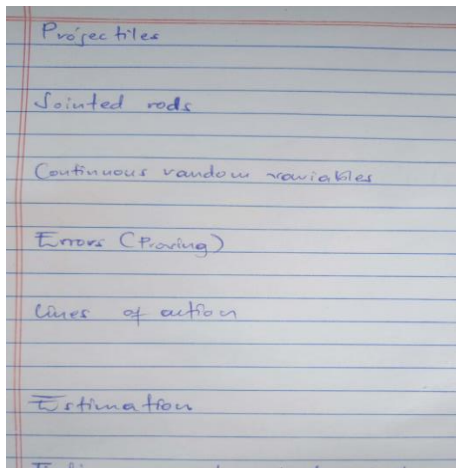
Centre of Gravity
Moments
Ladder problems
Probabilities
Normal Distribution



Similarities

- method of construction of “d” [F]
- connecting strokes of “ion” [F]
- slant of “f” [M]
- alignment of “s” [S]

CONCLUSION: IDENTIFIED



Similarities

- handwriting is cursive [M]
- method of construction of “E” [F]
- i-dottings [F]
- alignment of “n” [S]

CONCLUSION: IDENTIFIED

1) Propagation of errors
2) Jointed Rods
3) Continuous Random Variables
4) Price indices
5) Projectiles
6) Friction

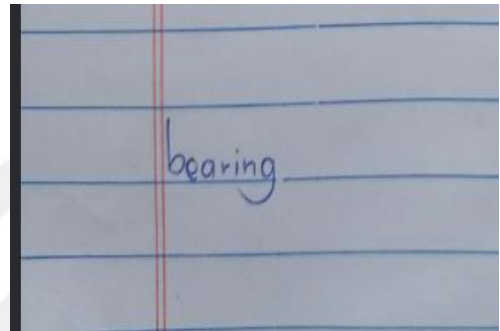
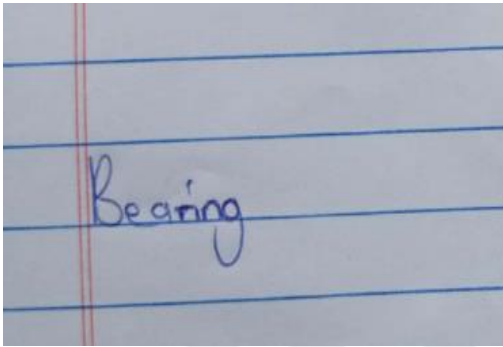
1) Propagation of errors
2) Jointed Rods
3) Continuous Random Variables
4) Price indices
5) Projectiles
6) Friction
7) Pulleys



Similarities

- Embellishment on “P” [F]
- i-dottings are similar [F]
- Method of construction of “R” [F]
- Internal proportion of the letters is similar [S]

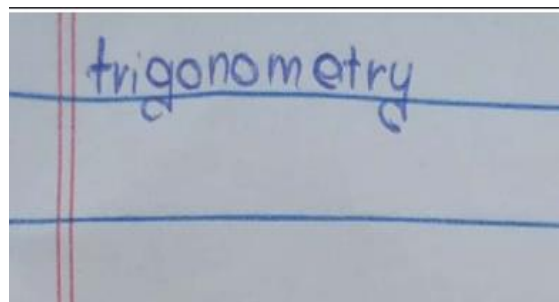
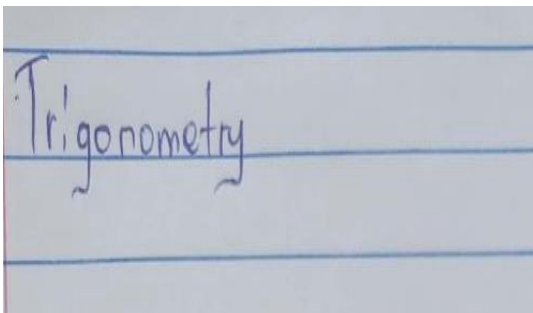
CONCLUSION: IDENTIFIED



Differences

- Nature of the g-loops [F]
- i-dottings [F]
- Difference in the rhythm [M]
- Alignment of “e” [S]

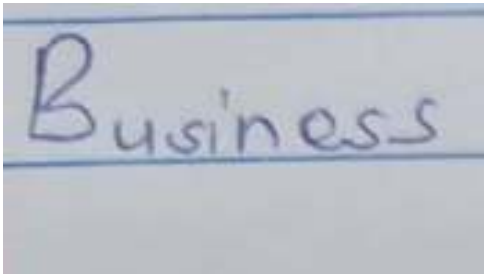
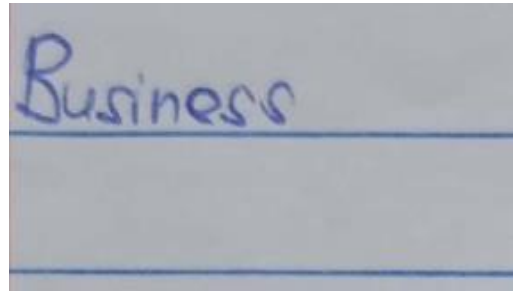
CONCLUSION: ELIMINATED



Differences

- Nature of the g and y loops [F]
- The slant of the t-crossings [M]
- Embellishment of “y” [F]
- Size of the letters [S]

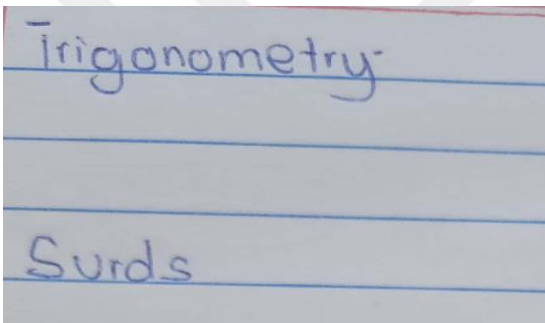
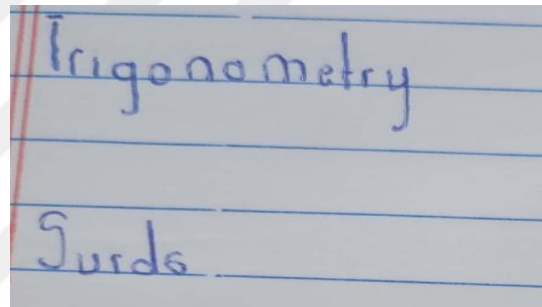
CONCLUSION: ELIMINATED

A photograph of a piece of lined paper with the word "Business" written in blue ink. The word is written on a single line and is slightly slanted to the right.A photograph of a piece of lined paper with the word "Business" written in blue ink. The word is written on a single line and is slightly slanted to the right.

Differences

- The alignment of "s"

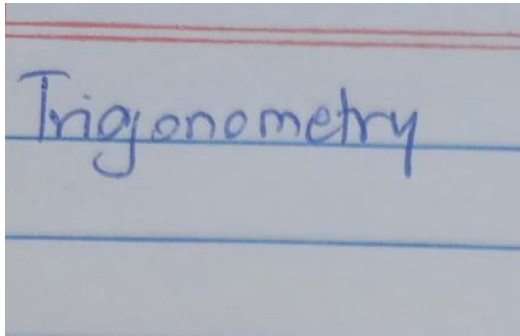
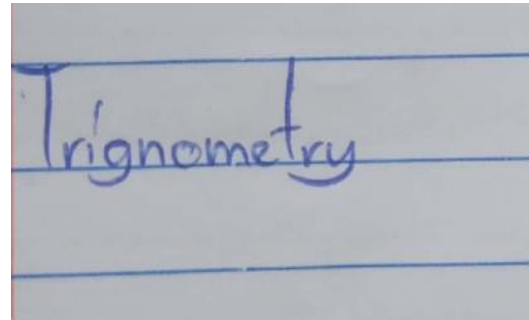
CONCLUSION: **INCONCLUSIVE**

A photograph of a piece of lined paper with the words "Trigonometry" and "Surds" written in blue ink. "Trigonometry" is on the top line and "Surds" is on the bottom line. The paper has a red margin line on the left.A photograph of a piece of lined paper with the words "Trigonometry" and "Surds" written in blue ink. "Trigonometry" is on the top line and "Surds" is on the bottom line. The paper has a red margin line on the left.

Differences

- External proportion of S [**M**]
- Baseline habits of g and y [**M**]
- Method construction of T [**F**]

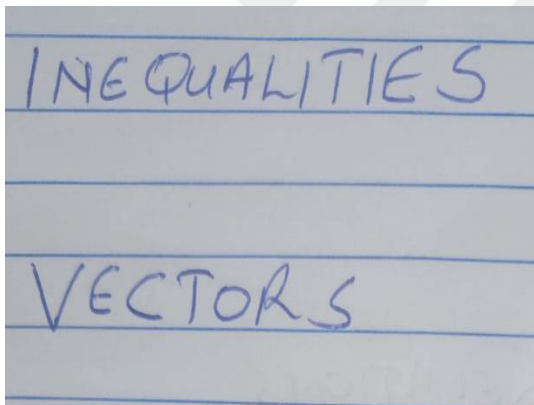
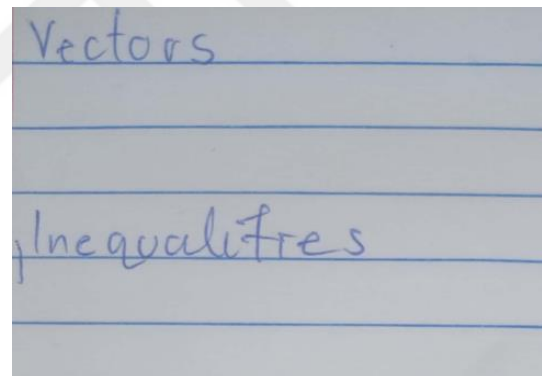
CONCLUSION : **ELIMINATED**

A photograph of a piece of lined paper with the word "Trigonometry" written in blue ink. The word is written in a cursive style, with the 'i' having a dot and the 'r' having a connecting stroke to the 'i'.A photograph of a piece of lined paper with the word "Trignometry" written in blue ink. The word is written in a cursive style, with the 'i' having a dot and the 'r' having a connecting stroke to the 'i'.

Differences

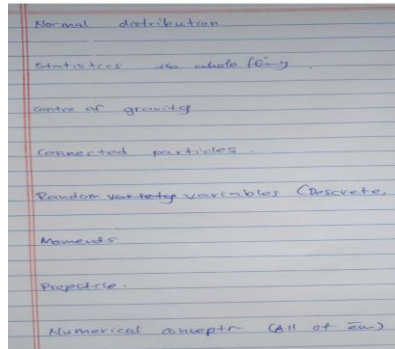
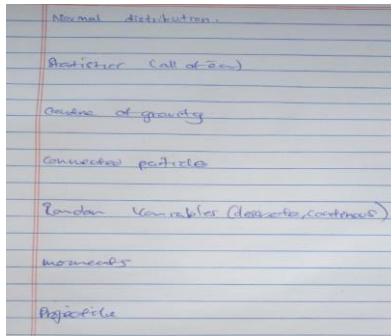
- Nature of the i- dottings [F]
- Connecting strokes of t and r [F]
- External and internal proportion of t [S]
- Baseline habits of "g" [M]
- The slant for m [M]

CONCLUSION: **ELIMINATED**

A photograph of a piece of lined paper with the words "INEQUALITIES" and "VECTORS" written in blue ink. The words are written in all capital letters in a cursive style.A photograph of a piece of lined paper with the words "Vectors" and "Inequalities" written in blue ink. The words are written in all lowercase letters in a cursive style.

One sample is written in lower case and the other in upper case and therefore no comparable features.

CONCLUSION: INCONCLUSIVE



Similarities

- Handwriting is cursive [M]
- Medial strokes of each word [F]
- Baseline habits of “g” and “y” [M]
- Method of construction of “v” [F]

CURRICULUM VITAE

Nuwamanya Henry

1. PERSONAL STATEMENT

I am a student Pursuing MSc. Forensic Sciences at Institute of Addiction and Forensic Sciences, Cukurova University, Turkey. I had a three months industrial training (Internship) at the Directorate of Government Analytical Laboratory (DGAL) in the Criminalistics department, Questioned Document Laboratory. I have completed my research thesis on the topic “*Spatial relationships, Movement and Form as discriminating factors in Forensic Handwriting Analysis in Uganda*”. This opportunity has allowed me to work on real case scenarios, honing my skills in examining questioned documents, detecting forgeries, and analyzing handwriting samples. I have developed a keen eye for detail, analytical mindset, and the ability to think critically.

I recognize the importance of maintaining objectivity and neutrality in my work, ensuring that my findings are based on solid and techniques. I aim to utilize my expertise to assist in criminal investigations, civil disputes, and the advancement of justice.

I am a highly organized and collaborative individual. I understand the significance of teamwork in effective communication and cooperation with colleagues, law enforcement agencies, and legal professionals.

2. ACADEMIC QUALIFICATIONS

(a) University Education:

University	Period	Qualification
Cukurova University Sciences (Turkey)	Sept 2021-Present	MSc. Forensic
Makerere University & Maths (Uganda)	Aug 2016 to May 2019	BSc. Educ.(Physics CGPA 4.14 out of 5)

(b) Pre-University Education:

School attended	Period	Qualification
Basajjabalaba Sec School	2014-2015	Uganda Advanced Education
Certificate of (U.A.C.E)		
Kihanda Sec School	2010-2013	Uganda Certificate of Education
(U.C.E)		
St.Peter's Kyoga Pri School	2001-2009	Primary Leaving Certificate
		(P.L.E)

(c) Courses undertaken:

Postgraduate School: **MSc. Thesis Title-** Spatial relationships, Movement and Form as Discriminating Factors in Forensic Handwriting Analysis in Uganda.

Undergraduate: Physics, Mathematics & Educational foundations

Pre-University school: Physics, Mathematics & Economics

3. WORKING EXPERIENCE

Internship (Industrial Training) at Directorate of Government Analytical Laboratory, Ministry of Internal Affairs, Kampala Uganda (Feb 2023 – May 2023)

4. SERVICES

Physics & Maths Instructor at Mengo Senior School (2020- Present)

5. TECHNICAL SKILLS AND COMPETENCIES

Video Spectral Comparator (VSC) operation
Electrostatic Detection Apparatus (ESDA)
Microsoft office suite and all its packages
LATEX Application
Basic knowledge of computer troubleshooting and operating systems
Internet applications