2023

Diagnostic Report

Book 3

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CONTENTS – PART 3

FOREWORD

The Grade 12 learners who sat for the National Senior Certificate (NSC) examinations in 2023, deliver a testimony of how dedication and resilience ultimately culminate in the dream of holding a credible school-leaving certificate. Notwithstanding a myriad of challenges, these young individuals have crossed the threshold into the next chapter of their lives. The Class of 2023 was subjected to unusual and adverse learning conditions during their Grade 9 and Grade 10 academic years in 2020 and 2021 respectively. The cumulative effect of Covid-19 and the resultant learning losses and disengagement from education had a significant impact on this cohort. The swift and collaborative response of the Department of Basic Education (DBE), teachers, parents, our partners in education and South Africans at large responded swiftly to devise a holistic recovery plan that has to a large degree mitigated the negative impact of compromises to the key learning milestones.

The father of our great nation, Nelson Rolihlahla Mandela, believed that 'Educating all our children must be one of our most urgent priorities. We all know that education, more than anything else, improves your chances of building better lives'. These words were affirmed in the 2023 State of the Nation Address when the President of the Republic of South Africa, the Honourable Cyril Matamela Ramaphosa, highlighted that 'the performance of learners from poorer schools is steadily improving, confirming the value of the support that government provides to them'. The President coined the improvement in Grade 12 results as 'a silent revolution taking place in our schools'.

Government has made education its apex priority precisely because it is a means of promoting good citizenship and of preparing our people for the needs of a modern economy and a democratic society. Various programmes are already underway to achieve this goal. The three-streams model which will allow learners to choose a vocational or an occupational stream in the Further Education and Training band is making progress. Implementing the General Education Certificate (GEC) will assist in moving our focus from the National Senior Certificate to the General Education and Training (GET) band. Systemic Evaluation, which is an assessment of learners and the system more broadly, targeting Grades 3, 6 and 9, will provide a more in-depth and comprehensive report on the performance of the system. The institutionalisation of the Early Learning National Assessment (ELNA), will allow us to assess the readiness of learners for Grade 1 so that the deficits can be identified at this early stage and remediated. By embracing innovation

while staying true to the fundamentals, of basic education, we can provide our learners with a comprehensive and future-proof education that prepares them for the challenges and opportunities of the ever-changing modern world.

In reflecting on our journey as the DBE, we have also made commendable strides in addressing the educational needs of persons with disabilities and learners who experience barriers to learning. We celebrate the adoption of the Constitution Eighteenth Amendment Bill, that amended Section 6 of the Constitution of the Republic of South Africa, that made the South African Sign Language (SASL) the 12th official language of the country. During the 2023 academic year, the DBE engaged with a wide array of stakeholders to provide support strategies to teachers and learners who offer South African Sign Language Home Language (SASL HL). The success of the ongoing support and engagements is reflected in the remarkable improvement in the results for subject.

The Class of 2023, despite the odds, had several success stories. The overall pass rate increased by 2,8% compared to 2022, four thousand and eighty (4 080) more candidates have obtained admission to Bachelor studies, 546 more schools obtained an overall pass rate above 80% and 501 of these schools are from quintiles 1, 2 and 3. One of the most significant improvements is the improvement in the performance in Mathematics from 55% in 2022 to 63,5%. This confirms that the DBE drive to increase the number of learners that can enter the fields of Science and Technology is bearing fruit.

The quality of the achievements of the Class of 2023 can be attributed to the relentless efforts of our school principals, teachers and parents, who united in the common understanding that we, as South Africans, have the power to transform the lives of millions of children, equipping them with the tools they need to succeed and positively impact the world.

We must work without ceasing to support learners who did not satisfy the requirements of the NSC the first time around. These learners may register for the Second Chance Matric Programme. We must make passing Grade 12 a national endeavour and help our young people to reach their full potential.

I am pleased to release the *2023 National Diagnostic Report on Learner Performance*. This report is in its thirteenth year of publication and serves as a comprehensive analysis of candidates' performance in the NSC Examinations.

This Diagnostic Report provides teachers, subject advisors, curriculum planners and social partners with insight into learners' performance. The pivotal purpose of the diagnostic report is to serve as a catalyst to improve the quality of teaching and learning through reflection and remediation at all levels of the system. The data and accompanying analyses prepared, post the writing of the 2023 NSC examinations have been used to identify strengths and weaknesses in candidates' knowledge and skills.

The Grade 12 Class of 2024 is reminded that the class of 2023 has set a high standard to emulate, and their good performance will serve as a lighthouse to future generations. Together we rise.

MRS AM MOTSHEKGA, MP
MINISTER OF BASIC EDUCATION
18 JANUARY 2024

1.1 INTRODUCTION, SCOPE AND PURPOSE

The 2023 Diagnostic Report explores in detail the observations in learner performance, and it serves as a supporting resource for teaching and learning in the 10 high enrolment subjects, Afrikaans First Additional Language, English First Additional Language, the 12 official home languages, the technologies, technical subjects and Engineering Graphics and Design. This report needs to be used in conjunction with the 2021 and 2022 diagnostic reports. These reports illuminate subject didactic principles and content matter that can be used effectively in the classroom in 2024.

Like previous reports, this report presents an evaluation of learner performance in the selected subjects and home languages by highlighting the areas of weakness in each of the subjects/languages and articulating the remedial measures to be adopted at school level to improve performance in these subjects/languages. The findings and recommendations are based on qualitative data taken from the subject reports compiled by the chief markers, internal moderators and subject specialists post the marking process. In the 10 key subjects, quantitative data was also gathered from the analysis of 100 scripts per paper, per subject, randomly selected from each province.

As a result, this *National Diagnostic Report on Learner Performance* provides teachers, subject advisors, curriculum planners and curriculum implementers with a picture of learner performance in each of the key subjects. The Diagnostic Report in each subject/language, commences by presenting comparative data on the performance trends observed over a five-year period in the subject/language. In the 10 key subjects, it also provides an overall performance of candidates per question, in the respective question papers for each subject. Common errors, misinterpretations and misconceptions identified during marking and suggestions for improvement are also provided. The poor quality of answers provided by some candidates in certain subjects continues to suggest gaps in the scope of content coverage, teaching methodology and the content knowledge of some of our teachers.

In Part 1, attempts have been made to track progress made in the subject and in content areas which were highlighted as problematic in previous years. Progress or lack thereof, in the said areas, should determine the extent to which further interventions are necessary in 2024.

It is envisaged that subject-based diagnostic analysis will be institutionalised within the pedagogical practice not only at national level, but also at provincial, district and school levels.

The DBE and Provincial Education Departments (PEDs) will monitor the distribution and utilisation of this report and feedback from teachers and subject advisors on the usefulness of these reports. Recommendations on how they could be improved will be solicited from all stakeholders.

1.2 METHODOLOGY

Each subject's diagnostic report commences by presenting comparative data on the performance trends observed over a five-year period in the subject, from 2019 to 2023.

The 2023 diagnostic report is formulated based on qualitative reports compiled by chief markers, internal moderators, and subject specialists post NSC marking. In the 10 key subjects and English First Additional Language, quantitative data was gathered from the analysis of 100 scripts per question paper, per subject, randomly selected from each province. This qualitative and quantitative data highlight the areas of weakness in each of the identified subjects and articulate the remedial measures to be adopted at school level to improve performance in these subjects.

As a result, this *National Diagnostic Report on Learner Performance* provides teachers, subject advisors, curriculum planners and curriculum implementers with a picture of learner performance in each of the key subjects. Based on the analyses, a detailed explanation is provided per question/subquestion under the following three main titles:

Section 1: Performance Trends (2019–2023)

A comparative analysis of the performance of learners over the last five years, in terms of the number of learners who wrote, the number and percentage of learners who achieved at 30% and above, and the number and percentage of learners who achieved at 40% and above, is presented in this section. The information is represented by tables and graphs to enable easier interpretation of any trends, especially of changes in the medium term, as well as changes from year to year.

Performance distribution curves are also provided to graphically present the distribution of learner scores in the last three examinations. Any improvement or decline in the performance can be observed from the position of the 2022 graph, relative to previous years. If the 2023 graph lies to the right of the two previous graphs, this suggests an improvement in performance, while a slant to the left indicates a decline in performance.

Section 2: Overview of Learner Performance

This section delves into the performance of learners in the question paper. The overview makes reference to generic areas of good performance or weakness and the possible reasons for these observations.

Section 3: Diagnostic Question Analysis

This includes the following:

- A graphical representation of the average percentage marks obtained per question;
- An analysis of the performance of learners in each specific question, stating whether the question was well answered or poorly answered (and the reason);
- Common errors and misconceptions that were identified in candidates' responses;
- Suggestions for improvement in relation to teaching and learning, content and methodology, subject advisory support and provision, and utilisation of LTSM.

The internal moderators' reports from all nine provinces for each question paper, per subject were consolidated and the findings are summarised in this report. It is recommended that this report be read in conjunction with the November 2023 NSC question papers since references are made to specific questions, in the respective question paper, in each subject. This will enable teachers to establish a baseline for the new cohort of Grade 12 learners in 2024; develop strategies for differentiated learning and provide a frame of reference for the development and design of school-based assessment during the year.

1.3 LIMITATIONS

The focus of this report is more qualitative than quantitative. The quantitative aspects are limited to the performance trends in each subject and the average performance per question in the 2023 question papers.

While further quantitative data would have been useful in providing feedback for the purpose of test development, this is not the intention of this report.

The diagnostic analysis of learner performance in this publication is limited only to the 10 subjects with high Grade 12 enrolments, Afrikaans First Additional Language, English First Additional Language and the 12 official home languages, the technologies and technical subjects. The remaining subjects will be covered in reports compiled by the provincial chief markers and internal moderators during the marking process. The DBE will endeavour to broaden the scope of the subject coverage in future.

It needs to be noted that areas of weakness could be unique to each district and each school. This report therefore provides a national summary of the general areas of weakness. However, district subject specialists are encouraged to develop a district diagnostic report. Ultimately, there should also be a school diagnostic report, which focuses specifically on the areas of weakness at school level.

1.4 OBSERVATIONS IN LEARNER PERFORMANCE

The 2023 diagnostic reports for the 10 key subjects covered in this publication (Part 1), indicate that the pass rate has improved in eight of the key subjects at the 30% level. However, the pass rate has declined at the 30% level in Mathematical Literacy and History. The pass rate for English First Additional Language increased at both the 30% and 40% levels. In the home languages (Part 2) the pass rate improved to varying degrees in Afrikaans, isiXhosa, isiZulu, Sepedi, Sesotho, Setswana, South African Sign Language Home Language, Siswati and Xitsonga, remained the same in Tshivenda and declined slightly in isiNdebele. The most notable decline in the pass rate at 40% was observed in English Home Language.

1.5 AREAS OF CONCERN

The following areas of concern were identified in candidates' responses during the marking processes in 2023.

- A topical issue affecting examinations and education in general is that of reading skills. Much has been written recently about the underperformance of learners who lack the skill of reading with meaning.

Markers noticed that weak learners might tend to focus selectively on a word(s) in a question that are easily recognisable and then attempt to provide a response that does not fit the context of the question. Other learners might tend to repeat or paraphrase questions or scenarios in their responses while some attempt to repeat answers from previous questions which would often be futile in earning marks.

- Instilling critical thinking skills is a key part of teaching, learning and assessment. It was evident from some candidates' responses that they lacked the skill to analyse and evaluate information critically, leading to superficial responses rather than demonstrating a deep understanding of the material. In the same vein, difficulty in applying theoretical knowledge to solve practical problems can be a challenge for candidates, indicating a need for more emphasis on real-world application in education. Teachers are encouraged to expose learners to a wide array of exercises that also include questions that assess higher order thinking skills.
- Poor time management skills can result in incomplete examinations or rushed responses, affecting the overall quality of the answers. It was observed that candidates spent a considerable amount of time on introductory questions, which resulted in them not responding well to the latter parts of question papers.
- Effective communication is key in responding adequately to questions. Expressing ideas clearly and concisely is crucial, and it was noted that many candidates lack the ability to communicate effectively in writing. It is important that candidates pay attention to detail when analysing and responding to questions. A lack of attention to detail can result in errors in calculations, misinterpretation of questions, or oversight of important information.
- Research skills play a pivotal role in candidates' ability to synthesise information. In 2023, it was apparent that a large percentage of candidates were unable to locate and use relevant information effectively in their responses. This highlights the need for improved research and information retrieval skills.
- One of the cornerstones of a good quality question paper is that it should not be predictable. The 2023 question papers included novel images, scenarios, and texts. In this year, more than in past years, it was noted that many candidates found it challenging to link the known/familiar subject matter to unfamiliar and abstract contexts. It is imperative that candidates do not merely rely on rote-learning, but that they also need to focus on understanding concepts deeply rather than memorising information. Learners must engage in active learning methods, such as discussing topics, teaching one another, and applying knowledge to real-life situations.
- Numeracy skills across the curriculum is an indispensable part of teaching and learning. In subjects requiring mathematical proficiency, it was noted that some candidates lack basic numeracy skills,

affecting their ability to solve mathematical problems accurately. The decline in the performance in Mathematical Literacy is primarily due to candidates' lack of understanding fundamental numerical concepts and principles.

Understanding these skill gaps allows teachers to tailor instructional strategies, incorporate skill-building activities, and provide targeted support to help learners develop a well-rounded set of competencies for successful examination performance.

1.6 KEY RECOMMENDATIONS

1.6.1 Teach reading for meaning in examinations

Teachers need to address learners' lack of reading for meaning at every available opportunity. The specific strategies for learners would include points that have been noted in previous Diagnostic Reports. These include:

- Underlining key words in a question;
- Identifying command words such as 'define', 'explain', 'compare', 'discuss' or 'analyse';
- Using evidence to substantiate explanations;
- Being alert to variations or 'tweaks' in different questions on similar topics;
- Appreciating the bigger context of the topic within the larger subject or topic;
- Learners being prepared to express their own opinions creatively in open-ended questions; and
- Learners being required to verbalise requirements or responses individually and in groups.

Teachers may focus on the following strategies to teach reading for meaning specifically in examinations,

- **Skimming and Scanning:** Train learners to skim quickly through a text for main ideas and scan for specific details relevant to the questions posed in the examination.
- **Understanding Question Types:** Familiarise learners with different question types (e.g. multiple choice, short answer, paragraph, essay) and teach them how to approach each. Guide learners to draw a clear link between the mark allocation and the required responses.

- **Annotation Skills:** Encourage learners to underline key points, circle keywords, and make brief notes in the margins to aid comprehension.
- **Prioritising Information:** Teach learners to identify and prioritise essential information, focusing on what directly addresses the question.
- **Practice with Past Question Papers:** Past examination papers can be used to simulate the examination environment and build familiarity with question formats.
- **Answering in Own Words:** Emphasise the importance of expressing understanding in their own words when answering questions.
- **Eliminating Distractions:** Teach techniques to ignore irrelevant details and concentrate on the core information required for each question. Emphasise the importance of reading questions thoroughly to avoid misinterpretations and to capture nuances. Advise learners to jot down key words or organise their thoughts as 'planning' in an answer book. The 'planning' needs to be marked as such in the answer book and ruled through.
- **Feedback and Review:** Provide feedback to learners on all assessment tasks and examinations. Emphasise areas for improvement and encourage regular review of mistakes.

1.6.2 Cognitive levels

It is imperative that teachers and learners are familiar with Bloom's Taxonomy and Barrett's Taxonomy. These taxonomies categorise cognitive skills from lower to higher order. This includes remembering, understanding, applying, analysing, evaluating, and creating.

In 2023, it was observed that candidates did not respond appropriately to higher-order questions. The following strategies can be employed to familiarise candidates with the expectations of higher-order questions.

Model Thinking Strategies: Teachers can demonstrate to learners how to approach higher-order questions. Show learners your thought processes by breaking down complex problems into manageable steps. Model critical thinking, analysis and synthesis.

Encourage Discussion: Foster a classroom environment that values open discussion. Encourage learners to express their thoughts and challenge each other's ideas. This helps them to develop reasoning and communication skills.

Provide Scaffolding: Offer support as learners work through higher-order questions. Start with simpler questions and gradually increase complexity. Provide relevant resources and guidance, allowing them to build confidence.

Use Real-World Examples: Connect learning to real-world scenarios. Present problems that mimic situations they might encounter outside the classroom. This helps learners see the practical application of higher-order thinking.

Ask Open-Ended Questions: Design questions that do not have straightforward answers. Encourage learners to think critically, consider multiple perspectives, and justify their responses.

Promote Metacognition: Teach learners to reflect on their own thinking processes. Encourage them to ask themselves how they arrived at a particular answer and if there are alternative approaches.

Diverse Assessment Methods: Evaluate understanding through various methods like projects, presentations, and essays. This allows learners to showcase higher-order thinking skills in different contexts.

Integrate Technology: Use educational technology to enhance learning experiences. Platforms that support collaborative problem-solving or simulations can engage learners in higher-order thinking.

1.6.3 Integrated support strategies

(i) Electronic platforms for learning

Teachers can explore a plethora of online and virtual platforms for teaching and learning, to facilitate revision activities and for examination preparations. Platforms such as Microsoft Teams, Zoom, Google Classroom and YouTube are effective e-learning tools.

Learners and teachers can gain access to online learning platforms such as YouTube that offer visual presentations and explanations of challenging topics. Teachers and subject specialists can source video clips and incorporate these in their lessons to give learners a clear understanding of subject matter.

(ii) Teacher and learner collaboration

Teachers from different schools in each circuit or district could collaborate to support one another in mediating challenging topics to learners. In view of this, different schools can build an item bank of higher-order questions and this bank can be used as a resource for revision purposes.

Challenging topics must be revisited regularly during the academic year through extension activities and they should form the basis of all extra classes. Teachers need to foster a supportive learning environment by promoting peer mentoring and group study sessions, enhancing collaborative learning. Stronger learners can be paired with weaker candidates to complete assignments on challenging topics.

(iii) Regular informal assessment

Teachers need to implement frequent quizzes and practice examinations to allow learners to gauge their progress and identify their areas of improvement. Regular feedback after each assessment task is imperative.

(iv) Artificial Intelligence (AI) as support strategies

Artificial Intelligence is here to stay. Although teachers, in general, have an aversion towards AI, AI-powered tutoring systems that offer real-time feedback, identify areas of weakness, and provide targeted guidance to help learners improve, can be beneficial to the teaching and learning space.

Furthermore, teachers can integrate AI chatbots to provide instant answers to common queries, offering additional support and resources outside regular classroom hours to learners.

AI-driven Virtual Reality (VR) Simulations can also be created for practical subjects, offering immersive learning experiences that enhance understanding and retention. The following platforms can be explored in this regard: *Unity3D, Unreal Engine, Aframe, Cospaces Edu, Google Expeditions, AltspaceVR, ClassVR, ThingLink VR, Engage* and *Minecraft Education Edition.*

Many a teacher has embraced the AI revolution and explored the effective use of platforms such as ChatGPT in teaching and learning. When incorporating ChatGPT, it is important to monitor and guide the interactions to ensure they align with educational goals. Emphasise the tool's supportive role, encouraging students to critically assess the generated content. Additionally, consider privacy and ethical considerations when implementing AI tools in the classroom.

Integrating ChatGPT into the classroom can be done in various ways to enhance the learning experiences and prepare learners effectively for assessment tasks and examinations. These include:

- **Q&A Sessions:** Use ChatGPT for interactive Q&A sessions, allowing students to ask questions related to the lesson content or clarification on specific topics.
- **Writing Assistance:** Incorporate ChatGPT to assist students with writing tasks, providing suggestions for improving structure, grammar, or generating creative ideas.
- **Language Learning:** Employ ChatGPT to facilitate language learning exercises, allowing students to practice conversations, write essays, or engage in language-related activities.
- **Debates and Discussions:** Use ChatGPT to stimulate debates or discussions by generating prompts or responses, encouraging critical thinking and argumentation skills.

1.7 RESPONSIBILITIES

Provincial Education Departments:

Given that the target audience of this report includes the teacher and learner, this report must be cascaded from the provincial to the district level and finally to the school.

Subject Advisors and District Officials:

- Subject specialists should initiate a baseline assessment of the 2023 Grade 12 cohort, to establish candidates' understanding of Grade 10 and Grade 11 topics that serve as a foundation for Grade 12 topics.
- Subject advisors are encouraged to convene meetings/workshops that aim to mediate this diagnostic report. It is further suggested that the use of this diagnostic report must be encouraged during on-site support visits.
- The improvement plans of teachers need to be monitored, looking specifically for the inclusion of recommendations emanating from the individual subject reports.
- District officials should closely monitor curriculum coverage to ensure that all the topics in a subject have been covered according to the Revised Annual Teaching Plan (ATP). This would ensure that all topics receive due attention, allowing candidates to be better prepared for the examination.
- The monitoring process also needs to focus on the standard and quality of the assessment tasks used for SBA, as these tasks prepare learners for the NSC examinations. They also provide an opportunity for the teaching and learning interventions to gain traction well before the NSC examinations.
- Subject advisors should direct teachers to websites that will enhance teaching and learning.

Teachers:

- Teachers should ensure that learners are provided with adequate resources to facilitate self-regulated learning. Learners must be able to study independently.
- To develop learners' holistic understanding and applied competence, teachers must prepare learners adequately by creating learning opportunities to reflect, analyse and evaluate the content.
- Teachers should ensure coverage of the curriculum and the full range of cognitive levels in their teaching and assessment strategies. The mere recall of procedures or specific content on the part of learners will not enable them to respond fully to the demands of the question paper.

CHAPTER 2

TECHNICAL MATHEMATICS

The following report should be read in conjunction with the Technical Mathematics Paper 1 and Paper 2 question papers for the NSC November 2023 examinations.

2.1 PERFORMANCE TRENDS (2019–2023)

The number of candidates who wrote the Technical Mathematics examination in 2023 increased by 536 compared to that of 2022.

There was also a pleasing improvement in the pass rate this year. Candidates who passed at the 30% level improved from 81,8% in 2022 to 88,5% in 2023.

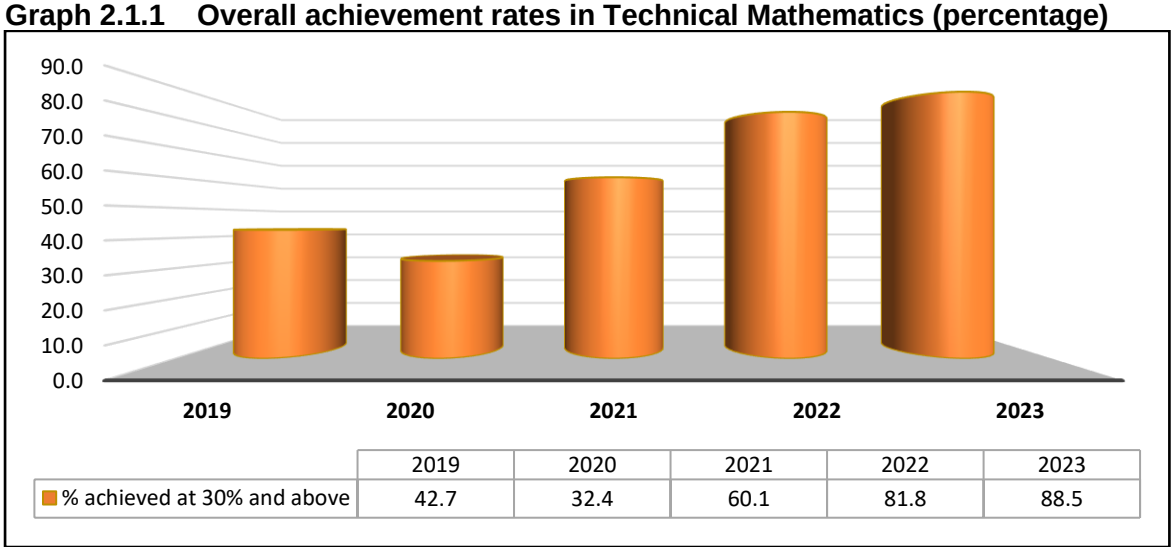
The percentage of distinctions over 80% improved from 1,5% in 2022 to 2,4% in 2023. Given the increase in the size of the 2023 cohort, this converts into an increase in the total number of distinctions from 220 to 365.

The various commendable intervention strategies employed by teachers, subject advisors and provincial education departments were continued in 2023. The resourcefulness and diligence of the above-average candidates also contributed to the overall improvement in the subject.

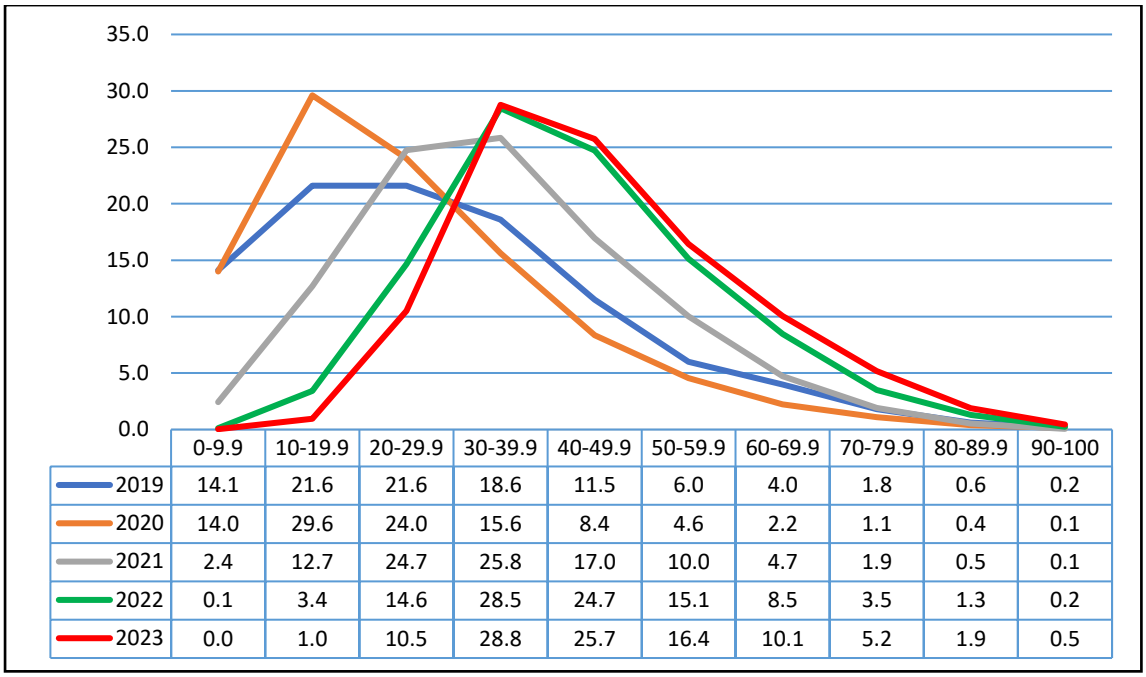
Table 2.1.1 Overall achievement rates in Technical Mathematics

Year	No. wrote	No. achieved at 30% and above	% achieved at 30% and above
2019	9 670	4 125	42,7
2020	10 731	3 476	32,4
2021	13 403	8 060	60,1
2022	14 657	11 993	81,8
2023	15 193	13 446	88,5

Graph 2.1.1 Overall achievement rates in Technical Mathematics (percentage)



Graph 2.1.2 Performance distribution curves in Technical Mathematics (percentage)



	0-9.9	10-19.9	20-29.9	30-39.9	40-49.9	50-59.9	60-69.9	70-79.9	80-89.9	90-100
2019	14.1	21.6	21.6	18.6	11.5	6.0	4.0	1.8	0.6	0.2
2020	14.0	29.6	24.0	15.6	8.4	4.6	2.2	1.1	0.4	0.1
2021	2.4	12.7	24.7	25.8	17.0	10.0	4.7	1.9	0.5	0.1
2022	0.1	3.4	14.6	28.5	24.7	15.1	8.5	3.5	1.3	0.2
2023	0.0	1.0	10.5	28.8	25.7	16.4	10.1	5.2	1.9	0.5

General comments on Paper 1 and Paper 2

Technical Mathematics *CAPS*, stipulates that 'Mathematical modelling is an important focal point of the curriculum' and 'Real-life technical problems should be incorporated into all sections whenever appropriate'. Candidates may have relied on past examination papers and not studied the subject content to its depth. The errors that candidates committed have been recurring for the past years' examinations, therefore, attention should be paid to revision of work from earlier grades. Addressing challenges surrounding mathematical skills, conceptual understanding and integration of topics will play an integral part in improving performance in the subject. An observation made was that candidates performed poorly in questions involving higher-order reasoning and interpretation. Performance will be further enhanced if candidates improve their ability to interpret and solve problems.

2.2 OVERVIEW OF CANDIDATES' PERFORMANCE IN PAPER 1

General comments

(a) The majority of the candidates were able to answer the knowledge and routine questions. They were able to score marks in most questions which suggest that they prepared well.

(b) Some candidates displayed poor algebraic skills required to solve many mathematical problems. They lacked the basic and fundamental mathematical competencies acquired in the lower grades. This makes it difficult for candidates to correctly respond to questions which are complex in nature.

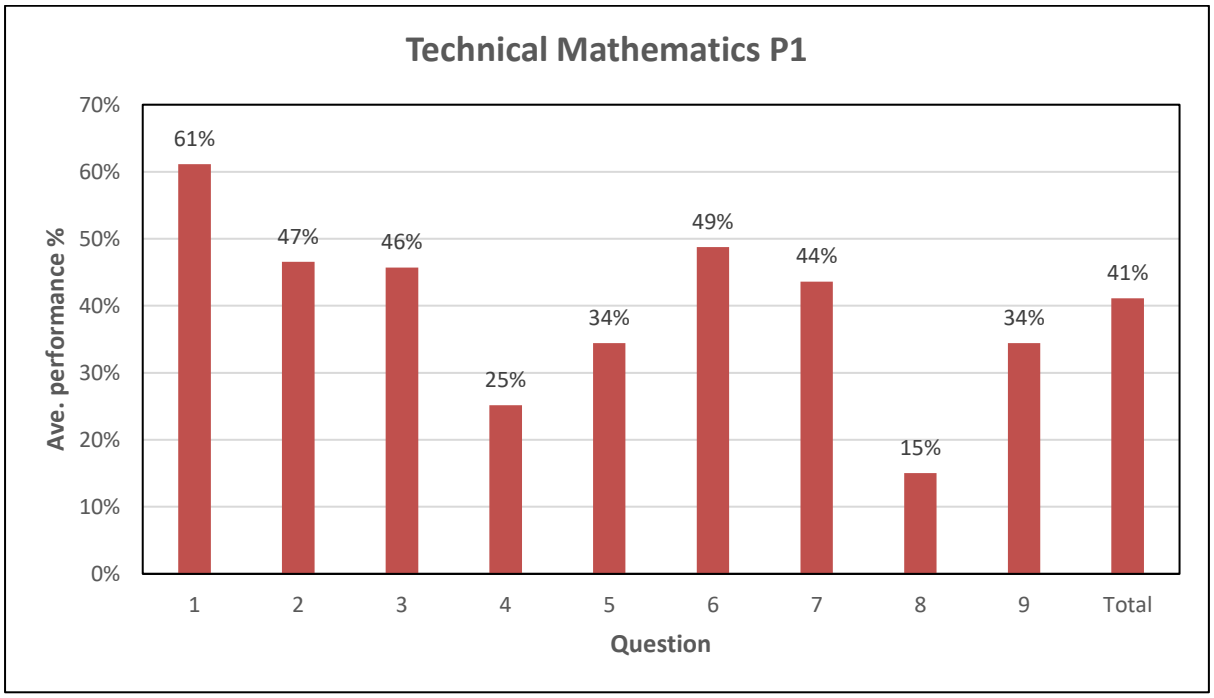
(c) Many candidates experienced challenges in answering complex and problem-solving questions. Questions that required candidates to interpret were either not answered or they were poorly answered. This suggests that candidates did not prepare well to deal with these kinds of questions.

(d) Some candidates had challenges using a calculator correctly and did not adhere to the instructions as specified in the question paper.

2.3 DIAGNOSTIC QUESTION ANALYSIS OF PAPER 1

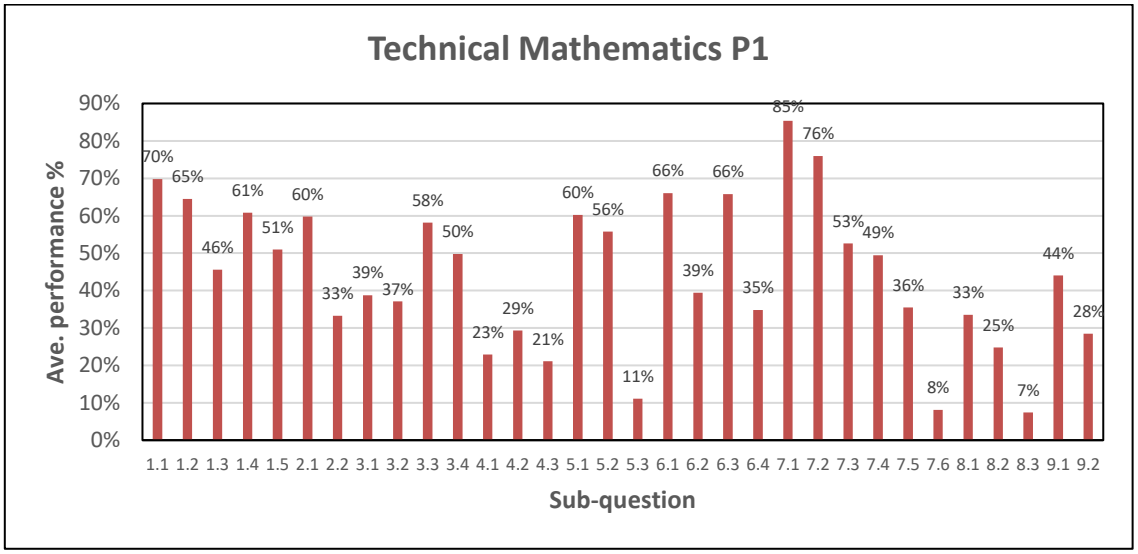
The following graph is based on data from a random sample of candidates' scripts. While this graph might not accurately reflect national averages, it is useful in assessing the relative degrees of challenge of each question as experienced by candidates.

Graph 2.3.1 Average performance per question in Paper 1



Q	Topic	Q	Topic
1	Equations, inequalities and binary numbers	6	Differential calculus (differentiation)
2	Nature of the roots of quadratic equations	7	Differential calculus (cubic function)
3	Exponents, surds, logarithms and complex numbers	8	Differential calculus (maxima/minima)
4	Functions and graphs	9	Integration
5	Finance, growth and decay		

Graph 2.3.2 Average performance per subquestion in Paper 1



2.4 ANALYSIS OF LEARNER PERFORMANCE IN EACH QUESTION IN PAPER 1

QUESTION 1: EQUATIONS AND INEQUALITIES (ALGEBRA)

Common errors and misconceptions

(a) In Q1.1.1 a few candidates did not realise that the equation was given in factor form. They instead expanded and got to a standard quadratic form and then incorrectly factorised or used a quadratic formula to solve for x.

(b) Some candidates in Q1.1.2 failed to transpose $\frac{1}{3}$. A few candidates copied the formula incorrectly. They wrote it as $x = -\text{b} \pm \frac{\sqrt{\text{b}^2 - 4ac}}{2a}$ or $x = \frac{-\text{b} \pm \sqrt{\text{b}^2 - 4ac}}{2a}$ and failed to get the correct roots. There were few candidates who left the roots in surd form.

(c) In Q1.1.3 most candidates failed to correctly identify the values for *a*, *b* and *c* which resulted in incorrect roots being presented. They had difficulty in interpreting the inequalities and could not differentiate between 'greater than' or 'less than'. They displayed poor understanding of the set builder notation and the meaning of 'or' and 'and'. They presented the solution as $x > -4$ or $x < -4$

(d) Many candidates failed to make y the subject of the formula in both equations. They incorrectly applied distributive property after substitution. Some candidates had their general equation in terms of y. They had $3y^2 + 3y - 8 = 0$ but forgot to change x into y in the quadratic equation. Their solutions were therefore reflected as x-values and used these values to find y – ultimately, they had two sets of y-values.

(e) Most of the candidates failed to manipulate the equation and to simplify the fraction to make *L* the subject in Q1.3.1.

(f) In Q1.3.2 some candidates failed to correctly substitute the given values. Many candidates displayed incompetency in the correct use of a calculator.

(g) Few candidates were unable to convert a decimal number to a binary number and vice versa in Q1.4.

Suggestions for improvement

(a) This question covered much of the work done in Grades 10 and 11. It is therefore important for teachers to do revision of topics done in earlier grades, e.g. *factorisation*, *products*, *solution of simultaneous equations* and *binary operations*.

(b) Revision tasks should cover topics done in the lower grades, the use of brackets when substituting an equation in another equation and when there is a negative value to be substituted.

(c) Weaker learners should be encouraged to use quadratic formula instead of finding factors. They should copy the formula correctly from the information sheet, identify the values of *a, b, c* and substitute correctly.

(d) Learners should be made aware that the variable in their quadratic equation must be made the subject of the formula in the quadratic formula:

If $3y^2 + 3y - 8 = 0$ then $y = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

(e) Teachers should expose learners to different forms of literal equations, subject of the formula, simplification and the correct use of calculators. Teachers should not take it for granted that learners are able to use the calculator – reskilling is necessary in Grade 12 as well.

(f) In teaching *inequalities*, teachers should show learners how to present inequalities on a number line and how to write an inequality reading from a number line. They should emphasise the use of correct notation when writing solutions to inequalities.

(g) Basic operations, i.e. *addition, multiplication, subtraction* and *division involving binary numbers* and the conversion from one number system to the other done in Grade 10, should be revised in Grade 12. Writing of the correct notation, i.e. for binary numbers the base 2 should be emphasised. Teachers should make learners aware that the base for the decimal number system is 10 and that we use the decimal number system more than any of the other number system. However, it is not necessary to write the base 10 each time one writes a decimal number.

QUESTION 2: NATURE OF ROOTS

Common errors and misconceptions

(a) In Q2.1.1 some candidates wrote the *discriminant* incorrectly as:

$\Delta = 4ac - b^2$ OR $\Delta = b - 4ac$ OR $\Delta = \frac{b^2 - 4c}{2a}$ OR $\Delta = -b^2 - 4a$

They did not realise that they needed to substitute the values of $q = 4$ into the *discriminant* to determine its numerical value.

(b) Some candidates had challenges in differentiating between *real* and *non-real* and *rational* and *irrational roots*. They failed to describe the nature of roots in Q 2.1.2.

(c) Many candidates failed to interpret the meaning of *non-real roots* in relation to $\Delta = b^2 - 4ac$ in Q2.2. Some candidates could not identify and use '*p'* the value of *c* in the *discriminant*, therefore they could not solve for the numerical value of '*p'*. They also used $\Delta = 0$ instead of $\Delta < 0$ for *non-real roots*.

Suggestions for improvement

(a) Teachers should emphasise to learners that the *discriminant*, $\Delta = b^2 - 4ac$, is used to determine the nature of roots of the quadratic equation.

(b) Learners should be taught that the *discriminant*, $\Delta = b^2 - 4ac$ originates from the quadratic formula $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$. The value that appears under the radical sign determines the nature of the roots of the equation.

(c) Teachers should demonstrate and emphasise the differences between roots that are *real, non-real, rational, irrational, equal* and *unequal* using quadratic function.

QUESTION 3: EXPONENTS, SURDS, LOGARITHMS AND COMPLEX NUMBERS

Common errors and misconceptions

(a) In Q3.1.1 few candidates changed the expression and wrote it as an equation $log_a a = \frac{1}{2}$.

(b) Some candidates failed to change the surd form to exponential form. They also neglected to multiply surds and to simplify the expression. They wrote:

$\sqrt{5x}\left(3\sqrt{5x} + 2.4\sqrt{5x}\right) = 15x^2 + 40x^2 = 55x^2$ in Q3.1.2

Some candidates did not show all the calculations. They used a calculator but struggled with the x^2 and did not know what to do with it.

(c) In Q3.2 some candidates demonstrated limited understanding of logarithmic properties.

(d) In Q3.3 a few candidates failed to identify the quadrant in which the given complex number appeared. They incorrectly applied the *Theorem of Pythagoras* to find the modulus, $= \sqrt{2^2 + 2i^2} = \sqrt{4 + (4 - 1)}$. They randomly chose values for *x* and *y* and used them to find the angle.

(e) Some candidates did not apply the distributive property in Q3.4. Furthermore, they did not equate the real part to a real part, and the imaginary part to an imaginary part. Many candidates were unable to find the value of *y* because they could not correctly simplify the equation.

Suggestions for improvement

(a) A thorough and regular revision of all exponential laws, surd and logarithmic laws, which are taught to learners in earlier grades, should be done in Grade 12.

(b) In teaching, an Argand diagram is useful in identifying the quadrant in which the real, imaginary part and angle are found. Emphasise the correct use of calculators and checking the correctness of the solutions.

(c) Learners should be exposed to different types of problems involving complex numbers and adhere to the given instructions be emphasised. Different representation of complex numbers should be taught.

QUESTION 4: FUNCTIONS

Common errors and misconceptions

(a) In Q4.1.1 and Q4.1.3 a few candidates confused the *x* and *y*-intercepts when they represented them as a set of ordered pairs. They wrote them interchangeably.

(b) Many candidates were unable to show that $k = 1$ in Q4.1.2. They instead found $g(-3) = -(-3) - 2$ =1 and concluded that $k = 1$.

(c) In Q4.1.4 many candidates did not realise that showing $f(x) = -x^2 + 2x + 8$ meant finding the equation of the parabola. Instead, they solved for x values which were already asked in previous questions.

(d) Many candidates failed to write the correct notation for the range, they left it as *y* = 9. Most of the candidates struggled with interpretation in Q4.1.6. They failed to correctly interpret the question and identify the end points where $f \geq g$.
They used an incorrect notation $(-2; 5)$ as well as $-2 > x$ or $x < 5$

(e) In Q4.2.1 some candidates gave the length of OD as a negative value.

(f) Some candidates in Q 4.2.2 failed to substitute the value of '*r*' and left the equation of the semi-circle as $h(x) = \sqrt{r^2 - x^2}$.

(g) Some candidates struggled with interpreting the given properties and failed to sketch the graph in Q4.3.

Suggestions for improvement

(a) In teaching functions, teachers should pay attention to concepts and definitions. The meaning of inequalities and the definition and correct notation of the domain and range of a function should be thoroughly explained.

(b) Teachers should use the basic hyperbola graph to explain the effects of parameters. They should also incorporate transformation, when teaching functions.

(c) Learners should be advised to use the table method to draw functions if they struggle to identify and use the properties of graphs.

(d) Teachers should spend more time discussing different ways of determining the equations of the graphs. Teaching of graphs should not be limited to the drawing of graphs; interpretation should be incorporated when teaching functions.

QUESTION 5: FINANCE, GROWTH AND DECAY

Common errors and misconceptions

(a) In Q5.1 some candidates failed to identify the correct formula. They substituted an incorrect value for *i* which was not divided by 12. Many candidates had difficulty in making i the subject of the formula. There were a few candidates who did not write the rate as a percentage.

(b) A few candidates used simple interest instead of compound growth formula in Q5.2.

(c) Many candidates had difficulty interpreting Q5.3. They did not realise that they had to use the *reducing-balance depreciation* formula to determine the period. They interchanged the values of *A* and *P* resulting in incorrect substitution. Many candidates had difficulty in making r and *P* the subject of the formula. Furthermore, candidates displayed a limited knowledge of the different compounding periods. Candidates failed to follow the timeline to see that the temperature dropped from 200 ^{o}Celsius to 80 ^{o}Celsius and dropped again to 50 ^{o}Celsius and it took 2 minutes from 80^{o} to 50^{o}. The values of *'A','P'* and '*n*' were then substituted incorrectly into the formula.

Suggestions for improvement

(a) Learners should be taught to identify the correct formula from the information sheet attached to the question paper. They should demonstrate competency in using a calculator and not round off too early in the calculation.

(b) Teachers should expose learners to equations involving changing the subject of a formula to obtain the variable needed. Learners should be encouraged to read and interpret what they have read even during lessons.

(c) Teachers should explain to learners that, *P* represents the initial value. In the case of a population, *P* represents the initial number and *A* represents the final value or number of species in the scenario. Furthermore, they should emphasise that in situations involving depreciation, the value of *P* will be greater than the value of *A*.

(d) The use of timelines to better understand complex problems involving several investments, deposits, and withdrawals, is strongly advised. All compounding periods (annually, quarterly, monthly, semi-annually/half-yearly and even daily) should be taught to learners.

QUESTION 6: CALCULUS

Common errors and misconceptions

(a) In Q6.1 a few candidates did not write the correct definition and lost marks for incorrect notations.

- $f(x) = \lim_{h \to 0} \frac{f(x+h)-f(x)}{h}$ OR $f'(x) = \frac{f(x+h)-f(x)}{h}$

They omitted brackets when doing the substitution and incorrectly simplified the expression.

- $f'(x) = \lim_{h\to 0} \frac{x+h-5-x-5}{h}$
- $f'(x) = \lim_{h\to 0} \frac{h}{h} = 0$

(b) In Q6.2.1 some candidates did not simplify the expression further:

$-27x^{8-1} - 7x^{1-1}$ OR $-3 \times 9x^{8-1} - 1 \times 7^{1-1}$.

Some candidates mixed *differentiation* and *integration*: $\frac{-27\times 8^{8+1}}{8+1} - \frac{7\times -1x^{-1+1}}{-1+1}$

(c) Many candidates in Q6.2.2 failed to correctly remove the radical sign and invert x in the denominator for the first term; rather, they changed the fraction altogether:
$3 \times 2x^{-1} + x^{-\frac{5}{2}}$

(d) In Q6.2.3 most candidates demonstrated limited understanding of the exponential laws needed to manipulate the equation to make *y* the subject of the formula thus finding the derivative function of *y.*

(e) Some candidates failed to identify the correct formula to calculate the gradient. Instead, they used the midpoint formula in Q6.3.1.

(f) Most candidates failed to relate gradient to derivative of the function, hence, they used the gradient formula instead of the derivative. Few candidates used the average gradient asked for in Q6.3.2.

(g) In Q6.4 many candidates swapped the *y*-value and gradient value when substituting in the equation of the straight line:
$g'(4) = 48 \text{ and } g(4) = 66$ and they wrote $y - 48 = 66(x - 4)$ as a result they lost a mark.
There were few candidates who used the formula for angle of inclination $m = tan\vartheta$.

Suggestions for improvement

(a) Emphasis should be placed on the use of correct notation when determining the derivative using either *first principles* or the *differentiation* rules.

(b) Learners should copy the formula for *first principles* correctly from the information sheet which is attached to the question paper.

(c) The difference between the *derivative* and an *integral* of a function should be explained and teachers should demonstrate the difference of each by calculating the *derivative* and *integral* of the same function. Notations $f'(x)$ if $f(x) = x^n$, $\frac{dy}{dx}$ if $y = x^n$, $\frac{d}{dx}\left(x^n\right)$ and $D_x\left(x^n\right)$ all have the same meaning.

(d) Revision of exponential and surd laws is encouraged before teaching *differentiation* which itself involves exponents and surds. The simplification of expressions involving algebraic fractions could not be over emphasised.

(e) Teachers should define and demonstrate the derivative in relation to the gradient at a point on a curve, or the gradient of a tangent.

QUESTION 7: CUBIC FUNCTION

Common errors and misconceptions

(a) In Q7.1 a few candidates demonstrated limited understanding of properties of functions. They failed to identify the *y*- intercept is -12 from the given function.

(b) In Q7.2 some candidates substituted correctly but were unable to simplify the equation after substitution.

(c) Many candidates in Q7.3 failed to use information from Q7.2. Instead, they started from the beginning by finding the roots of a cubic equation, using a quadratic formula. Many candidates confused the x -intercepts with coordinates of turning points.

(d) In Q7.4 most candidates failed to follow the instruction on correct numbering. They either wrote a response for Q7.4 in Q7.3 or omitted Q7.3 or Q7.4. Many candidates did not answer this question in its entirety because part one of it was done in Q7.3, they just wrote the coordinates of the turning points.

Many candidates managed to calculate the two *x*-coordinates of the turning points correctly but failed to substitute these values into the original function when determining the corresponding *y*-coordinates. Many candidates did not equate the derivative function to zero.

Some candidates calculated the *x*-coordinate of the turning point using the axis of symmetry and substituted in *f(x)* to get the *y*-coordinate of the turning point, without realising that this method was not applicable to cubic functions.

(e) In Q7.5 most candidates failed to draw the correct graph because of incorrect calculations of intercepts and turning points. This mainly affected the shape of the graph. A few candidates did not submit their answer sheets, and some did not draw the graph on the answer sheet.

(f) In Q7.6 many candidates failed to interpret this question and did not answer it. Those who were able to identify critical values failed to write the correct interval notation.

Suggestions for improvement

(a) Characteristics of functions should be explained and demonstrated to learners, by means of examples and illustrations, focus should also be on how these are related to one another.

(b) Learners should be exposed to various forms of graphical representations and all aspects of the functions, including sketching and interpretation of the graphs.

(c) The concept of the *derivative function* and the *turning point* should be explained in detail. Teachers need to emphasise that the derivative function is equal to zero at the turning point. Teachers should indicate to learners that calculating the *x*-coordinate of the turning point using $x = -\frac{b}{2a}$ only applies to quadratic functions.

(d) Teachers should explain the concept of *minima* and *maxima* thoroughly to learners. Teachers should demonstrate and explain to learners where the graph is increasing, constant or decreasing using diagrams.

(e) Software such as *Geometry Sketch Pad* and *Graph* and *GeoGebra*, are useful tools for the demonstration of where the function is increasing, turning or decreasing within an interval.

QUESTION 8: APPLICATION OF CALCULUS

Common errors and misconceptions

(a) In Q8.1 most of the candidates did not realise that they were supposed to use the formula for volume to get the height by equating the volume to 350 then make *h* the subject.

(b) Many candidates did not attempt Q8.2 and Q8.3. Those who attempted the questions struggled to correctly differentiate the function in order to find *r* and *h*. Most of the candidates did not understand the meaning of the instruction 'show' and what was required of them. Instead, they worked with what needed to be shown.

Suggestions for improvement

(a) Learners should be made aware that they need to identify and write correct formulae and that 'hence' means the use of the answer already obtained, to solve the question.

(b) The concept of minimum and maximum should be thoroughly explained to learners. The procedure should be clearly illustrated. Different questioning strategies should be employed by teachers in class activities, tests and examinations.

(c) Learners should be given a variety of exercises which should not be limited to *Calculus of motion* and *rate of change* but *mensuration* as well.

(d) Teachers should expose learners to questions involving modelling and technical applications. Drill learners on the questions where after failing to answer a 'show' type question, they should use that formula to answer the following questions. Different formulae involving solids, cones and pyramids etc. should be taught to learners and demonstrate how these can be used as part of the real-life context.

QUESTION 9: INTEGRATION

Common errors and misconceptions

(a) In Q9.1.1 some candidates integrated correctly but failed to write the integral in terms of *t* but of *x*; they wrote the integral as $-4x+C$.
A few candidates omitted *C* when writing the indefinite integral.

(b) Many candidates in Q9.1.2 failed to simplify the expression first. They wrote $\frac{x^6}{6}\left(\frac{x^4}{4}-\frac{9x^{-5}}{-5}\right)+c$ and lost the marks.
They also did not apply the integration rules correctly: $\int x^8-9x^{-1}\,dx=\frac{x^9}{9}-\frac{9x^{-1+1}}{-1+1}$
they did not recall that $\int\frac{1}{x}dx=lnx+c$

(c) In Q9.2 most candidates were unable to set up the area using *integration*. They did not know the exact boundaries to use leading to the mismatch of boundaries. Many candidates confused *integration* with *differentiation*. Some candidates incorrectly substituted lower and upper limits. There were a few candidates who left the area as a negative value. They did not realise that they could calculate the area of a triangle by using the formula A $= \frac{1}{2}bh$.

Suggestions for improvement

(a) Learners should be reminded that the constant *'C'* for indefinite integrals should not be omitted. They should be encouraged to consistently check formulae given on the information sheet attached in the question paper.

(b) Teachers should explain and demonstrate to learners the difference between *differentiation* and *integration*.

(c) In the teaching of integration, teachers should emphasise that learners must include the lower and upper boundaries when setting up the area notation for definite integrals. The use of brackets when substituting boundaries should be encouraged.

(d) Learners should be exposed to a variety of applications involving *integration* to enhance their understanding of the concept. They need to understand that area cannot be negative.

2.5 ANALYSIS OF CANDIDATES' PERFORMANCE IN EACH QUESTION IN PAPER 2

(a) Candidates performed very well in Q2, which assessed Analytical Geometry. Candidates performed extremely well in questions involving concepts done in earlier grades.

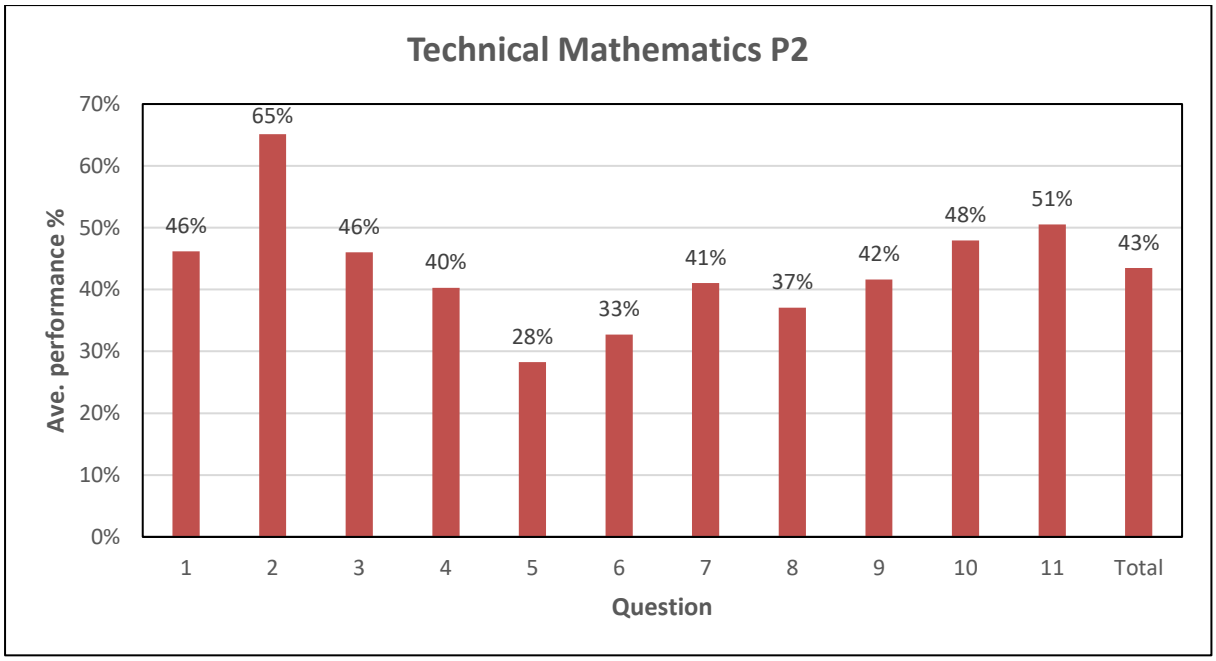
(b) Candidates performed poorly in Q3, Q4, Q5 and Q6 which indicates that they were challenged by higher-order questions.

(c) Some candidates did not adhere to the instructions stipulated in the question paper.

2.6 DIAGNOSTIC QUESTION ANALYSIS OF PAPER 2

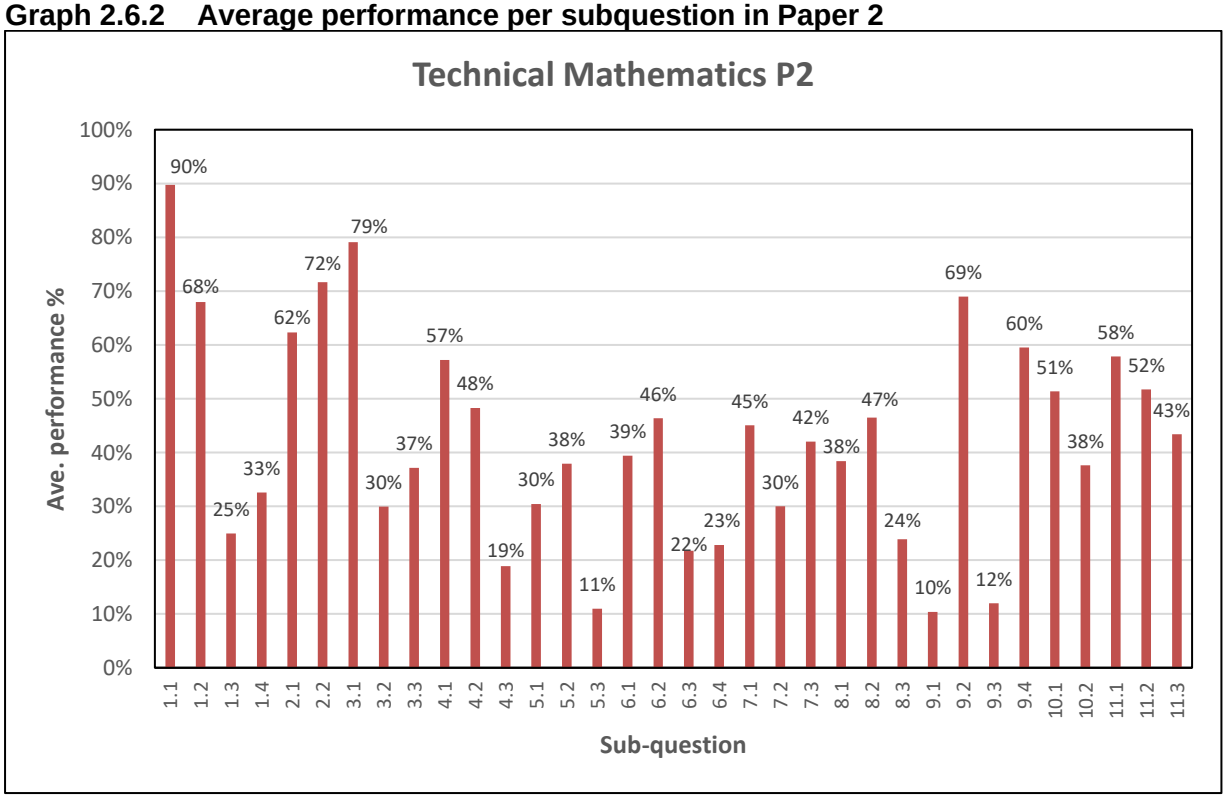
The following graph is based on data from a random sample of candidates' scripts. While this graph might not accurately reflect national averages, it is useful to assess the relative degrees of challenge of each question as experienced by candidates.

Graph 2.6.1 Average performance per question in Paper 2



Q	Topics	Q	Topics
1	Analytical Geometry – Lines	7	Euclidean Geometry - Circle
2	Analytical Geometry - Circle; Tangents; Ellipse	8	Euclidean Geometry - Circle
3	Trigonometry - Definitions and equations	9	Euclidean Geometry - Proportionality
4	Trigonometry - Angles Reduction-Identities	10	Mensuration- Angles, Angular movement, and Height of a segment
5	Trigonometry - Functions and graphs	11	Mensuration
6	Trigonometry - 2D - sine		

Graph 2.6.2 Average performance per subquestion in Paper 2



2.5.1 ANALYSIS OF CANDIDATES' PERFORMANCE IN EACH QUESTION IN PAPER 2

QUESTION 1: ANALYTICAL GEOMETRY

Common errors and misconceptions.

(a) In Q1.1 some candidates either used the wrong formula or they substituted the wrong coordinates into the correct formula. Some candidates still swopped the numerator and denominator around as in $m = \frac{\Delta x}{\Delta y}$, while it is supposed to be, $m = \frac{\Delta y}{\Delta x}$.

(b) In Q1.2 a number of candidates calculated *tan* of a gradient instead of *arctan* of a gradient. Some did not substitute a gradient but rather a coordinate or a length. Many candidates calculated the reference angle correctly, but stopped there, instead of subtracting it from $180°$ because of the negative gradient. Most candidates used the negative gradient to calculate a negative reference angle.

(c) In Q 1.3 a few candidates did not understand how to prove that a line goes through a specific point, or not. A number of candidates used the midpoint formula to calculate midpoints and which lead to incorrect calculations and conclusion.

(d) In Q 1.4 some candidates substituted angles instead of the length of a side. They substituted coordinates. They did not realise they needed to determine a specific side's lengths first. Some used the hypotenuse as a side.

Suggestions for improvement

(a) Teachers should focus on teaching learners the different formulae and how, where and when they should be applied.

(b) Teachers should reiterate that a reference angle can **NEVER** be negative. Learners should be provided with several opportunities to practise problems where there is a positive, as well as a negative gradient, when calculating the angle of inclination.

(c) More examples of how to prove whether a line passes through a specific point must be issued to learners.

(d) Learners should be provided with more opportunities to calculate equations of straight lines when they are either parallel or perpendicular to each another.

QUESTION 2: ANALYTICAL GEOMETRY

Common errors and misconceptions.

(a) In Q2.1.1 some candidates did not know the standard form or equation of a circle. They either used that of an ellipse or a straight line.

(b) In Q2.1.2 a number of candidates did not know the theory. They either wrote that the answer is equal to 1 or they used m_{OK}.

(c) In Q2.1.3 some candidates did not score full marks, they either used the wrong gradient, and/or substituted the coordinate incorrectly.

(d) In Q2.2.1 some candidates did not know how to rewrite a number into its corresponding exponential notation where the exponent is a 2.

(e) In Q2.2.2 a number of candidates did not know how to determine the correct coordinates. Some candidates switched the values for the axis and used the $x-$ coordinates on the $y-$ axis and visa versa. Some candidates did not use a standard scale for both axis which made the ellipse look like a circle, or even a horizontal ellipse.

Suggestions for improvement

(a) Teachers need to emphasise the standard equation of a circle and how to determine the equation through a point. The emphasis should be on writing the final equation not to end with the determination of the radius.

(b) Teachers need to emphasise the properties of two lines that are parallel or perpendicular to each other.

(c) Learners should be taught step-by-step calculations for the equation of a tangent to a circle must be taught. Let the learners write them down as step 1, step 2, etc.

(d) Learners must be shown how to write a number in its squared form, especially if it is not a complete square.

QUESTION 3: TRIGONOMETRY

Common errors and misconceptions

(a) In Q 3.1.1 it seemed that some candidates either did not have a calculator, did not know how to use calculators or their calculators were set to radians instead of degrees.

(b) In Q 3.1.2, a number of candidates did not know the basic theory that $secx = \frac{1}{cosx}$. They used a wide variety of functions to equate value.

(c) In Q3.2.1, a number of candidates were unable to answer the question as they did not know the basic theory that $cosecx = \frac{1}{sinx}$. They also did not know that cosec and sin are reciprocals of one another. Some candidates substituted the ratio into the trig function as an angle.

(d) In Q 3.2.2, a number of candidates could not determine in which quadrant to draw the diagram, hence, they could not calculate the correct value of x. Therefore, they could not substitute/determine the correct ratio for the given trigonometric functions. They also neglected to simplify. Some candidates first calculated the size of the angle and then substituted that angle into the given expression and then used their calculators to determine the answer, even though the question specifically stated 'without' the use of a calculator.

(e) In Q 3.3 some candidates failed to realise that they had to simplify the $-sin\ 56{,}7°$ first. Some candidates divided by *cos* and then substituted the angle by a 0.

Suggestion for improvement

(a) Teachers should revise the settings of the calculator so that learners can differentiate between degrees and radians.

(b) Teach different ratios and reciprocals.

(c) Emphasis should be placed on how and in which quadrant to draw the triangle and how to use the given ratio to determine the third side of the triangle, when teaching trigonometry.

(d) Learners should be given various types of trigonometric equations, of varying difficulty.

(e) Learners should know how to get rid of a trigonometric function using the *arcsine, arccosine* or *arctan* function.

(f) Teachers should repeat concepts of basic trigonometry.

(g) Basic algebra like adding fractions should be done more often.

QUESTION 4: TRIGONOMETRY

Common errors and misconceptions

(a) In Q4.1.1 a number of candidates were unfamiliar with the properties of cosec.

(b) In Q4.1.2 and Q4.1.3 a number of candidates were unable to do the reduction into the correct quadrant**.**

(c) In Q4.2 some candidates could not do the reduction at all. They used the distributive law properties and multiplied the function with each 'angle' inside the bracket. They could not identify the method of reduction. They did not know how to use the square with reduction. They did not know the properties of *cot* in order to write it in terms of *sin* and *cos*. Many candidates changed from two terms to a one term by multiplying the $\sin^2 A$ with the first term, instead of adding them.

(d) In Q4.3.1, many candidates still have not mastered factorisation. They are not able to use the basic method of identifying the highest common factor.

(e) In Q4.4.3, many candidates struggled with the fraction and all the functions. They could not factorise the numerator with the HCF of $cosecx$. They could not substitute the $\tan^2 x + 1$ with $\sec^2 x$. Even if they did both, they could not simplify past that point.

Suggestions for improvement

(a) Learners should be drilled on the basic theory of trigonometry. Too many marks are being lost because learners do not know basic reduction of identities.

(b) Teachers must put more emphasis on teaching concepts with integration of different topics, for example factorisation in trigonometry.

(c) Teachers should show learners how to look for identities and how to apply them.

(d) Teachers must hone the skills required for factorisation, from Grade 10.

(e) Familiarise learners with the information provided in the information sheet and how to use it.

QUESTION 5: TRIGONOMETRY

Common errors and misconceptions

(a) In Q5.1.1 and Q5.1.2 a number of candidates did not see that the cosine graph had one complete cycle in $180°$. They did not understand the implication on the formula if the period changed. Candidates did not understand the principle of period, nor did they realise how it changed.

(b) In Q5.1.3, a number of candidates could still not solve a very basic trigonometric equation, even though the instruction stipulated that they should use the graph. Therefore, the candidates were unable to read it from the graph. They did not think of isolating the tan function and looking for a specific value on the sketch.

(c) In Q5.1.4, a number of candidates did not understand the concept of *range*. They did not know how to write the range in the correct notation.

(d) In Q5.1.5, a number of candidates struggled with interpretation. They did not understand the interpretation of $f(x) < 0$. They also could not write the answer in the correct notation.

(e) In Q5.2, some candidates used their calculators which resulted in a wrong answer as they did not get the correct answer in Q5.1.1. They were unfamiliar as to how to use the given sketch to determine the values.

(f) In Q5.3 many candidates did not know the difference between *increasing* and *decreasing* in a function. They also could not write the answer in the correct notation.

Suggestions for improvement

(a) Learners struggle with the interpretation of graphs. They must be taught about the changes in the equation of a function when the period and/or amplitude changes.

(b) Teachers are encouraged to teach the correct notation in which to write an interval.

(c) Function notation and the meaning of $f(180°)$, and how to read it from a graph must be reinforced.

(d) Teachers must revise basic theory like period, amplitude, etc. with the learners.

QUESTION 6: TRIGONOMETRY

Common errors and misconceptions

(a) In Q 6.1 some candidates did not realise that they had to use the *sine*-rule. They also did not know how to apply the sine-rule. They had to calculate the size of $\hat{R}$ before they could substitute into the sine-rule. Very few candidates did this. They only

substituted the two given angles, irrespective of whether they were in the correct position or not. Some candidates used the *sine, cosine,* and *tan definition ratios* as if the triangle was a right-angled triangle.

(b) In Q6.2 some candidates did not know the properties of complementary angles. They could not subtract the $49°$ from the $90°$ that was provided in the question.

(c) In Q6.3 many candidates did not know the difference between the hypotenuse, adjacent and opposite sides in a right-angled triangle. They also did not know the different ratios for the different trigonometric functions.

(d) In Q6.4 many candidates thought that PQ and RM were of equal length, therefore, they subtracted the 5m from the given 8m and responded that $MT = 3m$. They confused the parallel markings on the two sides.

Suggestions for improvement

(a) Teachers should emphasise the difference between the sine-rule and cosine-rule and where and when to apply each.

(b) Learners must be equipped with the skills to determine what information is needed to apply the sine-rule and cosine-rule and how to calculate the unknown in each rule.

(c) Basic concepts like complimentary angles need reinforcement.

(d) Teachers are encouraged to assist learners to analyse diagrams and see what information is given and what can be determined.

QUESTION 7: EUCLIDEAN GEOMETRY

Common errors and misconceptions

(a) Most candidates were able to determine the size of the angle but failed to provide the correct **acceptable** reason for the statement.

(b) In Q7.1 some candidates gave the reason as *'line from centre is perpendicular to chord*", omitting *'to the mid-point of chord'.*

(c) In Q7.3 most candidates struggled to identify the correct theorem to use whether to use Pythagoras, proportionality, or similarity to answer the question. Some were unable to identify the theorem (tangent $\perp$ radius) that would create the right-angled triangle, to apply for the use of Pythagoras theorem.

(d) Candidates could not identify the correct reason and were confused about which theorem was appropriate to use for between tangent $\perp$ radius, line from centre $\perp$ chord and tan-chord.

Suggestions for improvement

(a) Learners should be drilled on stating theorems in full when they are engaging with questions on Euclidean Geometry.

(b) Teachers should give learners more exercises that require learners to integrate different theorems and their converses when they practise the application of circle

theorems.

(c) Learners must be given access to acceptable reasons that are in the *Examination Guidelines*. This must form part of teaching and learning in the classroom from earlier grades.

(d) Basic geometry calculations within circles which include Pythagoras should be done extensively.

QUESTION 8: EUCLIDEAN GEOMETRY

Common errors and misconceptions

(a) Most candidates were able to calculate/determine angles, but they struggled with the application of theorems. Reasons and statements given by candidates did not correlate.

(b) Most candidates struggled to apply circle geometry theorems especially when the use of a combination of these theorems was required to answer a question.

(c) Candidates used non-*CAP*S reasons, e.g. *'bowtie-theorem'* or *'central angle theorem'*, isosceles triangle, radii, *'base angles of isosceles triangle'*, etc. No marks were awarded for these terms.

(d) In Q2.2 some candidates did not understand similarity nor how to prove it. Some did *congruency* or *proportionality*.

Suggestions for improvement

(a) Learners should be taught to identify information in relation to the theorems that they are taught. They should be encouraged to scrutinise the given information and the diagram for clues. In this way, they would be able to identify which theorems could be used in answering a specific question.

(b) Learners should practise using the 'acceptable reasons' as stated in the *Examination Guidelines* during lessons, so that they get familiar with them.

(c) When using alternate, corresponding, and co-interior angles, learners should remember to specify which lines are parallel.

(d) Teachers should emphasise conditions for quadrilaterals to be cyclic.

(e) Continuous revision of Grade 11 work needs to be done in Grade 12. Furthermore, the use of the ratios of the proportional sides when triangles are similar and vice versa must be revised.

(f) Learners should be taught that all statements must be accompanied by reasons. Statements must be logical and lead to solving the problem. It must become a habit for learners to indicate and add information to their diagrams as they unpack and solve riders in sub-questions.

QUESTION 9: EUCLIDEAN GEOMETRY

Common errors and misconceptions

(a) Candidates were confused with the terms 'proportionality' and 'similarity'.

(b) In Q9.1 and Q9.3 candidates did not know how or which reason to use and sometimes gave an incomplete reason, e.g. most candidates just wrote 'prop. Theorem' and did not include parallel lines as a response to in Q9.1.

(c) In the whole Q9 candidates did not understand how to write the correct ratio for proportionality from a triangle. Hence, they substituted the wrong values.

Suggestion for improvement

(a) Teachers should revise diagrams as they provide clues of solving some Geometric problems.

(b) *Similarity* and *congruency* done in Grade 9, should be revised.

(c) Teachers should expose learners to different ways of applying proportionality theorems even when the triangle has more than one pair of parallel sides given. They should be taught to view each triangle separately first; apply theorems and then look for connections.

QUESTION 10: CIRCLES, ANGLES AND ANGULAR MOVEMENT

Common errors and misconceptions

(a) In Q10.1.1 some candidates used the wrong ratio to convert from degrees to radians. They used $\frac{180^\circ}{\pi}$ instead of using $\frac{\pi}{180^\circ}$.

(b) In Q10.1.3 converting velocity or revolutions in minutes or hours to per second, proved to be a challenge for many candidates.

(c) Most candidates could identify the correct formula and the correct substitution, but they struggled to convert the answer to the correct units or substituted the angle in degrees rather than in radians.

(d) Q10.1.4(b) candidates did not realise that the circumferential velocity of the two pulleys were equal, not the angular velocity.

(e) In Q10.2 most candidates used the correct formula, but some made incorrect substitutions. Some candidates did not know what the different variables represented. A number of candidates used an incorrect version the formula. They were expected to know it as that version was not on the information sheet.

Suggestions for improvement

(a) Teachers should revise the conversion of angles from degrees to radians and vice versa. Some formulae require angle in radians and some formulae require time in different units. Converting velocity or revolutions in minutes or hours to per second, should be emphasised during the lessons.

(b) Learners should be able to relate each variable in the formula to what it represents. This will prevent incorrect substitution. Learners should be exposed to exercises where formulae are manipulated to determine other variables within the formulae.

(c) Learners should be given clear understanding of the concept of *circumferential velocity, angular velocity* and the understanding of *rotational frequency*.

(d) Formula sheets should be effectively used during teaching from Grade 10 and be pasted in learners' daily activities books.

QUESTION 11: MENSURATION

Common errors and misconceptions

(a) In Q11.1.2 many candidates struggled to determine the missing ordinate using the concept of average.

(b) Some candidates had a total misconception for π: They were confused with $\pi \text{ rad} = 180°$ that was given on the information sheet.

(c) In Q11.1.3 some candidates copied the mid-ordinate formula incorrectly. In some instances, when they copied this formula correctly, they had no idea how to interpret the o_{n-1}. They subtracted 1 from the ordinates which resulted in the incorrect area.

(d) In Q11.3.2 most candidates could not calculate the new slant height, nor did they realise that the slanted height would also be affected. Some calculated the radius but used the old, slanted height in the new calculations. Some did the calculations but failed to write a conclusion based on their calculations.

Suggestions for improvement

(a) Teachers should explain the use of π in angles and in measurement.

(b) Teachers should revise the formula well before application. This will help learners to apply it with understanding.

(c) Learners should be taught to master the concept of increase and decrease in either percentage or fraction.

(d) Teachers should revise manipulation of formulae with learners, i.e. calculation of radius from given volume such as Q11.2.

CHAPTER 3

TECHNICAL SCIENCES

The following report should be read in conjunction with the Technical Sciences question papers of the NSC November 2023 examinations.

3.1 PERFORMANCE TRENDS (2019–2023)

The number of candidates who wrote the Technical Sciences examination in 2023 increased by 569 compared to that of 2022.

There was also a significant improvement in the pass rate this year. Candidates who passed at the 30% level improved from 89,9% in 2022 to 95,6% in 2023.

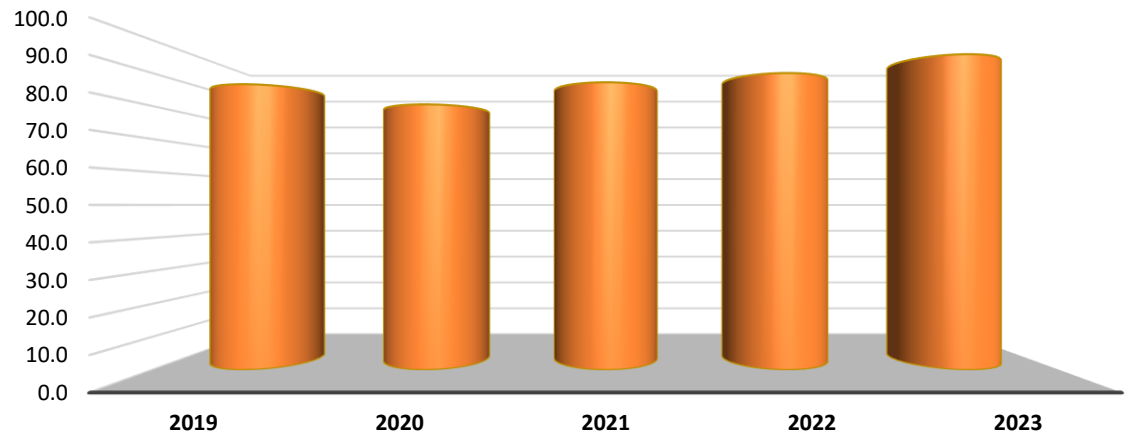
The percentage of distinctions over 80% declined from 0,9% in 2022 to 0,7% in 2023. Given the increase in the size of the 2023 cohort, this converts into decrease in the total number of distinctions from 142 to 114.

The various commendable intervention strategies employed by teachers, subject advisors and provincial education departments were continued in 2023. The resourcefulness and diligence of the above-average candidates also contributed to the overall improvement in the subject.

Table 3.1.1 Overall achievement rates in Technical Sciences

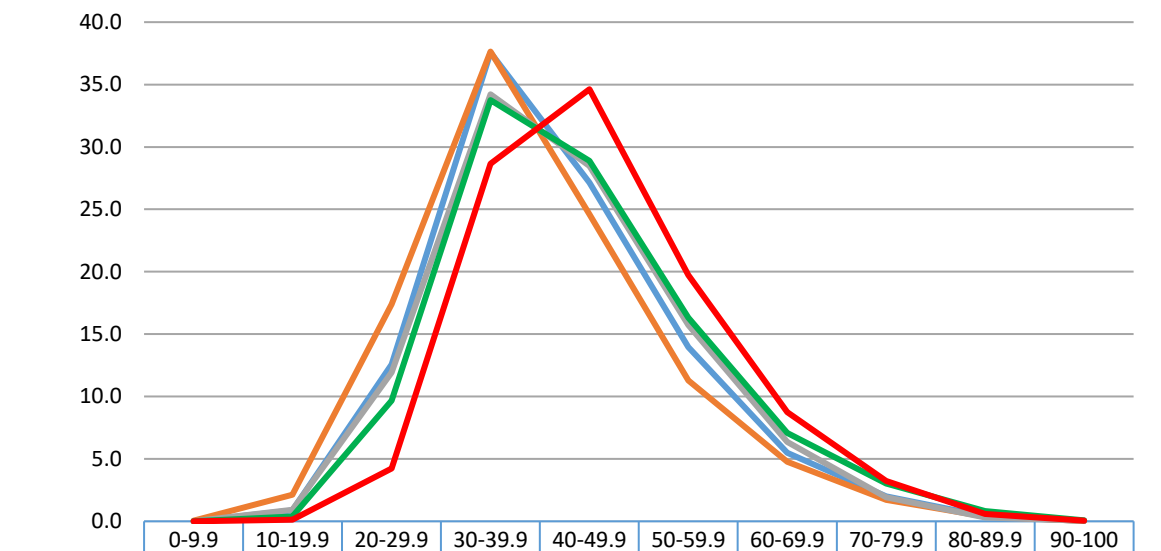
Year	No. wrote	No. achieved at 30% and above	% achieved at 30% and above
2019	10 862	9 401	86,5
2020	11 655	9 375	80,4
2021	14 642	12 758	87,1
2022	15 753	14 168	89,9
2023	16 322	15 609	95,6

Graph 3.1.1 Overall achievement rates in Technical Sciences (percentage)



	2019	2020	2021	2022	2023
% achieved at 30% and above	86.5	80.4	87.1	89.9	95.6

Graph 3.1.2 Performance distribution curves in Technical Sciences (percentage)



	0-9.9	10-19.9	20-29.9	30-39.9	40-49.9	50-59.9	60-69.9	70-79.9	80-89.9	90-100
2019	0.0	0.9	12.6	37.6	27.1	13.9	5.5	2.0	0.4	0.0
2020	0.1	2.1	17.4	37.6	24.6	11.3	4.8	1.7	0.4	0.0
2021	0.0	0.9	11.9	34.2	28.5	15.7	6.4	1.9	0.3	0.0
2022	0.0	0.4	9.7	33.8	28.9	16.3	7.1	3.0	0.8	0.1
2023	0.0	0.1	4.2	28.6	34.6	19.7	8.7	3.2	0.6	0.1

There is much room for improvement in the performance of the candidates as the challenges surrounding conceptual understanding, mathematical skills, integration of topics, problem-solving skills and practical work are being addressed.

3.2 OVERVIEW OF CANDIDATES' PERFORMANCE IN PAPER 1

General comments

(a) The multiple-choice items and questions on elasticity, hydraulics and viscosity; generators, motors and transformers were generally well answered.

(b) In general, Q6, Q7 and Q8 were poorly answered. Q6 focused on reflection and refraction of light; Q7 examined electromagnetic radiation and Q8 dealt with capacitors.

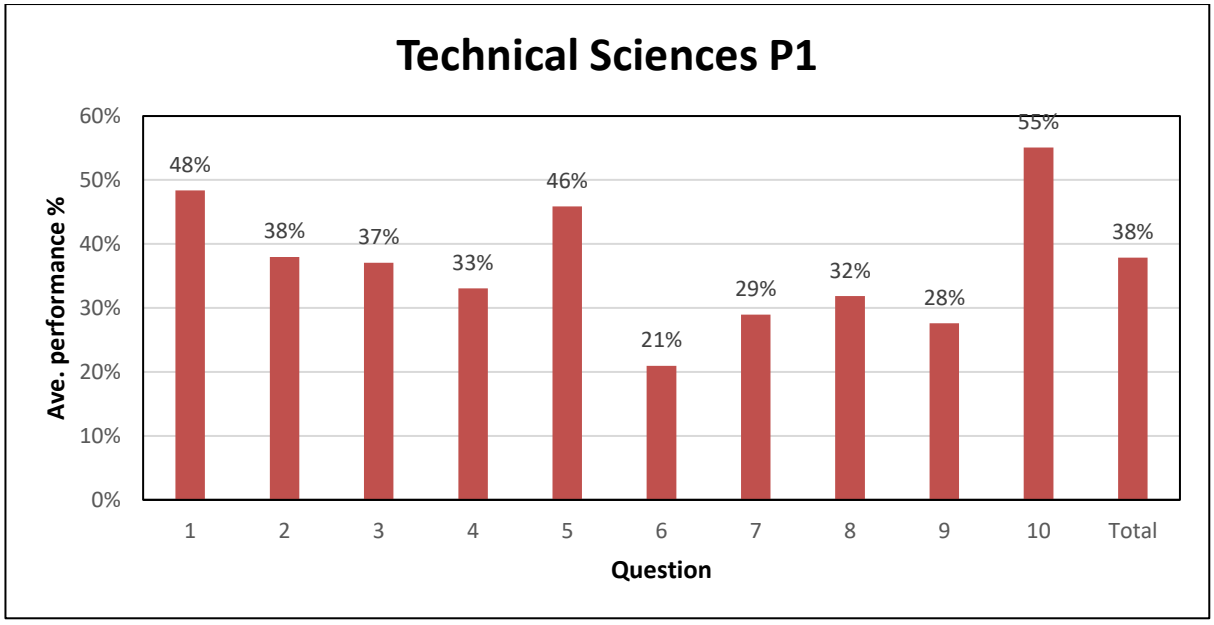
(c) Recall questions still posed a challenge to most of the candidates, although there was a notable improvement in these types of questions.

(d) A significant number of candidates lacked mathematical skills, such as understanding, using formulae and scientific notation as well as interpreting and representing direction in terms of a positive and negative sign.

3.3 DIAGNOSTIC QUESTION ANALYSIS OF PAPER 1

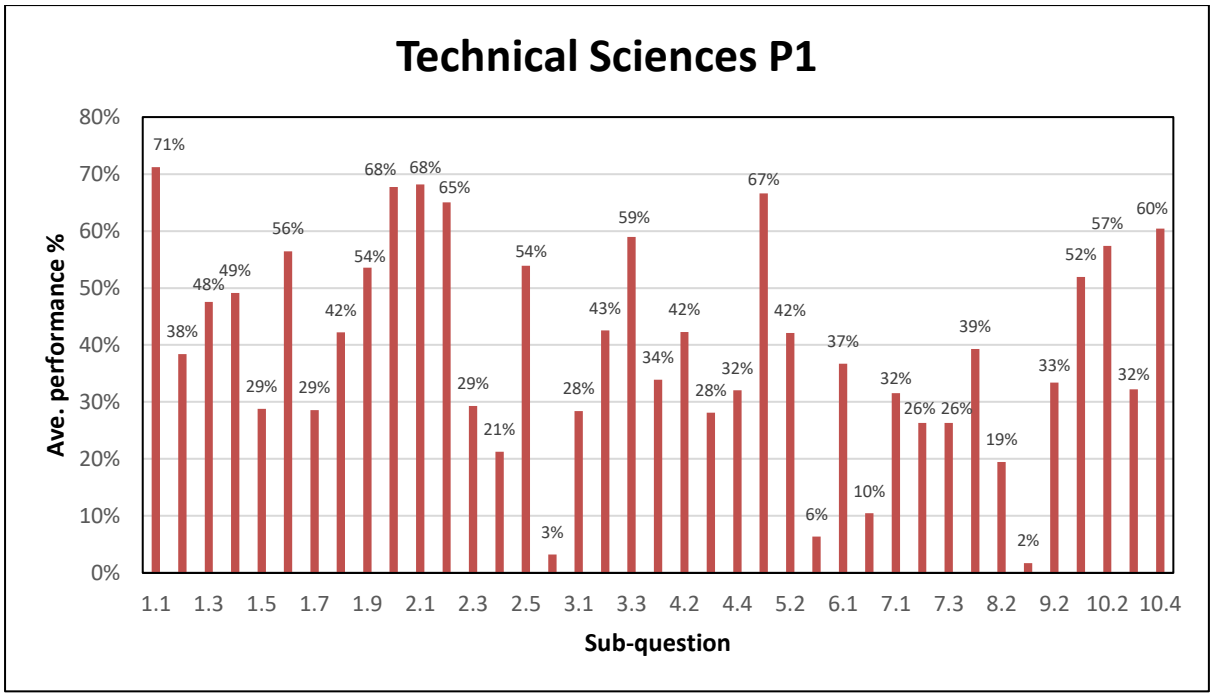
The following graph is based on data from a random sample of candidates. While this graph might not accurately reflect national averages, it is useful in assessing the relative degrees of challenge of each question as experienced by candidates.

Graph 3.3.1 Average performance per question in Paper 1



Q	Topic	Q	Topic
1	MCQ	6	Reflection and refraction
2	Newton's laws (Forces)	7	Electromagnetic radiation
3	Momentum and impulse	8	Electric Circuits: Capacitors
4	Work, energy and power	9	Electric Circuits: Energy, power and costs
5	Elasticity, hydraulics and viscosity	10	Generators, motors and transformers

Graph 3.3.2 Average performance per subquestion in Paper 1



3.4 ANALYSIS OF LEARNER PERFORMANCE IN EACH QUESTION IN PAPER 1

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Common errors and misconceptions

(a) Q1.2 was poorly answered because most candidates had difficulty in understanding and interpreting graphs. They were unable to recognise that the gradient of the graph represents the mass of an object. A common incorrect response was D which showed that candidates thought that acceleration is independent of mass of an object.

(b) In Q1.3 candidates had a challenge of using the formula $F_{net} \cdot \Delta t = \Delta p$ to deduce that F_{net} is the gradient of the graph. They were then expected to calculate the gradient and equate it to the F_{net}. The phrase 'resultant force' instead of 'net force' was used in the question paper, candidates were not aware that net force and resultant force can be used interchangeably.

(c) A significant number of candidates lacked understanding of the relationship between fluid pressure, density and gravitational acceleration in Q1.5. A common incorrect option was D as candidates associated pressure of a liquid with its mass and volume.

(d) In Q1.7 most candidates struggled to interpret ray diagrams involving the critical angle and total internal reflection.

(e) A notable number of candidates had a challenge in stating the relationship between wavelength of light wave and energy of its photons in Q1.8.

Suggestions for improvement

(a) Subject advisors are urged to monitor and support teachers to utilise a booklet of MCQ per topic compiled using previous NSC and preliminary examinations papers.

(b) Learners must be given activities that include MCQ on a regularly basis. Teachers must insist that learners provide a reason for the choice so that if there are any misconceptions, they can be rectified.

(c) Teachers should pay more attention to the drawing and interpretation of graphs. Formulae must also be used to analyse and interpret graphs.

(d) Teachers should also focus on the drawing and interpretation of ray diagrams to explain concepts like reflection, refraction, critical angle and total internal reflection.

(e) The use of formula sheets to recall laws and principles as well as to determine the relationship between variables must be infused into daily teaching and learning.

QUESTION 2: NEWTON'S LAW OF MOTION

Common errors and misconceptions

(a) A notable number of candidates committed the following errors in Q2.1.1:
- Omitting the dot on a free body diagram.
- Drawing a force diagram instead of a free body diagram.
- Using lines without arrowheads to represent the forces.
- Not drawing the tension at an angle, i.e. drawing tension, T as a horizontal force.
- Including additional force(s).
- Drawing arrows that are not touching the dot.
- Using unacceptable symbols like FG instead of Fg and W instead of w.
- Some Afrikaans candidates used *w* for friction (*wrywing*). They also used F_T for applied force (*toegepaste krag*).

(b) In Q2.2 most candidates omitted keywords like *net* and *mass* when stating Newton's Second Law of Motion.

(c) A significant number of candidates used tension instead of the horizontal component of tension when writing down the net force acting on a 220 kg block in Q2.3.

(d) In Q2.4 the majority of the candidates had difficulty calculating the coefficient of kinetic friction, μ_k as this calculation was a multi-step problem. A notable number of candidates did not even attempt the second calculation or attempted the second calculation only. Some of them used tension, T instead of the horizontal component of the tension, 165 cos 30° when writing the net force acting on a 75 kg block. Others were unable to write a correct sign conversion in terms of a negative and a positive sign to represent opposite directions. Some omitted 'net' on the formula, $F_{net} = ma$.

(e) In Q2.6 most candidates had a challenge stating and explaining a relationship between a normal and frictional force. They were unable to use the formulae, $f_k = \mu_k mg$ or $f_k = \mu kN$ and $f_k = \mu_k (mg - F{\cdot}\sin\theta)$ to explain how the change in an angle of the applied force will affect the magnitude of the frictional force.

Suggestions for improvement

(a) Learners must be exposed to problems involving the drawing of free body and force diagrams. These diagrams are important to answer questions based on forces acting on an object. They must be drilled on how to identify the forces acting on an object, noting that the number of forces is equal to the mark allocation.

(b) Teachers should pay attention to capacitating learners to answer questions involving definition of terms, stating laws and principles by insisting on the inclusion of keywords. These keywords must be underlined/emphasised during teaching and learning.

(c) Learners must be exposed to multi-step problems as they carry more marks.

(d) Learners must be encouraged to use formulae to explain relationship between variables.

QUESTION 3: IMPULSE AND CONSERVATION OF MOMENTUM

Common errors and misconceptions

(a) In Q3.1.1 most candidates omitted keywords like *total*, *linear* or *isolated system* when stating the principle of conservation of linear momentum. Some candidates stated the principle of conservation of mechanical energy instead of the principle of conservation of linear momentum.

(b) Q3.1.2 most candidates used incorrect formulae like $\Sigma p_i = \Sigma p_f$ or $a = \frac{\Delta v}{\Delta t}$ and $p = mv$ to calculate the average speed of trolley **P** and **Q**. A significant number of candidates had difficulty converting mm to m.

(c) Calculating the total momentum after collision posed a challenge to most candidates in Q3.1.3. This could be due to the fact that they struggled to determine the speed of the trolleys in Q3.1.2. Some of the candidates calculated momentum of one trolley instead of the total (sum of) momentum of the two trolleys after collision.

(d) In Q3.2.1 most candidates omitted keywords like *product* or *net* when defining impulse. Some wrote 'impulse is the rate of change in momentum'.

(e) Sign conversion in terms of representing the velocity in opposite direction with a negative sign posed a serious challenge for most of the candidates in Q3.2.2. Some candidates forfeited 1 mark for not writing the direction in the final answer. Others had difficulty converting 600 g to 0,6 kg.

(f) In Q3.3 a significant number of candidates had difficulty naming the safety features in modern cars that reduce the severity of injuries during accidents. Some of the incorrect responses included *advanced braking system* (ABS), *child lock*, *hand brake*, *wind screen*, etc.

Suggestions for improvement

(a) Learners must be drilled to include all the keywords when defining terms/concepts and stating laws or principles.

(b) Sign conversion must be emphasised when dealing with calculations involving forces acting on an object in the opposite direction or velocities of objects moving in the opposite direction. In the case of vectors, learners must be encouraged to include the units and direction in the final answer.

(c) Conversion of units and the use of scientific notation must be infused into daily teaching and learning.

QUESTION 4: WORK AND ENERGY AND POWER

Common errors and misconceptions

(a) In Q4.1 most candidates omitted keywords like *product*, *force applied* and *displacement* when defining work done.

(b) A notable number of candidates calculated gravitational potential energy using E = mgh instead of the work done by gravity in Q4.2. Most of the candidates failed to show that the work done is equal to the change in gravitational potential energy. Some of the candidates substituted cos 90° instead of cos 0° or 1 in a formula $W = F \cdot \Delta x \cdot \cos \theta$.

(c) A significant number of candidates could not convert power in watts to horsepower. Some of the commonly incorrect values used to convert power from watts to horsepower were 764; 743 and 734. Other candidates forfeited marks as they omitted subscripts on the formula $P_{ave} = F \cdot v_{ave}$. A notable number of candidates used the formula $P = \frac{W}{\Delta t}$ and substituted time without showing how it was obtained/determined as it was not given.

(d) In Q4.4.3 most candidates had difficulty motivating the answer in Q4.4.2 as they assumed that the question was based on conservation of mechanical energy. Q4.4.2 could have been phrased to read '… *its mechanical energy as it hit the ground*.' and not '… *mechanical energy on the ground*.'

(e) A notable number of candidates forfeited a mark for writing incomplete formulae by omitting the subscripts on $(ME)_{at\ A} = (ME)_{at\ B}$ and the square/superscript on $\frac{1}{2}mv^2$.

Suggestions for improvement

(a) Learners must be exposed to different problem-solving exercises from previous examination papers.

(b) Emphasise the relationship between potential gravitational energy and work done by gravity.

(c) Teachers are advised to inform learners that they will forfeit marks when they write incomplete formulae, for instance, omitting subscripts or superscripts.

(d) Learners must also be taught to master unit conversion. They must be encouraged to show all their work/steps in calculations.

QUESTION 5: ELASTICITY, HYDRAULICS AND VISCOSITY

Common errors and misconceptions

(a) A notable number of candidates failed to round off their final answers to two decimal places in Q5.1.1. Some of them wrote an incomplete formula by omitting subscripts on

the formula $\frac{F_1}{A_1} = \frac{F_2}{A_2}$ and forfeited a mark. Some candidates were unable to calculate the correct area; they substituted the value for the diameter in the formula, $A = \pi r^2$ that required the radius. Others forgot to convert mm to m.

(b) In Q5.1.2 most candidates struggled to provide a motivation for their answers/choices.

(c) A notable number of candidates had difficulty in defining stress in Q5.2.1.

(d) In Q5.2.2 a significant number of candidates had a challenge to convert mm to m.

(e) In Q5.2.2 and Q5.2.3 a notable number of candidates confused *stress* and *strain*. They swapped the formula for *stress* with that of *strain*.

(f) In Q5.3 most candidates had difficulty with substituting the correct value of $\Delta\ell$ in Q5.2.3. They substituted 188 mm instead of -12 mm. A notable number of candidates proved to have no understanding of compression and expansion, as they substituted +12 (expansion) instead of -12 (compression), hence they got an answer with a positive value instead of an answer with a negative value. Some candidates wrote units for *strain* in the final answer.

(g) A notable number of candidates had difficulty stating the disadvantage of using monograde oil in modern cars. Some of the common incorrect responses included: '*The car will burn'; 'Will damage the engine'* and '*Can only be used for one season'*.

Suggestions for improvement

(a) Teachers are encouraged to emphasise the rounding off of answers to a minimum of two decimal places correctly.

(b) Learners must be exposed to questions of a higher-order cognitive level that involve explaining, justifying and comparing.

(c) Unit conversion must be integrated into daily teaching, learning and assessment.

(d) Learners must be exposed to problems of strain involving expansion and compression. They must be encouraged to write correct SI units in the final answers.

(e) Teachers must expose learners to open-ended questions.

QUESTION 6: REFRACTION AND REFLECTION OF LIGHT

Common errors and misconceptions

(a) In Q6.1.1 most candidates had difficulty with writing down the physical phenomenon, *reflection* illustrated in the diagram. Common incorrect responses included 'refraction', 'dispersion', 'refetion' and 'refatious'.

(b) A notable number of candidates struggled to state the relationship between θ_1 and θ_2 in Q6.1.2. A common incorrect response was θ_1 is directly proportional to θ_2.

(c) In Q6.1.3 most candidates had a challenge in stating properties of the image formed on a flat mirror. Some of the common responses included, '*the image is on opposite side', 'the image is real*' and 'the image is upwards'.

(d) In Q6.2.2 a significant number of candidates had difficulty in stating changes that occur to the light ray at water-air interface.

(e) Q6.2.3 was faulty and confusing as the leading statement referred to a critical angle of 48,6° and the angle of incidence being increased to 50°, however, the angle of incidence in the diagram was 48°. Therefore, most candidates struggled to draw the required diagram.

Suggestions for improvement

(a) Teachers should allocate sufficient time for teaching this topic as it is not covered well in Grades 10 and 11.

(b) Teach learners to differentiate between *dispersion*, *reflection* and *refraction*.

(c) Learners must be taught laws of reflection and their applications. They must also be taught the difference between reflection and refraction using ray diagrams.

(d) Properties of image formed on a flat mirror must be emphasised.

(e) Teachers are encouraged to teach *total internal reflection* and its application must be taught using ray diagrams. Learners must be assessed extensively on this concept to reinforce understanding.

QUESTION 7: ELECTROMAGNETIC RADIATION (WAVES/SPECTRUM)

Common errors and misconceptions

(a) In Q7.1.1 a significant number of candidates had difficulty identifying the electromagnetic radiation used to kill cancer cells. A common incorrect response was X-ray.

(b) Most candidates had a challenge with writing down the properties of gamma rays that make it suitable to kill cancer cells in Q7.1.2.

(c) In Q7.1.3 a common mistake by some candidates was to leave out the units in the final answer.

(d) In Q7.2.1 a notable number of candidates had a challenge in identifying lenses 1 and 2. They confused a concave with a convex lens.

(e) A significant number of candidates had no idea that a virtual image is formed at point B in Q7.2.2.

(f) In Q7.2.3 most candidates had difficulty in explaining why a virtual image is formed at point B.

Suggestions for improvement

(a) Learners must be taught to identify different electromagnetic radiations and their properties. They must also know their applications/uses.

(b) Emphasis should be placed on the relationship between energy, wavelength and frequency of radiations.

(c) Teachers must place emphasis on teaching learners to draw ray diagrams showing the lenses, objects and images. The position of an object and type of lens must be varied.

QUESTION 8: ELECTRIC CIRCUITS AND POWER - CAPACITORS

Common errors and misconceptions

(a) Most of the candidates struggled with a multi-step problem in Q8.1. They calculated capacitance only and did not calculate potential difference as was required of them. Some of candidates wrote the formulae and did not substitute or attempt to substitute in those formulae, thus forfeiting marks for writing the formulae. A notable number of candidates tried to manipulate the formula $C = \frac{Q}{V}$ and wrote it incorrectly. Incorrect manipulation included $Q = \frac{V}{C}$ and $C = \frac{V}{Q}$.

(b) In Q8.2 a notable number of candidates gave the electronic devices with capacitors instead of stating the uses of capacitors.

Suggestions for improvement

(a) Multi-step problems must be infused into daily teaching, learning and assessment. Learners must be taught to move from the known variables to the unknown.

(b) Learners must be encouraged to copy the formulae verbatim from the formula sheet and substitute into a correct formula.

(c) Teachers must emphasise the uses/applications of capacitors and the electronic devices with capacitors.

QUESTION 9: ELECTRIC CIRCUITS AND POWER

Common errors and misconceptions

(a) In Q9.1 a significant number of candidates had difficulty to explain the meaning of the phrase, '*The electric welding machine is specified as 5,3 kW, 220 V*'.

(b) Most candidates struggled to calculate resistance in Q9.2.1. A significant number of candidates used 220 V instead of 218,11 V. Some of them omitted the units in the final answer.

(c) In Q9.2.3 a notable number of candidates had a challenge in calculating the cost of operating a welding machine for 30 minutes.

Suggestions for improvement

(a) Learners must be exposed to questions based on ratings of electric devices.

(b) Teachers must instil in learners the writing of a correct formula, substitution and answer with correct unit.

(c) Expose learners to activities based on calculating the cost of electricity.

QUESTION 10: GENERATORS, MOTORS AND TRANSFORMERS

Common errors and misconceptions

(a) A notable number of candidates omitted the word *device* when defining the generator in Q10.1. Some of the candidates confused a generator with a motor in terms of energy conversion.

(b) In Q10.2 the majority of the candidates were guessing as to whether the generator was an AC or DC as they could not motivate their answer in Q10.3.

(c) A significant number of candidates wrote '*split ring'* as motivation for the answer in Q10.3.

(d) In Q10.3 most candidates justified their answers to Q10.2 by comparing the voltage in a primary and secondary coil instead of the number of turns. They forfeited marks as the voltage in a secondary coil was unknown.

(e) The majority of candidates did not write the formula for calculating the secondary voltage in Q10.4.2. They used the ratio of the number of windings in a primary coil to the number of windings in a secondary coil to arrive at the answer and forfeited 1 mark for not using the formula. Some of them wrote an incorrectly manipulated formula and forfeited all the marks.

(f) A notable number of candidates used a ratio of the number of windings/turns in a primary coil to the number of windings in a secondary coil instead of the formula to determine the number of secondary voltage.

Suggestions for improvement

(a) Learners must be taught the difference between AC and DC generators by referring to the features of the generators and type of current produced. The difference between a motor and generator must also be emphasised.

(b) Teachers must encourage learners to copy formulae directly from the formula sheet and substitute into them without manipulating. They must emphasise that marks are awarded for writing the correct formula, substitution and a correct answer with correct units.

3.5 OVERVIEW OF CANDIDATES' PERFORMANCE IN PAPER 2

General comments

(a) Most candidates performed poorly in questions involving physical properties (Q3) and chemical reactions (Q4) of organic compounds.

(b) Questions based on the investigation were poorly answered.

(c) Some candidates did not adhere to the instructions in Q3.2 and Q4.2 as stipulated in the question paper.

(d) Q2.1, Q3.1, Q4.5, Q5.1 and Q6.1 which required the definition of concepts continues to be problematic for most candidates.

(e) The majority of the candidates struggled with Q1.3 which was based on electronic properties of matter.

(f) Most candidates struggled with Q3.3.5 which involved scientific reasoning.

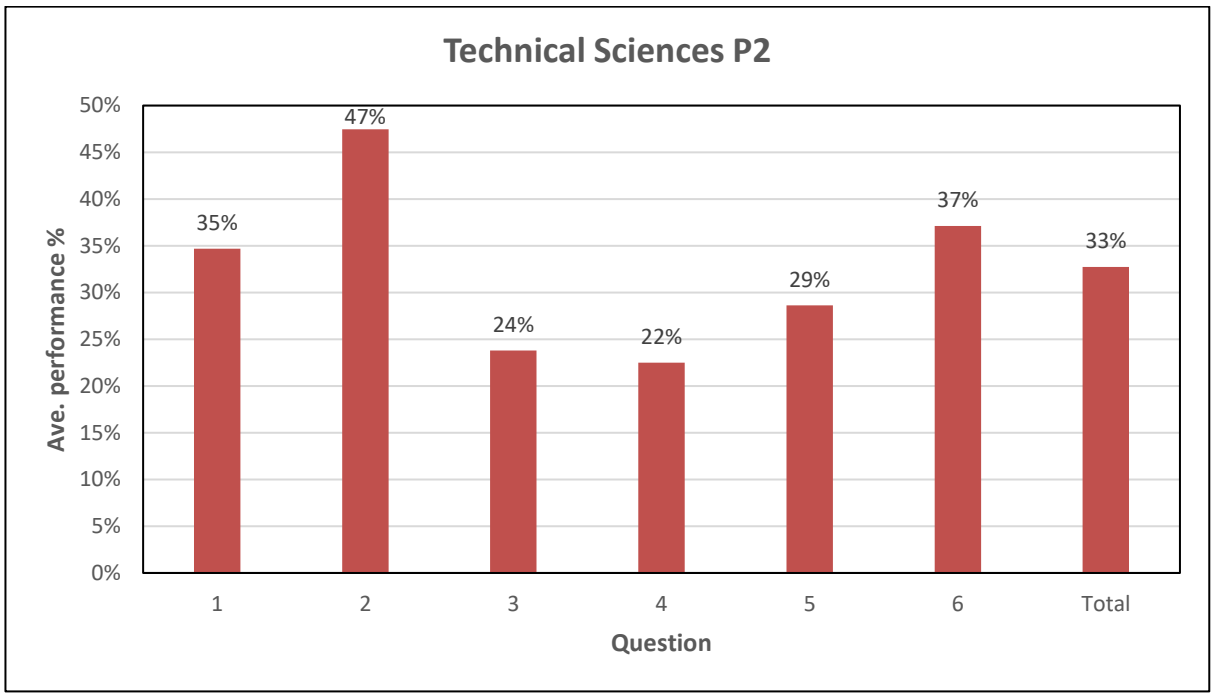
(g) The interpretation and the use of the Table of Standard Reduction Potentials was a challenge for most of the candidates.

(h) Teachers should prioritise conduction of informal experiments. This will assist learners with questions that require scientific enquiry.

3.6 DIAGNOSTIC QUESTION ANALYSIS OF PAPER 2

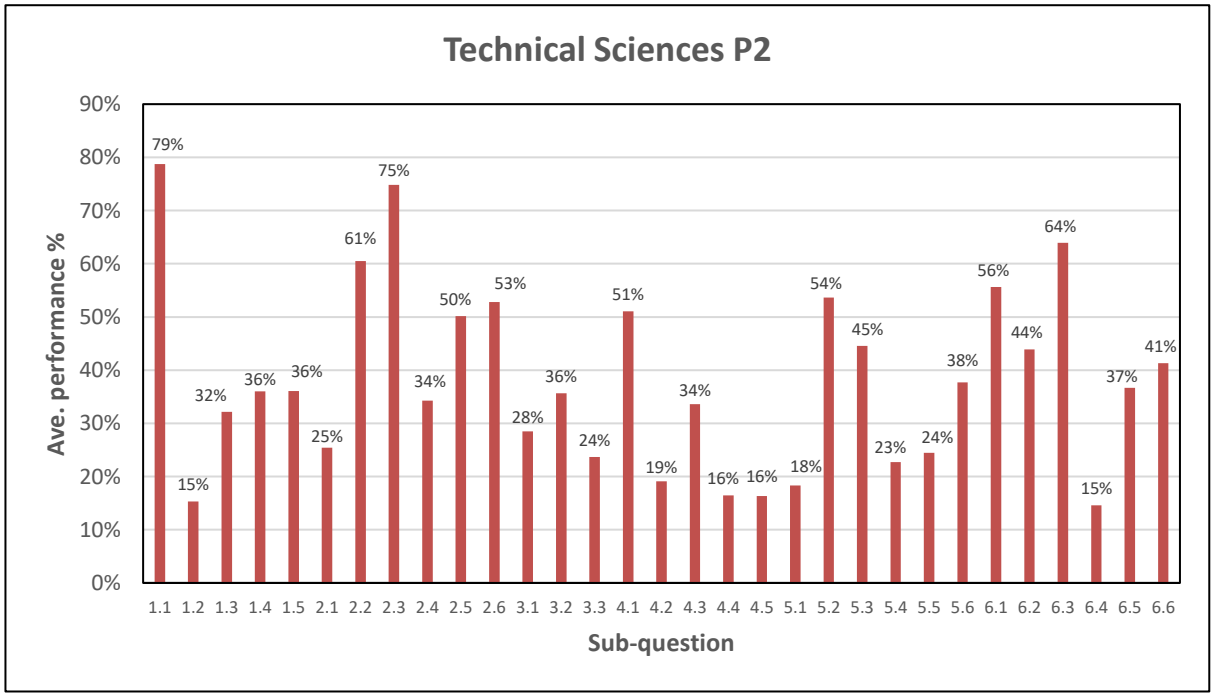
The following graph is based on data from a random sample of candidates. While this graph might not accurately reflect national averages, it is useful in assessing the relative degrees of challenge of each question as experienced by candidates.

Graph 3.6.1 Average performance per question in Paper 2



Q	Topics	Q	Topics
1	Multiple-choice Questions	4	Reactions of Organic Compounds
2	Naming of Organic Molecules and Structures	5	Electrolytic Cell
3	Physical Properties of Organic Molecules	6	Galvanic Cell

Graph 3.6.2 Average performance per subquestion in Paper 2



3.7 ANALYSIS OF LEARNER PERFORMANCE IN EACH QUESTION IN PAPER 2

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Common errors and misconceptions

(a) In Q1.2 candidates were unable to differentiate between *interatomic* and *intermolecular forces*.

(b) Candidates struggled with the concept of valence electrons in terms of doping in Q1.3. They could not choose the number of free electrons when germanium is doped with an impurity that is having five valence electrons.

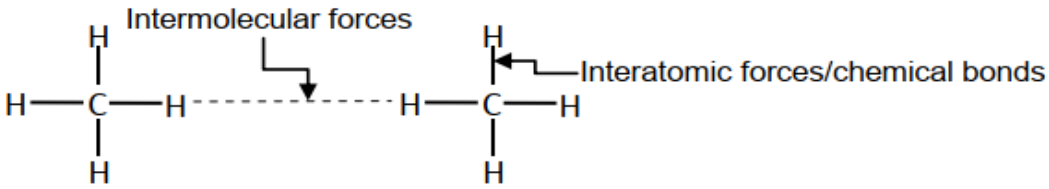
(c) In Q1.4 most candidates could not identify the reducing agent from the cell notation provided.

(d) The majority of the candidates did not know which electrode the anions will migrate to in an electrolytic cell in Q1.5.

(e) Most candidates failed to choose the correct option in the multiple-choice questions due to the lack of content knowledge and understanding of the basics of the topics assessed.

Suggestions for improvement

(a) The difference between interatomic and intermolecular forces should be explained and illustrations be used.



(b) Doping with a pentavalent and a trivalent material should be thoroughly explained.

(c) Teachers must thoroughly explain which electrodes the anions and cations in an electrolytic cell will migrate to and why.

(d) Learners must be taught how to interpret the cell notation and how to incorporate the use of the table of standard reduction potential.

(e) Daily activities and formal assessment should include multiple-choice questions so that learners practise the skill of interpreting the stem and identifying distractors to reduce the number of incorrect answers.

(f) Teachers should set up a question bank of multiple-choice questions and give it to learners to practise for revision purposes. The questions must include application based, scenario based and questions which require higher-order level of thinking.

(g) Give constructive feedback to learners on both the correct and incorrect answers.

QUESTION 2: NAMING OF ORGANIC MOLECULES AND STRUCTURAL FORMULAE

Common errors and misconceptions

(a) Candidates defined *hydrocarbon* instead of *organic molecule* in Q2.1. The key words 'molecule' and 'atoms' were omitted. They incorrectly stated that organic molecules contain carbon atoms only. The inclusion of the word 'only' made the definition incorrect.

(b) In Q2.2.2 most candidates gave one letter instead of a pair when identifying positional isomers from the given structural formulae and the IUPAC names. They failed to demonstrate understanding of the concept of functional isomerism.

(c) Some candidates struggled to give the letter of the compound that was an alkane when the condensed structural formula was given in Q2.2.3.

(d) Common errors committed by candidates when drawing structural formula for butane in Q2.3.1 were the following:
- They omitted some of the hydrogen atoms and bonds.
- They had less or more carbon atoms in the longest chain.

(e) Common errors committed by candidates when drawing structural formula for butane in Q2.3.2 were the following:
- Omitted some of the hydrogen atoms and bonds
- Had less or more carbon atoms as the longest chain
- The functional group was written as -Oℓ instead of -O-H

(f) Candidates omitted key words like 'compounds', 'molecular' and 'group' when defining functional isomer in Q2.4. Some defined 'structural isomer' instead of a 'functional isomer'. Examples of incorrect responses were as follow:
- Organic substances that have the same formula and different functions.
- Organic compounds that have the same chemical formula and different functional.
- Organic molecules having the 'same general formula' instead of the 'same molecular formula'.

(g) When naming propanal in Q2.5 candidates struggled to identify the correct functional group or to adhered to the IUPAC rules for naming compounds and they used the incorrect suffix. They wrote the name as '1-propanal', 'propan-1-one', 'propanol' and 'propanoic acid'.

(h) In Q2.6 candidates failed to link the name *propanone* to its homologous series.

Suggestions for improvement

(a) The definition of organic molecules should not have the word 'only' because it excludes the hydrogen atoms or any other relevant atoms like oxygen.

(b) All types of *structural isomers*, i.e. *positional, chain* and *functional* should be defined and explained using examples. Teachers should emphasise that isomers can be two or more.

(c) Drawing of condensed structural formula of the compounds from different homologous series should be emphasised and assessed.

(d) The IUPAC rules must be adhered to when naming organic compounds and learners should practise as much as possible.

(e) When drawing structural formulae, learners should be aware of the following:
- Identify the homologous series, functional group and the number of carbons in the parent chain.
- Each carbon must have a maximum of four bonds.
- All the hydrogen atoms must be included.
- All bonds must be indicated.
- Hydrogen should have only ONE bond.

(f) Teachers should spend more time teaching the basics of organic molecules such as to identify the homologous series from the functional group and naming.

QUESTION 3: PHYSICAL PROPERTIES OF ORGANIC COMPOUNDS

Common errors and misconceptions

(a) A significant number of candidates defined *boiling point* instead of *melting point* in Q3.1. When defining the term *melting point* candidates:
- Left out the key word *temperature* and *equilibrium*.
- Instead of writing *temperature*, they wrote *the* point/pressure.

(b) In Q3.2 the majority of the candidates failed to identify the type of intermolecular forces of propane and butane. Common errors included:
- They compared the boiling points instead of the strength of the intermolecular forces of these compounds.
- In their explanation they referred to energy instead of the molecular structure when explaining the difference in the melting points of propane and butane as was required of them.
- Candidates appeared not to have basic understanding of the concept of intermolecular forces.
- They used words such as 'larger' and 'bigger' instead of 'weaker' and 'stronger', 'higher' or 'lower' instead of 'increase' or 'decrease' when referring to the intermolecular forces.
- Candidates used a vague statement that compound B is stronger than compound A and did not compare the strength of the intermolecular forces.
- The abbreviation IMF that is not scientifically correct was used by candidates when referring to the intermolecular forces.

(c) In Q3.3.1 most candidates could not explain why the investigation was fair. For example, the response was that the compounds belong to the same functional group instead of the same chain length or had the same number of carbon atoms.

(d) In Q3.3.2 most candidates struggled to formulate an investigative question. The common mistakes were as follow:
- Phrased the investigative question as a statement and not a question.
- Omitted the question mark.
- Failed to include the dependant and independent variables and to show the relationship of the two variables.
- Provided a question whose response will be yes.

(e) Some candidates could not identify the independent variable in Q3.3.3.

(f) Candidates failed to link the melting point to viscosity in Q3.3.4 and to use the strength of the intermolecular forces to explain the difference in the viscosity of propane and propan-1-ol in Q3.3.5.

Suggestions for improvement

(a) Teachers should emphasise the importance of including key words when defining concepts.

(b) Teachers should assist learners to:
- Identify the intermolecular forces found in different homologous series.
- Compare the strength of intermolecular forces in different homologous series by mentioning both compounds.
- Explain the relationship between melting point and viscosity.

(c) Teachers must emphasise the importance of following instructions as given in the question paper. Assist learners to develop skills on how to interpret tables.

(d) The relationship between physical properties and the impact they have on one another using the strength of intermolecular forces should be explained.

(e) Learners must be exposed to questions which relate to practicals or experiments, for example, investigative questions, aim, variables (independent, dependent, controlled), whether the investigation is fair or not, observations, conclusion etc.

(f) Teachers must refrain from using the unconventional abbreviation of IMF in lessons. A distinct differentiation must also be made by teachers between bonds and intermolecular forces.

(g) Use and teach correct terminology such as *increase*, *decrease*, *stronger*, *weaker*, *higher*, *lower*, *longer chain* and *shorter chain*.

QUESTION 4: REACTIONS OF ORGANIC COMPOUNDS

Common errors and misconceptions

(a) Some candidates struggled to name the types of reactions in Q4.1.1 and Q4.1.2 given the flow diagram. They incorrectly stated that the type of reaction in Q4.1.2 was subtraction instead of substitution.

(b) In Q4.2 the majority of the candidates used the *structural formula* instead of *molecular formula* as stated in the question when writing the chemical equation for the reaction of propene to get propane. Common errors were:
- The arrow was omitted, and some candidates used an equal sign instead of the arrow, and a lower case 'h' was used for 'H' (hydrogen).
- The combination of the molecular and structural formula was used.
- Some candidates gave only the reactants or products.
- Some of the candidates who got the correct response did not balance the chemical reaction.

(c) In Q4.3 the hyphen was omitted by some of the candidates when writing the IUPAC name of 2-bromopropane and 1-bromopropane.

(d) In Q4.4 most candidates struggled to identify the reaction condition when a haloalkane reacts with excess water. Some candidates wrote '*heat'* instead of '*mild heat'* and other irrelevant responses like *'strong base'* or *'concentrated sulphuric acid'.*

(e) When defining the terms *macromolecule* in Q4.5.1 some candidates stated that it is 'a small molecule consisting of large atoms' instead of 'a molecule that consists of a large number of atoms'.

(f) When defining *polymerisation* in Q4.5.2 most of the candidates omitted the key words like 'reaction' and 'monomer'. Some candidate gave the definition of a polymer instead of polymerisation.

Suggestions for improvement

(a) The different types of reactions and the conditions should be thoroughly explained and identified from the flow diagram. Learners should draw structures before attempting the questions from the flow diagram.

(b) The difference between molecular formula, structural formula and condensed structural formulae should be thoroughly explained with examples when writing chemical reactions.

(c) When writing chemical reaction, the arrow should be used to differentiate between the reactants and products. Correct letters representing the different atoms should be used as they appear in the periodic table when drawing structural formulae, e.g. 'H' for hydrogen.

(d) The IUPAC rules for naming compounds should be adhered to. The hyphen should be placed between a number and a letter and the comma should separate the numbers. For example, 2-bromopropane or 2,3-dimethylpentane.

(e) Define the terms as stated in the CAPS and the *Examination Guidelines* with emphasis on the key words.

QUESTION 5: ELECTROLYTIC CELL

Common errors and misconceptions

(a) In Q5.1 most candidates defined the term electrolytic cell or electrolysis instead of electrolyte.

(b) Most candidates stated the energy conversion in an electrolytic cell incorrectly as *mechanical energy is converted to electrical energy* or *chemical energy to electrical energy* instead of *electrical energy is converted to chemical energy* in Q5.2.

(c) A significant number of candidates could not give a reason why the electrolytic cell is spontaneous in Q5.3.

(d) The majority of the candidates could not write the half reaction taking place at electrode X which was the anode. They wrote the oxidation half reaction of Cu instead of Ag. Some *candidates* used double arrows when writing half reaction in Q5.4.2.

(e) Some candidates confused the advantages of electroplating with those of biodiesel in Q5.5 and Q5.6.

Suggestions for improvement

(a) Teachers should explain the difference between *electrolysis*, *electrolytic cell* and *electrolyte* using relevant examples.

(b) The difference in the energy conversions of the galvanic and electrolytic cell should be thoroughly explained.

(c) Teachers should emphasise the difference between spontaneous and non-spontaneous reactions in electrochemical cells.

(d) Practical experiments of the electrolytic cell should be infused into the lessons to emphasise the reactions taking place at the anode and the cathode during electroplating.

(e) Teachers should train learners on how to use the table of standard reduction potentials. Emphasise that single arrows are used when writing half reactions to clearly indicate whether the reaction is for oxidation or reduction.

(f) The advantages for electroplating and for using biodiesel should be clarified to learners.

(g) Alternate energy sources should be thoroughly taught.

QUESTION 6: GALVANIC CELL

Common errors and misconceptions

(a) Most candidates could not define the term *oxidation* in Q6.1 and gave a definition of the oxidising agent. Incorrect definitions included:
- Loss of electrodes or gain of electrons
- Substance that loses electrons

(b) In Q6.2 the majority of the candidates struggled to use the standard reduction table to identify the negative electrode in a Cu-Ag galvanic cell. They wrote a generic response, *'anode'* instead of being specific by choosing between copper and silver. Some candidates wrote the formula of the negative electrode as Cu^{2+} instead of *Cu*.

(c) The majority of the candidates failed to state the observations made at the silver electrode. Common incorrect responses included '*bubbles will form', 'a red-brownish layer formed'* and *'there is a colour change'* in Q6.4.

(d) A significant number of candidates could not write the cell notation and confused it with the net ionic cell reaction in Q6.5.

(e) In Q6.6 most candidates swapped the E^{θ} values of the anode and the cathode when calculating the emf of the cell. Unconventional formulae were used and they also omitted the superscript θ which makes the formula incomplete. Some used the value of the incorrect half reaction of copper of $Cu^{+} + e \rightarrow Cu$ of 0,52 V instead of 0,34 V. They could not give a conclusion whether the bulb will glow or not even after getting the value of the emf of the cell. Some *candidates* omitted the SI unit.

Suggestions for improvement

(a) Teachers must clearly explain the difference between *oxidation* and *reduction* in terms of electron transfer and oxidation numbers.

(b) Learners must be taught how to use the table of standard reduction potentials to identify the anode (negative electrode) and the cathode (positive electrode) in a galvanic cell.

(c) Experiments must be infused in lessons when teaching the galvanic cell. Observations on both electrodes should be emphasised.

(d) Teachers must explain how the cell notation is written and what the symbols represent. The difference between the cell notation and net cell reaction should be explained thoroughly using examples.

(e) Learners should be exposed to the use of the standard reduction potentials table to get the correct E^{θ} values of the anode and the cathode when calculating the emf of the cell.

CHAPTER 4

CIVIL TECHNOLOGY

Civil Technology encompasses three specialisation subjects, namely Civil Services, Construction and Woodworking. This was the sixth examination in which the specialisation subjects were examined. The following report should be read in conjunction with the respective question paper of the November 2023 NSC examinations.

A detailed analysis of performance trends is provided for each specialisation subject. It must be noted that the following General Comments are observations noted across all three subjects and are therefore stated at the outset.

General comments on Civil Services, Construction and Woodworking:

Certain trends were identified in the 2021, 2022 and 2023 NSC examinations, however, most of the challenges stated in the 2022 diagnostic report were still evident in the 2023 November NSC examinations.

(a) It was noted that a significant number of candidates did not start each question on a new page as requested in the instructions.

(b) Many candiadtes lacked the ability to understand and appropriately use academic and subject-specific terminology.

(c) Responding accurately to the different action verbs used in the question paper (describe, explain, deduce, differentiate, etc.) proved to be a challenge to many candidates. They did not seem to be able to differentiate between the different types of questions.

(d) The majority of the candidates showed weak interpretation and sketching abilities. Many candidates lacked the ability to distinguish between sketches, line diagrams, scale drawings, and pictorial views. Drawing equipment was not used for a lot of scale drawings.

(e) Many candidates displayed an inability to draw sketches that were not tested in previous question papers. Candidates' knowledge seems to be limited to sketches from previous question papers that were studied verbatim without showing understanding of the different parts of the drawings.

(f) The candidates' responses indicated that they lacked exposure to and experience in real-world situations.

(g) A significant number of candidates failed to label their drawings and, as a result, were not credited with marks.

(h) Describing and explaining posed a challenge for many candidates and they were unable to express themselves when responding to these types of questions.

(i) Some candidates did not attempt to answer matching-items and multiple-choice questions.

(j) Questions that were structured differently than in previous question papers, posed a challenge for many candidates as they were not able to respond correctly to the new types of questions. Very poor reading and comprehension skills were evident in the answers provided by many candidates.

(k) Many candidates found it difficult to explain practical applications theoretically due to lack of practical experience,

(l) A significant number of candidates provided only one response instead of two in a question that counted 2 or more marks.

(m) It was observed that candidates performed poorly in the ATPs final topics. A possible reason for the poor performance may be that towards the year's end, teachers are under pressure to complete the ATP and do not spend enough time teaching these topics.

(n) The activities in the textbooks are not sufficient and, in many instances, do not address the expected outcomes of the *CAP*S. Teachers should therefore develop alternative questions that address the expected outcomes, as listed in the *CAP*S for all the topics, to cover all cognitive levels.

(o) Learners must be aware that if the relevant unit of measurement is not stated in their answers in calculations, they may not be credited for the answer.

(p) It is extremely important that learners adhere to the instructions in the question, e.g. to draw a line diagram OR a drawing showing all detail of the object. If the learner responds incorrectly to the instructions, they may lose marks as a result.

(q) Teachers and candidates should take note that the assessment criteria in the answer sheets do not indicate all the aspects and mark allocations of the drawings required as it is leading the candidate and has an impact on the cognitive demand of the question. The table on the left is an example of details that will appear in the question paper. The table on the right reflects details in the marking guideline. This implies that learners should know all the parts and dimensions of all required drawings.

ASSESSMENT CRITERIA		
NO.	**MARK**	**CANDIDATE'S MARK**
1	2	
2	2	
3	2	
4	1	
5	1	
TOTAL:	**8**	

NO.	**ASSESSMENT CRITERIA**	**MARK**
1	First course	2
2	Second course	2
3	Third course	2
4	Hatching of bricks	1
5	Projection lines	1
	TOTAL:	**8**

4.1 CIVIL SERVICES

The following report should be read in conjunction with the Civil Services question paper of the November 2023 examinations.

4.1.1 PERFORMANCE TRENDS (2019–2023)

The number of candidates who wrote the Civil Services examination in 2023 increased slightly by 31 compared to that of 2022.

The table below indicates consistent performance over the past five years with pass rates in the 96.7% to 99% range. The performance of the candidates in 2023 remains consistent with 97,7% of candidates passing at 30% (Level 2).

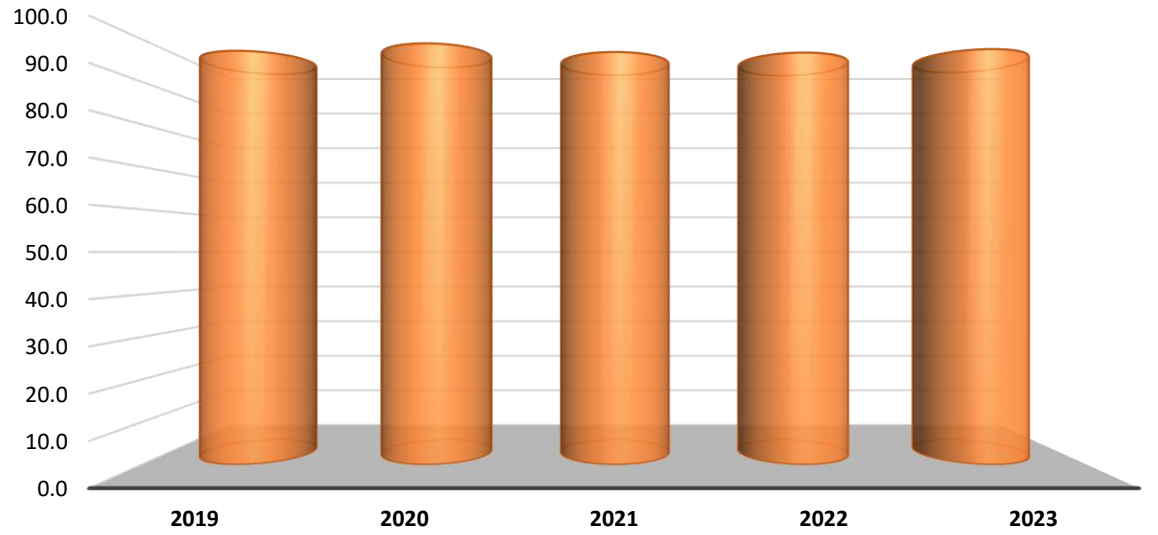
The percentage of distinctions (over 80%) declined from 2,8% in 2022 to 1,3% in 2023. Given the increase in the size of the 2023 cohort, this converts into a decrease in the total number of distinctions from 21 to 10.

Despite the decline in distinctions, the various commendable intervention strategies employed by teachers, subject advisors and provincial education departments were continued in 2023. The resourcefulness and diligence of the above-average candidates also contributed to the overall improvement in the subject.

Table 4.1.1 Overall achievement rates in Civil Services

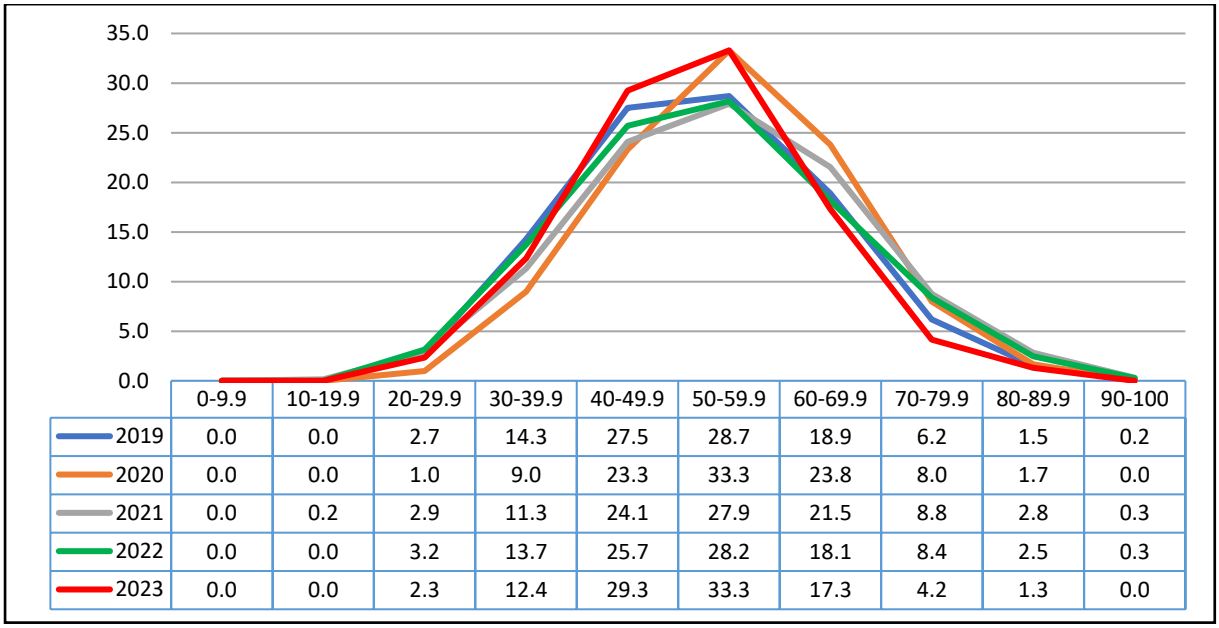
Year	No. wrote	No. achieved at 30% and above	% achieved at 30% and above
2019	582	566	97,3
2020	601	595	99,0
2021	627	608	97,0
2022	738	714	96,7
2023	769	751	97,7

Graph 4.1.1 (a) Overall achievement rates in Civil Services (percentage)



	2019	2020	2021	2022	2023
% achieved at 30% and above	97.3	99.0	97.0	96.8	97.7

Graph 4.1.1 (b) Performance distribution curves in Civil Services (percentage)



	0-9.9	10-19.9	20-29.9	30-39.9	40-49.9	50-59.9	60-69.9	70-79.9	80-89.9	90-100
2019	0.0	0.0	2.7	14.3	27.5	28.7	18.9	6.2	1.5	0.2
2020	0.0	0.0	1.0	9.0	23.3	33.3	23.8	8.0	1.7	0.0
2021	0.0	0.2	2.9	11.3	24.1	27.9	21.5	8.8	2.8	0.3
2022	0.0	0.0	3.2	13.7	25.7	28.2	18.1	8.4	2.5	0.3
2023	0.0	0.0	2.3	12.4	29.3	33.3	17.3	4.2	1.3	0.0

4.1.2 ANALYSIS OF CANDIDATES' PERFORMANCE IN EACH QUESTION IN CIVIL SERVICES

QUESTION 1: OHSA, MATERIALS, TOOLS, EQUIPMENT AND JOINING

Common errors and misconceptions

(a) In Q1.1 (12 marks) a significant number of candidates performed poorly in the multiple-choice questions.

(b) In Q1.2 (6 marks) most candidates were not able to identify, account for use or explain how the joining fixture selected would be used.

(c) In Q1.3 (1 mark) many candidates responded by stating general consequences if the laser level was not stored properly, instead of focusing on the storage in cold areas.

(d) In Q1.4 (1 mark) many candidates referred to the different objects and parts that are used in conjunction with the dumpy level, instead of the dumpy level itself, as required by the question.

Suggestions for improvement

(a) It is recommended that teachers ensure that the generic topics that are covered in Grades 10, 11 and 12 are still focused on in Grade 12 and not merely revised at the beginning of the year. Ensure that multiple-choice questions are used in formal and informal assessments. This will assist to ensure that learners are familiar with these types of questions.

(b) It would be beneficial to learners if they are taught to answer questions that are based on applications in real-life situations and to be able to explain the steps that would be followed to use a joining fixture in a specific situation. Physically using the fixtures and installing them during practical periods would greatly improve the learners' knowledge and skills.

(c) Learners must be taught to first read the question(s) carefully. Learners should then isolate the exact aspect within the topic that would form the basis of their response.

(d) Use all other assessments to provide opportunities for learners to practise answering questions accurately. Additionally, discussing the correct answers during intervention sessions or feedback sessions after assessments, would give the learners a clear idea of how answers are assessed.

QUESTION 2: GRAPHICS AS A METHOD OF COMMUNICATION

Common errors and misconceptions

(a) Many candidates experienced challenges identifying the different fixtures and drawing symbols on the building plans.

(b) A surprising number of candidates were not able to name the SI unit that was used to indicate the dimensions on the building plans in Q2.2 (1 mark).

(c) Some candidates neglected to write out the full answer, for example, if they are requested to state the size of a fixture, they would not add the unit.

(d) The interpretation of the north symbol seemed to have been a challenge to many candidates, and they were unable to identify the elevation that the sink was located on in Q2.12 (1 mark).

(e) Q2.14 (1 mark) was answered poorly by most candidates. The phrasing of the question seems to have posed a challenge to the candidates as they misinterpreted the question.

(f) Q2.20 (1 mark) seemed to have been challenging for the candidates. The candidates failed to identify and describe the shape of the balusters as expected.

(g) Q2.21 (1 mark) was answered poorly by the majority of the candidates. Performance reflects that the candidates did not know what hinged openings of windows are.

(h) The drawing of the electrical symbol in Q2.23 was not answered well by many candidates as they drew the wrong number of poles and switches in the symbol.

(i) Many candidates found it challenging to answer questions that involved calculations.

Suggestions for improvement

(a) Actual building plans should be used during teaching to familiarise learners with the interpretation of these items.

(b) It should not be assumed that learners know the different SI units used for measuring. It is recommended that the explanation and interpretation of different units should be incorporated into lessons.

(c) Encourage learners to write answers in full and always include the SI units in their answers.

(d) More analytical questions and worksheets, similar to Q2, should be covered in class, focusing on the correct terminology for each part of the drawings as well as the interpretation of the different symbols.

(e) Use different verbs when setting assessment tasks to expand the learners' vocabulary and reading comprehension. This will assist learners to be able to respond accurately to the questions.

(f) The drawing of different parts of the building plans will familiarise learners with the different shapes of these objects.

(g) It is recommended that teachers put more emphasis on teaching learners how to draw the symbols used on building plans and write the abbreviations of these symbols during class and homework activities. Also to give learners short informal assessments on this topic on a regular basis.

(h) It is recommended that the symbols should be drawn and discussed in the classroom and not just identified during assessments. If the learners know what each part of the symbol symbolises, they will be able to redraw it more easily.

(i) Learners should be exposed to more calculations involving area, perimeter and lengths of walls to ensure that they are capable of responding accurately to these questions.

QUESTION 3: CONSTRUCTION ASSOCIATED WITH CIVIL SERVICES, OHSA AND QUANTITIES

Common errors and misconceptions

(a) Q3.2.1 (3 marks) was poorly answered by many candidates. Candidates only identified A and C and not A to C, as requested.

(b) Q3.3 (4 marks) was answered poorly by most candidates. Questions that involved calculations presented a challenge to most candidates.

(c) In Q3.6 (2 marks) many candidates did not leave proof of the projection lines from the top view to the front view and were not credited for the projection lines as a result.

Suggestions for improvement

(a) It is recommended that questions of this nature should be asked in formal and informal assessments to familiarise the learners with the vocabulary being used, enabling learners to accurately respond to these questions.

(b) It is advised that questions involving calculations should be practised regularly, and that these exercises are not only limited to the examples in the resource material and previous question papers.

(c) Encourage learners to read the questions carefully and leave all proof of obtaining a certain answer or, in this case, leave the projection lines on the drawing to prove that they did indeed project from the top view as requested by the question.

QUESTION 4: COLD AND HOT-WATER SUPPLY, TOOLS, EQUIPMENT AND MATERIALS

Common errors and misconceptions

(a) In Q4.2 (5 marks) the majority of candidates were not equipped to interpret the question that required them to change the underlined words to make the statement *TRUE.* Most candidates responded by writing TRUE or FALSE instead of writing the word that would make the statement true next to the question number.

(b) In Q4.2.2 (2 marks) the majority of candidates were not able to explain the working principles of the demand pillar tap. Many candidates stated characteristics instead of working principles.

(c) In Q 4.3 (4 marks) most candidates found it difficult to explain, in chronological order, how they would fix a leaking pipe.

(d) The naming of the hot-water *SANS* symbols and writing down the abbreviation of each in Q 4.7 (6 marks) was answered very poorly by the majority of the candidates. Many candidates only named the symbols and also did not give the abbreviation.

(e) In Q4.10 (2 marks) most candidates had difficulty in differentiating between the *dezincification* and *galvanic corrosion* processes, and instead listed the characteristics or causes of each.

Suggestions for improvement

(a) It is recommended that teachers spend more time and give more activities to learners. This will assist in developing learners' critical thinking, reading and comprehension skills in all topics that lends itself to this kind of questions.

(b) Learners should communicate using the correct subject terminologies, and teachers should avoid using layman's terminology when teaching.

(c) Learners will benefit from having more practical experience in the fixing of pipes. Doing these reparations during practical sessions will enable the learners to respond better in writing, having a better frame of reference.

(d) It is recommended that drawing and identification of these symbols, should be tested on a regular basis, as they play an integral part in the communication of this subject. Learners should be encouraged to read the questions more than once to ensure that the response meets the expectations of the question.

(e) It is advised that teachers explain the differences between the different action verbs that can be used in question papers. Also, use these different verbs during assessment tasks to ensure that the learners can differentiate between the questions and know exactly what is expected from a question.

QUESTION 5: GRAPHICS AS MEANS OF COMMUNICATION, ROOF WORK AND STORM WATER

Common errors and misconceptions

(a) In Q5.1 (3 marks) many candidates were not able to respond well to the questions on roof work.

(b) Many candidates found it challenging to answer questions that expected them to describe a process, e.g. in Q 5.2 (5 marks) where the process of the installation of galvanised mild steel brackets to the fascia should have been described.

(c) Poor performance was displayed in the drawing of the development of the frustrum of a cone in Q5.4 (18 marks). Many candidates were not able to apply the basic drawing principles for developments or did not attempt the question at all. It was also evident that many candidates did not use drawing equipment.

Suggestions for improvement

(a) It will benefit learners if a gutter with brackets, gutter outlet, stop ends and a down pipe can be erected in the workshop. This ensures that learners are exposed to this topic in a real-life context.

(b) It is recommended that teachers use pictures and video clips that can be obtained from various platforms on the internet to explain the processes of installing brackets to a fascia.

(c) It will be beneficial if the subject teachers of Civil Services and Engineering Graphics Design can come to an agreement on the method that will be used for the drawing of the developments and that both subjects focus on this topic a bit more.

QUESTION 6: SEWERAGE, SANITARY FITTINGS AND JOINING

Common errors and misconceptions

(a) In Q6.3 (2 marks) many candidates described the general characteristics of cast iron pipes, instead of referring to its strength and corrosion resistance.

(b) Q6.4.4 (3 marks) was answered poorly by many candidates. The candidates were unable to describe the first three steps of the compression test.

(c) Many candidates did not indicate the water level on their drawings of the *S-trap* and *P-trap* as required in Q6.6 (2 marks).

(d) In Q6.7 (6 marks) the interpretation of the drainage plan was challenging to many candidates. Candidates struggled to identify different components, faults and explain the working principles of the drainage plan.

(e) Q6.8 was answered very poorly by most candidates. Many candidates did not even attempt to complete the drawing of a vacuum tank.

Suggestions for improvement

(a) Learners will benefit from studying all the statements under a certain heading, and it is advised that teachers promote this. This will enable learners to be able to answer questions that are more concentrated on a specific aspect within the topic.

(b) It will be beneficial for learning and teaching to accumulate equipment like the compressed air test apparatus and incorporate practical demonstrations using these types of equipment.

(c) Questions that require learners to indicate certain parts in a drawing should be set in all types of assessments. Learners should be encouraged to add as much detail to drawings as possible, as they will not be penalised for extra information.

(d) It will benefit learners if teachers organise site visits where drainage systems are being installed and can be viewed. It is also advised that the prescribed practical tasks that include drainage plans should be given more attention.

(e) A possible reason for the poor performance in this question may be that candidates were not exposed to the drawings and working principles of a vacuum tank as compared to a septic tank during class and homework exercises. It is advised that teachers teach the whole curriculum and use previous question papers only for revision.

4.2 CONSTRUCTION

The following report should be read in conjunction with the Construction question paper of the November 2023 Examinations.

4.2.1 PERFORMANCE TRENDS (2019–2023)

The number of candidates who wrote the Construction examination in 2023 decreased by 386 compared to that of 2022.

The table below indicates consistent performance over the past five years with pass rates in the 97% to 99% range. The performance of the candidates in 2023 remains consistent with 98,4% of candidates passing at 30% (Level 2).

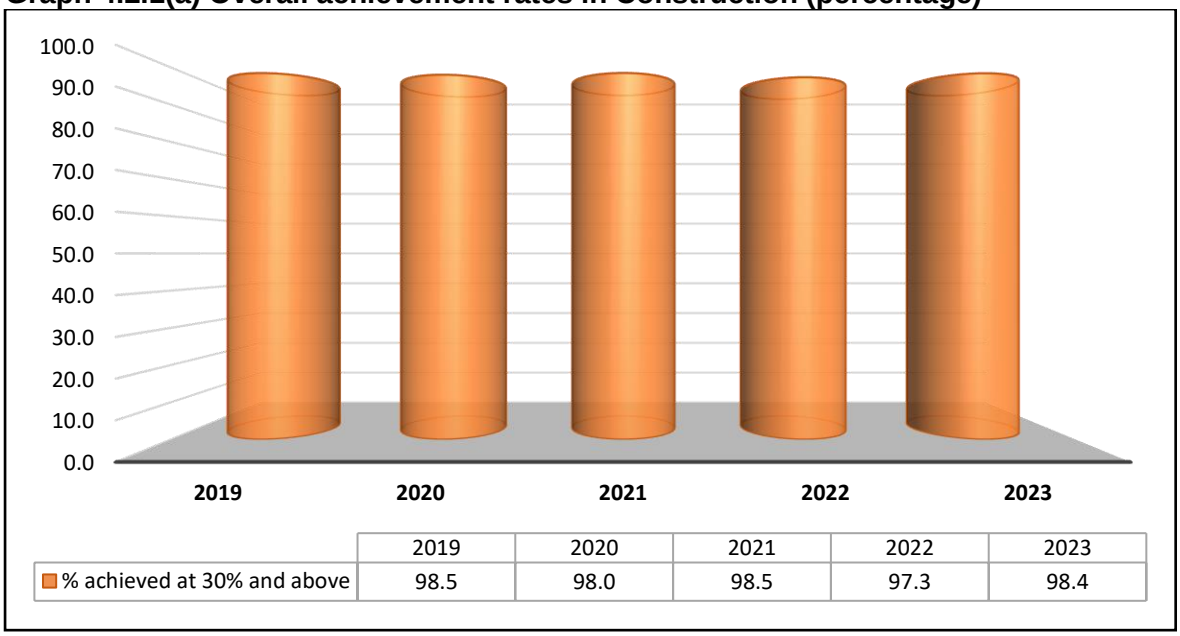
The percentage of distinctions (over 80%) declined from 2,6% in 2022 to 1,5% in 2023. Given the decrease in the size of the 2023 cohort, this converts into a decrease in the total number of distinctions from 124 to 66.

Despite the decline in distinctions, the various commendable intervention strategies employed by teachers, subject advisors and provincial education departments were continued in 2023. The resourcefulness and diligence of the above-average candidates also contributed to the overall improvement in the subject.

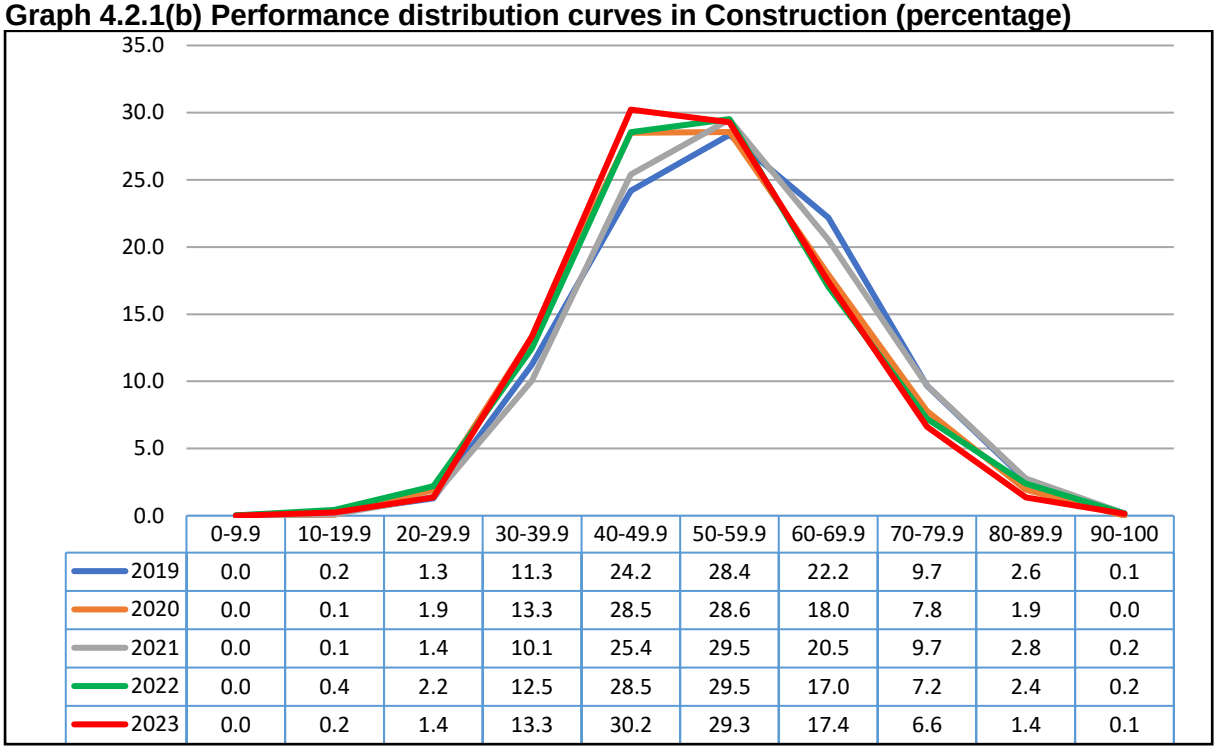
Table 4.2.1 Overall achievement rates in Construction

Year	No. wrote	No. achieved at 30% and above	% achieved at 30% and above
2019	3 492	3 438	98,5
2020	3 582	3 511	98,0
2021	4 474	4 406	98,5
2022	4 773	4 646	97,3
2023	4 387	4 317	98,4

Graph 4.2.1(a) Overall achievement rates in Construction (percentage)



Graph 4.2.1(b) Performance distribution curves in Construction (percentage)



	0-9.9	10-19.9	20-29.9	30-39.9	40-49.9	50-59.9	60-69.9	70-79.9	80-89.9	90-100
2019	0.0	0.2	1.3	11.3	24.2	28.4	22.2	9.7	2.6	0.1
2020	0.0	0.1	1.9	13.3	28.5	28.6	18.0	7.8	1.9	0.0
2021	0.0	0.1	1.4	10.1	25.4	29.5	20.5	9.7	2.8	0.2
2022	0.0	0.4	2.2	12.5	28.5	29.5	17.0	7.2	2.4	0.2
2023	0.0	0.2	1.4	13.3	30.2	29.3	17.4	6.6	1.4	0.1

4.2.2 ANALYSIS OF CANDIDATES' PERFORMANCE IN EACH QUESTION IN CONSTRUCTION

QUESTION 1: OHSA, MATERIALS, TOOLS, EQUIPMENT AND JOINING

Common errors and misconceptions

(a) In Q1.1 (12 marks) a significant number of candidates performed poorly in the multiple-choice questions.

(b) In Q1.2 (6 marks) most candidates were not able to identify, account for use or explain how the joining fixture selected would be used.

(c) In Q1.3 (1 mark) many candidates responded by stating general consequences if the laser level was not stored properly, instead of focusing on the storage in cold areas.

(d) In Q1.4 (1 mark) many candidates referred to the different objects and parts that are used in conjunction with the dumpy level, instead of the dumpy level itself, as required by the question.

Suggestions for improvement

(a) It is recommended that teachers ensure that the generic topics that are covered in Grades 10, 11 and 12 are still focused on in Grade 12 and not merely revised at the beginning of the year. Ensure that multiple-choice questions are used in formal and informal assessments. This will assist to ensure that learners are familiar with these types of questions.

(b) It would be beneficial to learners if they are taught to answer questions that are based on applications in real-life situations and to be able to explain the steps that would be followed to use a joining fixture in a specific situation. Physically using the fixtures and

installing them during practical periods would greatly improve the learners' knowledge and skills.

(c) Learners must be taught to first read the question(s) carefully. Learners should then isolate the exact aspect within the topic that would form the basis of their response.

(d) Use all other assessments to provide opportunities for learners to practise answering questions accurately. Additionally, discussing the correct answers during intervention sessions or feedback sessions after assessments, would give the learners a clear idea of how answers are assessed.

QUESTION 2: GRAPHICS AS A METHOD OF COMMUNICATION

Common errors and misconceptions

(a) Many candidates experienced challenges identifying the different fixtures and drawing symbols on the building plans.

(b) A surprising number of candidates were not able to name the SI unit that was used to indicate the dimensions on the building plans in Q2.2 (1 mark).

(c) Some candidates neglected to write out the full answer, for example, if they were requested to state the size of a fixture, they did not add the unit.

(d) The interpretation of the north symbol seemed to have been a challenge for many candidates, and they were unable to identify the elevation that the sink was located on in Q2.12 (1 mark).

(e) Q2.14 (1 mark) was answered poorly by most candidates. The phrasing of the question seems to have posed a challenge to the candidates as they misinterpreted the question.

(f) Q2.20 (1 mark) seemed to have been challenging for the candidates. The candidates failed to identify and describe the shape of the balusters as expected.

(g) Q2.21 (1 mark) was answered poorly by the majority of the candidates. Performance reflects that the candidates did not know what hinged openings of windows are.

(h) The drawing of the electrical symbol in Q2.23 was not answered well by many candidates as they drew the wrong number of poles and switches in the symbol.

(i) Many candidates found it challenging to answer questions that involved calculations.

Suggestions for improvement

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(a) Actual building plans should be used during teaching to familiarise learners with the interpretation of these items.

(b) It should not be assumed that learners know the different SI units used for measuring. It is recommended that the explanation and interpretation of different units should be incorporated into lessons.

(c) Encourage learners to write answers in full and always include the SI units in their answers.

(d) More analytical questions and worksheets, similar to Q2, should be covered in class, focusing on the correct terminology for each part of the drawings as well as the interpretation of the different symbols.

(e) Use different verbs when setting assessment tasks to expand the learners' vocabulary and reading comprehension. This will assist learners to be able to respond accurately to the questions.

(f) The drawing of different parts of the building plans will familiarise learners with the different shapes of these objects.

(g) It is recommended that teachers put more emphasis on teaching learners how to draw the symbols used on building plans and write the abbreviations of these symbols during class and homework activities. Also to give learners short informal assessments on this topic on a regular basis.

(h) It is recommended that the symbols should be drawn and discussed in the classroom and not just identified during assessments. If the learners know what each part of the symbol symbolises, they will be able to redraw it more easily.

(i) Learners should be exposed to more calculations involving area, perimeter, and lengths of walls to ensure that they are capable of responding accurately to these questions.

QUESTION 3: ROOFS, STAIRCASES AND JOINING

Common errors and misconceptions

(a) Q3.1.1 and Q3.1.2 (8 marks) reflected an average performance. Candidates found it challenging to draw the L-bolt and welded headed stud cast-in anchors and neglected to draw the concrete around the anchors.

(b) In Q3.2.1 and Q3.2.2 (4 marks) most candidates were not familiar with the correct terminologies, components and specifications regarding staircases.

(c) Q3.3 (2 marks) was answered poorly by the majority of candidates. Candidates could not respond accurately when requested to name the spaces between the roof trusses.

(d) Q3.4 (2 marks) proved to be challenging for most candidates. Candidates showed an inability to differentiate between the regulations (span) of different roof trusses, highlighting a lack of understanding of relevant regulations relating to roofs.

(e) In Q3.5 (6 marks) most candidates drew the ridge construction, however, the placement of the ridge beam was incorrect.

(f) In Q3.6 (8 marks) many candidates were unable draw the components of a lean-to roof truss to scale. Candidates did not apply the prescribed scale.

Suggestions for improvement

(a) It will be beneficial if practical examples of the different types of cast-in anchors are used during teaching. It is also advised that learners be given the opportunity to practically apply these anchors during practical sessions. Thus, they will be able to

understand the principles and application of these types of anchors in the correct contexts.

(b) It is recommended that teachers use wall charts and scale models of the different types of staircases indicating the different parts with the correct terminology during teaching.

(c) The understanding of the concept of the spacing of roof trusses to carry different types roof covering can be improved by using scale models. These models should clearly indicate the dimensions of the spacing between the roof trusses with different types of roof covering.

(d) A possible reason for the poor performance in this question may be that learners did not have the required resource material or were not well prepared for the examination.

(e) It is recommended that simulation tasks should be done during practical lessons that require learners to build models showing the differences between truss members.

(f) It will be beneficial to learners if teachers provide them with more exercises on the drawing of scale drawings focussing on the application of different scales and the correct use of drawing equipment.

QUESTION 4: EXCAVATIONS, FORMWORK, TOOLS AND EQUIPMENT AND MATERIALS

Common errors and misconceptions

(a) In Q4.1 (5 marks) the majority of the candidates were not equipped to interpret the question that required them to change the underlined words to make the statement *TRUE.* Most candidates responded by writing TRUE or FALSE instead of writing the word that would make the statement true next to the question number.

(b) In Q4.2 (8 marks) many of the candidates displayed difficulty in recalling the content knowledge applicable to *excavations* and *formwork* for excavations.

(c) In Q4.3 (3 marks) many candidates could not accurately respond to the questions about the concrete mixer.

(d) The majority of the candidates had difficulty in Q4.6 (2 marks) naming the defects when shuttering seams and joints are not watertight.

(e) Most candidates were not adequately equipped to draw the formwork for a straight flight of concrete stairs with a landing in Q4.7 (17 marks).

Suggestions for Improvement

(a) It is recommended that teachers spend more time and give more activities to learners to develop their critical thinking, reading and especially comprehension skills in all topics that lends itself to these kinds of questions.

(b) It will be beneficial to the learners if excavations can be dug, and shuttering can be done during practical lessons. This will broaden the learners' knowledge and will enable them to apply this knowledge during assessments.

(c) Using equipment during practical lessons is very important for the learners to acquire the basic skills. If the equipment is not available, then videos of it can be displayed during lessons. The topic on tools and equipment should not be neglected in Grade 12 because it was covered in Grades 10 and 11. Revision on these topics can be done before formal assessments to refresh the learners' knowledge on these topics.

(d) It is advisable to have in-depth discussions on all the construction topics and discussing the different consequences of faulty installations to enable the learners to respond accurately to these types of questions.

(e) A possible reason for the very poor performance in this question may be that learners were not exposed to the drawing of the formwork for a straight flight of concrete stairs during class and homework activities. The activities in the textbook does not have a question that requires the drawing of this formwork. It is of utmost importance that teachers do not only rely on the activities in the textbook. Instead, teachers are encouraged to develop additional questions on each topic to accurately address the expected outcomes in the *CAP*S.

QUESTION 5: PLASTER AND SCREED, BRICKWORK AND GRAPHICS AS MEANS OF COMMUNICATION

Common errors and misconceptions

(a) In Q5.1 (3 marks) many candidates had difficulty responding accurately to the questions based on *plastering*.

(b) Responses from most candidates indicated that they found it difficult to explain how to prepare concrete for a monolithic screed in Q5.3.1 and Q5.3.2 (3 marks).

(c) Q5.4 and Q5.5 (3 marks) required the candidate to explain beam filling. Many candidates were not able to explain the beam filling process accurately.

(d) In Q5.6 (4 marks) many candidates could not differentiate between the different types of arches by means of sketches.

(e) In Q5.7 (4 marks) many candidates were unable to distinguish between the shape of the bricks and mortar joints of *rough* and *gauged arches.*

(f) The majority of the candidates had difficulty completing the drawing of a detailed sectional view of the foot of a roof showing an open eave according to the required scale in Q5.8 (11 marks).

Suggestions for improvement

(a) It is recommended that all the tools that are prescribed in the *CAP*S should be available for learners to use and that the plastering process should be done by learners during practical sessions.

(b) More attention should be given to the language and comprehension skills of learners to enable them to critically interpret, evaluate and logically differentiate between different aspects and processes. This should equip learners with the ability to respond better to the type of questions as asked in Q5.3, Q5.4 and Q5.5.

(c) It is recommended that teachers provide learners with more exercises on the drawing and interpretation of the sectional views of arches focussing on the different parts, shapes of parts and the differences between the parts of the different types of arches.

(d) Most textbooks do not have activities that require the drawing of the open and closed eaves of a roof truss. Teachers are encouraged to develop additional activities on drawing of the open and closed eaves of a roof truss. These activities should be done as class and homework activities.

QUESTION 6: REINFORCEMENT IN CONCRETE, FOUNDATIONS, CONCRETE FLOOR AND QUANTITIES

Common errors and misconceptions

(a) In Q6.1 (5 marks) many of the candidates displayed an inability to select the correct description in column B to match the items listed in column A.

(b) It was evident that most candidates found it difficult to respond correctly to Q6.2.1 to 6.2.5 (8 marks) that was related to reinforcement in concrete.

(c) In Q6.3 (11 marks) many candidates were not able to respond correctly to the drawing of the sectional view through the rib and block floor.

(d) Many candidates experienced a challenge to accurately represent *tensile* and *compression forces* in their sketches in Q6.4 (4 marks). They were also unable to distinguish between the two types of forces, resulting in incorrect illustrations.

(e) It was evident that the calculation of the volume of hardcore filling and the amount of DPM needed for the building was challenging for many candidates. They demonstrated a lack of knowledge in the correct use of the dimension paper in Q6.5 (12 marks).

Suggestions for improvement

(a) The poor performance in this question may be related to a lack of understanding of the different concrete piles and the installation processes of each. It is recommended that learners are taught to understand each process and drawing. Learners are discouraged to memorise without understanding. Instead focus on equipping learners with the skills on how to break down and reassemble processes and drawings in a logical manner. This will assist learners to recall and represent the required detail when asked to do so in assessments.

(b) Learners will benefit greatly from being taught different aspects related to reinforcement in concrete as a unit. Teachers are encouraged to break it down into smaller sections so that learners can understand the use of each part. Thus, its position in the process and the reason for each part in the correct context. This will have a greater impact than teachers teaching each section in isolation and relying on rote learning for learners to recall information.

(c) The rib and block floor is not only a drawing, but it is also a process that needs to be understood to enable the learners to interpret and draw this drawing from different views. It is therefore advised that this process be taught practically in the workshop and that learners start by drawing freehand drawings of what they see from different views after the rib and block floor was practically installed. Only when learners fully understand the process, position and purpose of each part should they progress to the

drawing of instrument drawings.

(d) A possible reason for the inability of learners to draw the representations of the compression and tensile forces correctly may be a lack of exposure to these concepts during teaching and assessment.

(e) Learners should be exposed to more exercises on the calculation of quantities of materials for a building to develop a better understanding of the topic. These calculations should always be done on dimension paper so that learners become familiar with this process in preparation for examinations.

(f) It is advised that teachers implement teaching methods that encourage critical thinking, problem-solving, and practical application of knowledge rather than rote learning.

4.3 WOODWORKING

The following report should be read in conjunction with the Woodworking question paper of the November 2023 examinations.

4.3.1 PERFORMANCE TRENDS (2019–2023)

The number of candidates who wrote the Woodworking examination in 2023 decreased by 329 compared to that of 2022.

The table below indicates consistent performance over the past five years with pass rates in the 95,6% to 99% range. The performance of the candidates in 2023 remains consistent with 96,1% of candidates passing at 30% (Level 2).

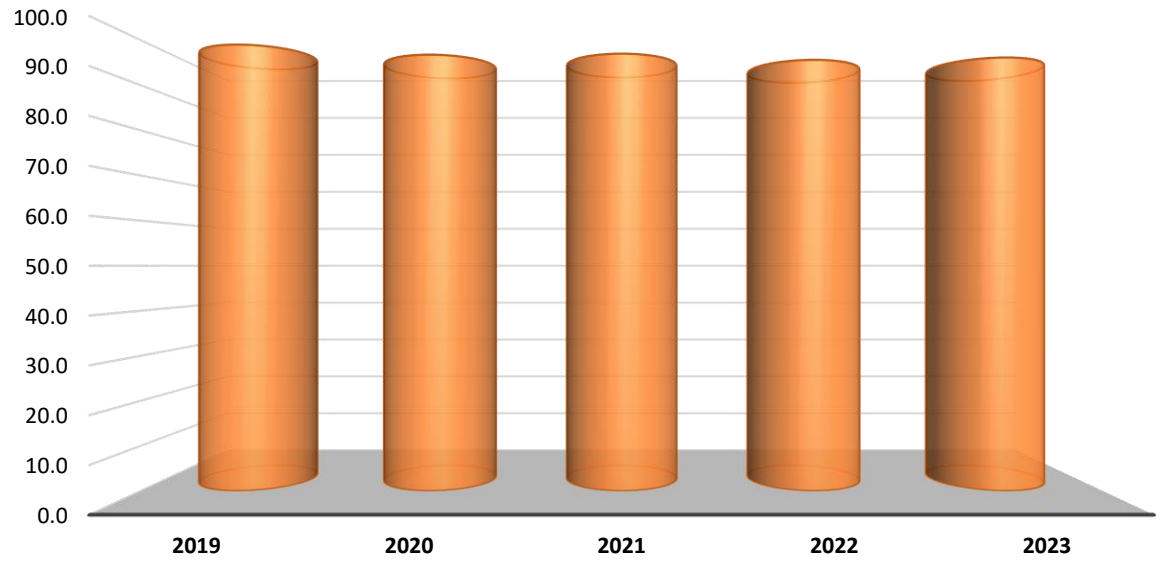
The percentage of distinctions (over 80%) declined from 1,7% in 2022 to 1,5% in 2023. Given the decrease in the size of the 2023 cohort, this converts into a decrease in the total number of distinctions from 43 to 33.

Despite the decline in distinctions, the various commendable intervention strategies employed by teachers, subject advisors and provincial education departments were continued in 2023. The resourcefulness and diligence of the above-average candidates also contributed to the overall improvement in the subject.

Table 4.3.1 Overall achievement rates in Woodworking

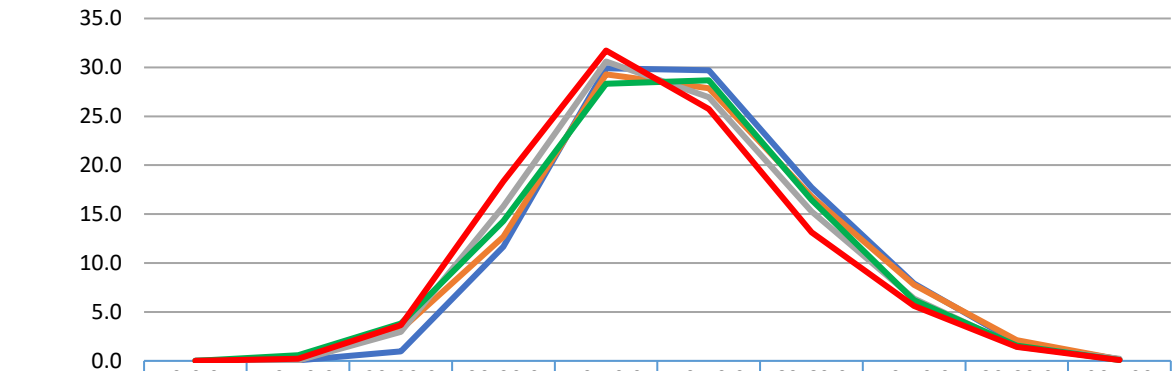
Year	No. wrote	No. achieved at 30% and above	% achieved at 30% and above
2019	1 946	1 926	99,0
2020	1 837	1 777	96,7
2021	2 366	2 294	97,0
2022	2 542	2 430	95,6
2023	2 213	2 127	96,1

Graph 4.3.1(a) Overall achievement rates in Woodworking (percentage)



	2019	2020	2021	2022	2023
% achieved at 30% and above	99.0	96.7	97.0	95.6	96.1

Graph 4.3.1 (b) Performance distribution curves in Woodworking (percentage)



	0-9.9	10-19.9	20-29.9	30-39.9	40-49.9	50-59.9	60-69.9	70-79.9	80-89.9	90-100
2019	0.0	0.1	1.0	11.7	29.9	29.7	17.7	7.9	1.9	0.2
2020	0.0	0.1	3.2	12.7	29.3	27.9	16.8	7.8	2.1	0.2
2021	0.0	0.0	3.0	15.8	30.6	27.0	15.3	6.4	1.5	0.2
2022	0.0	0.6	3.8	14.3	28.3	28.7	16.4	6.2	1.6	0.1
2023	0.0	0.2	3.7	18.3	31.7	25.8	13.1	5.6	1.4	0.1

4.3.2 ANALYSIS OF CANDIDATES' PERFORMANCE IN EACH QUESTION IN WOODWORKING

QUESTION 1: OHSA, MATERIALS, TOOLS, EQUIPMENT AND JOINING

Common errors and misconceptions

(a) In Q1.1 (12 marks) a significant number of candidates performed poorly in the multiple-choice questions.

(b) In Q1.2 (6 marks) most candidates were not able to identify, account for use or explain how the joining fixture selected would be used.

(c) In Q1.3 (1 mark) many candidates responded by stating general consequences if the laser level was not stored properly, instead of focusing on the storage in cold areas.

(d) In Q1.4 (1 mark) many candidates referred to the different objects and parts that are used in conjunction with the dumpy level, instead of the dumpy level itself, as required by the question.

Suggestions for improvement

(a) It is recommended that teachers ensure that the generic topics that are covered in Grades 10, 11 and 12 are still focused on in Grade 12 and not merely revised at the beginning of the year. Ensure that multiple-choice questions are used in formal and informal assessments. This will assist to ensure that learners are familiar with these types of questions.

(b) It would be beneficial to learners if they are taught to answer questions that are based on applications in real-life situations and to be able to explain the steps that would be followed to use a joining fixture in a specific situation. Physically using the fixtures and installing them during practical periods would greatly improve the learners' knowledge and skills.

(c) Learners must be taught to first read the question(s) carefully. Learners should then isolate the exact aspect within the topic that would form the basis of their response.

(d) Use all other assessments to provide opportunities for learners to practise answering questions accurately. Additionally, discussing the correct answers during intervention sessions or feedback sessions after assessments, would give the learners a clear idea of how answers are assessed.

QUESTION 2: GRAPHICS AS A METHOD OF COMMUNICATION

Common errors and misconceptions

(a) Many candidates experienced challenges identifying the different fixtures and drawing symbols on the building plans.

(b) A surprising number of candidates were not able to name the SI unit that was used to indicate the dimensions on the building plans in Q2.2 (1 mark).

(c) Some candidates neglected to write out the full answer, for example, if they were requested to state the size of a fixture, they would not add the unit.

(d) The interpretation of the north symbol seemed to have been a challenge for many candidates, and they were unable to identify the elevation that the sink was located on in Q2.12 (1 mark).

(e) Q2.14 (1 mark) was answered poorly by most candidates. The phrasing of the question seems to have posed a challenge for the candidates as they misinterpreted the question.

(f) Q2.20 (1 mark) seemed to have been challenging for the candidates. The candidates failed to identify and describe the shape of the balusters as expected.

(g) Q2.21 (1 mark) was answered poorly by the majority of the candidates. Performance reflects that the candidates did not know what hinged openings of windows are.

(h) The drawing of the electrical symbol in Q2.23 was not answered well by many candidates as they drew the wrong number of poles and switches in the symbol.

(i) Many candidates found it challenging to answer questions that involved calculations.

Suggestions for improvement

(a) Actual building plans should be used during teaching to familiarise learners with the interpretation of these items.

(b) It should not be assumed that learners know the different SI units used for measuring. It is recommended that the explanation and interpretation of different units should be incorporated into lessons.

(c) Encourage learners to write answers in full and always include the SI units in their answers.

(d) More analytical questions and worksheets, similar to Q2, should be covered in class, focusing on the correct terminology for each part of the drawings as well as the interpretation of the different symbols.

(e) Use different verbs when setting assessment tasks to expand the learners' vocabulary and reading comprehension. This will assist learners to be able to respond accurately to the questions.

(f) The drawing of different parts of the building plans will familiarise learners with the different shapes of these objects.

(g) It is recommended that teachers put more emphasis on teaching learners how to draw the symbols used on building plans and write the abbreviations of these symbols during class and homework activities. Also to give learners short informal assessments on this topic on a regular basis.

(h) It is recommended that the symbols should be drawn and discussed in the classroom and not just identified during assessments. If the learners know what each part of the symbol symbolises, they will be able to redraw it easier.

(i) Learners should be exposed to more calculations involving area, perimeter and lengths of walls to ensure that they are capable of responding accurately to these questions.

QUESTION 3: CASEMENTS, CUPBOARDS, WALL-PANELLING AND QUANTITIES

Common errors and misconceptions

(a) In Q3.1 (4 marks) most candidates had difficulty drawing the sectional view of the bottom rail that would fit on the given transom. Instead of drawing the bottom rail most candidates redrew the given transom and were not credited as a result. A possible reason for the poor performance in this question may be that candidates are not equipped to identify or draw parts of casements in a systematic manner in the correct position to produce a partial or complete drawing.

(b) In Q3.2 (9 marks) most candidates were not equipped to correctly calculate the total length of wall plate needed and the total length of timber required for the king posts. It was also evident in this question that many candidates were not able to use the dimension paper correctly.

(c) In Q3.3 (13 marks) it was evident from the responses of many candidates that they were unable to project and draw a sectional left view of the free-standing cupboard with an oval hanging rail and a drawer correctly from the given front view. Many candidates did not show the projection lines and were not credited for the projection lines as a result.

(d) In Q3.3 (4 marks) the majority of the candidates attempted the question and were able to show the tongue and groove boards but were not able to correctly show the secret nailing. Most candidates could not identify the horizontal rough ground and drew vertical rough grounds into the horizontal rough ground for which they were not credited.

Suggestions for improvement

(a) It is recommended that subject advisors should conduct workshops on the teaching methodology of drawings of the whole casement and of each different member of the casement. Learners should be able to identify each drawing or part of the drawing. They should then draw each member of the casement separately and as a unit on drawing paper using drawing instruments.

(b) More exercises on the calculation of quantities of all the different materials should be given to learners. It is recommended that learners be taught to read and interpret drawings, to think logically and to use the dimension paper for the calculation of quantities of the different materials correctly.

(c) It will be beneficial for learners if teachers use scale models of cupboards with different layouts and parts as a teaching aid from which learners can draw the different views of cupboards. Learners will be able to see and understand the composition of the structure of the cupboards. Learners should also be taught to draw drawings in proportion and exactly according to the given specifications.

(d) Use models of wall panelling to enable learners to interpret and understand the different parts and views of wall panelling so that they will be able to draw the front, top and sectional views of the wall panelling correctly as required.

QUESTION 4: ROOFS, CEILINGS, TOOLS AND EQUIPMENT, AND MATERIALS

Common errors and misconceptions

(a) In Q4.1 (5 marks) many of the candidates were not sufficiently equipped to select the correct description of the uses of different tools to match the tools listed in column A.

(b) In Q4.2 (5 marks), the majority of the candidates were not equipped to interpret the question that required them to change the underlined words to make the statement *TRUE.* Most candidates responded by writing TRUE or FALSE instead of writing the word that would make the statement true next to the question number.

(c) Many candidates were not able to correctly draw the constructional detail of a trapdoor opening as seen from below in Q4.3.3 (5 marks). Most candidates drew a hinged trapdoor with a frame instead.

(d) In Q4.4 (4 marks) most candidates were not able to logically explain the installation of the first corrugated iron roof sheet onto a roof structure.

(e) In Q4.5 (2 marks) the majority of the candidates were not familiar with the uses of a *truss hanger* and a *gang nail* and were unable to differentiate between the two.

(f) Q4.6 (4 marks) were well answered by most candidates, but many candidates did not draw a line diagram as required. Instead, they drew a two-dimensional drawing of the close-couple roof truss.

(g) In Q4.7 (2 marks) most candidates were not able to explain why it is important to galvanise and factory coat metal roof sheets in coastal areas. It was evident that the candidates did not possess the comprehension skills required to link the given context to the effect on the metal roof sheets.

(h) A significant number of candidates were able to correctly calculate the distance between the battens in Q4.8 (3 marks).

(i) In Q4.9 (2 marks) the majority of the candidates were not able state the requirements for the design and construction of roof trusses. Most candidates referred to general requirements of a roof truss instead of the design requirements as required in the question.

(j) The majority of the candidates were not fully equipped to respond correctly to the questions on the orbital sander in Q4.10 (4 marks) and demonstrated a lack of practical exposure to the use of this machine.

Suggestions for improvement

(a) It would benefit learners to be exposed to more practical work using all the prescribed machines to familiarise them with the uses and safety procedures of these machines.

(b) It is recommended that teachers spend more time and give more activities to learners to develop their critical thinking, reading and especially comprehension skills in all topics that lend itself to these kinds of questions.

(c) A practical application of this content will assist learners in understanding how the frame of a trapdoor is constructed between two tie beams and to differentiate between the frame of a common trap door and a hinged trapdoor with a frame.

(d) The ability of learners to respond logically and correctly to this type of question can be drastically improved by exposing them to the practical installation of a few roof sheets on a roof structure. Scale models can be used very successfully to demonstrate the process of installing roof sheets correctly in the correct sequence and applying the correct techniques.

(e) Teachers are strongly advised to use practical examples in real-life situations when teaching materials and components as it is very difficult for learners sometimes to relate correctly to only pictures and two-dimensional examples of the components that they need to be able to apply, explain and compare.

(f) It is of the utmost importance that learners are taught the difference between line diagrams, two-dimensional drawings, three-dimensional drawings, pictorial drawings, and scale drawings. Learners will be expected to respond to questions using the different types of drawings. If learners use the wrong type of drawing to respond to the question, they may not be credited for the answer provided.

(g) Expose learners to activities that require their critical thinking and comprehension skills to interpret, evaluate a situation, and to formulate a logical response. These activities can assist learners in answering questions such as Q4.7 and Q4.9.

(h) It is advised that learners should be offered the opportunity to use these types of equipment during practical sessions to obtain the necessary exposure and experience and enable them to accurately respond to these types of scenarios and questions.

QUESTION 5: CENTERING, FORMWORK, SHORING AND GRAPHICS AS MEANS OF COMMUNICATION

Common errors and misconceptions

(a) Most candidates responded fairly well to Q5.1 (2 marks), Q5.2 (1mark) and Q5.3 (1 mark).

(b) In Q5.4 (6 marks) the majority of the candidates were not able to correctly draw the formwork of a round column with a shaped yoke.

(c) In Q5.5 (8 marks) most candidates could not correctly complete the drawing of the constructional detail at the base of a centre by drawing the omitted members. Many candidates failed to print one label as required which resulted in them not obtaining all the marks.

(d) In Q5.6 (12 marks) most of the candidates were able to draw the drawing of the long- and short, shouldered mortice and tenon joint for rebated frames correctly but many candidates were not able to project accurately from the given view to obtain the correct height and width.

Suggestions for improvement

(a) It is recommended that teachers should practically demonstrate these topics to provide learners with more exposure in order to understand the concepts of this topic. The fact that the activities in the resource material do not cover all the drawings as prescribed in the *CAP*S may also have contributed to learners not being exposed to these drawings during class and homework activities.

(b) Learners should be exposed to more drawings on centring and the different types of centring focussing on the logical order in which the different parts of the centre are assembled and the purpose of each member. This may assist learners in understanding the structure and remembering the correct sequence of drawing the members.

(c) It will benefit learners if they are exposed to more activities where they have to project from one view to another to ensure that they master and apply the correct technique when they are required to use projection to complete a drawing.

QUESTION 6: SUSPENDED FLOORS, STAIRCASES, IRONMONGERY, DOORS AND JOINING

Common errors and misconceptions

(a) In Q6.1 (2 marks) the majority of the candidates had difficulty stating two different ways in which locks could be installed on doors.

(b) In Q6.2 (8 marks) most candidates' responses reflected that they were not equipped to explain the steps of marking and cutting a tenon for a mortice and tenon joint.

(c) In Q6.3 (7 marks) most candidates were not familiar with the different parts on the vertical sectional view of a framed ledged and braced batten door and could not draw the required sectional view correctly.

(d) Very few candidates were able to correctly draw the side elevation of a straight flight of stairs with a landing in Q6.4 (9 marks) according to the given specifications. It was evident that most learners lacked the reading and comprehension skills to analyse the given specifications and to correctly interpret and apply the specifications to the drawing that they were required to draw.

(e) Most candidates did not answer Q6.5 (14 marks) or were not able to correctly draw a vertical section of the supporting structure of a suspended timber floor as seen from two different directions. Even though the 2023 PAT required the learners to make a scale model of a suspended timber floor, the majority of learners still did not fully understand how a suspended timber floor is constructed.

Suggestions for improvement

(a) It is recommended that learners are exposed to the practical fitting and installation of the different types of locks during practical periods, so that they can practically see where and how these locks are used.

(b) It will be beneficial to learners if they are exposed to more examples where they are required to draw drawings from given specifications to develop their reading and comprehension skills that will enable them to respond more accurately to this type of questions.

(c) It is critically important that learners understand what they are drawing for them to respond correctly to any drawing question. It is therefore recommended that teachers make use of physical examples of every drawing that learners are required to draw. Learners should be required to draw freehand drawings of each part that they physically see. Only after the learners fully understand each part and where it is placed, should they be required to draw instrument drawings as required.

(d) Learners should be taught to carefully read all the instructions before attempting to answer any question. Learners should also be taught how to summarise and organise the specifications that was given in the question to enable them to apply the given information correctly in the required drawing or question.

(e) The physical installation of part of a suspended timber floor with all components, including the supporting piers during practical periods, will assist learners in gaining a better understanding of this topic. Learners may then be required to draw neat freehand drawings of all the parts of the completed timber floor as seen from at least two different directions, as well as from the top.

CHAPTER 5

ELECTRICAL TECHNOLOGY

5.1 DIGITAL ELECTRONICS

The following report should be read in conjunction with the Digital Electronics question paper of the November 2023 examinations.

5.1.1 PERFORMANCE TRENDS (2019–2023)

The number of candidates who wrote the Digital Electronics examination in 2023 has remained stable at 391 for the past two years.

The table below indicates consistent performance over the past five years with pass rates in the 95% to 98% range. The performance of the candidates in 2022 remains consistent with 97,2% of candidates passing at 30% (Level 2).

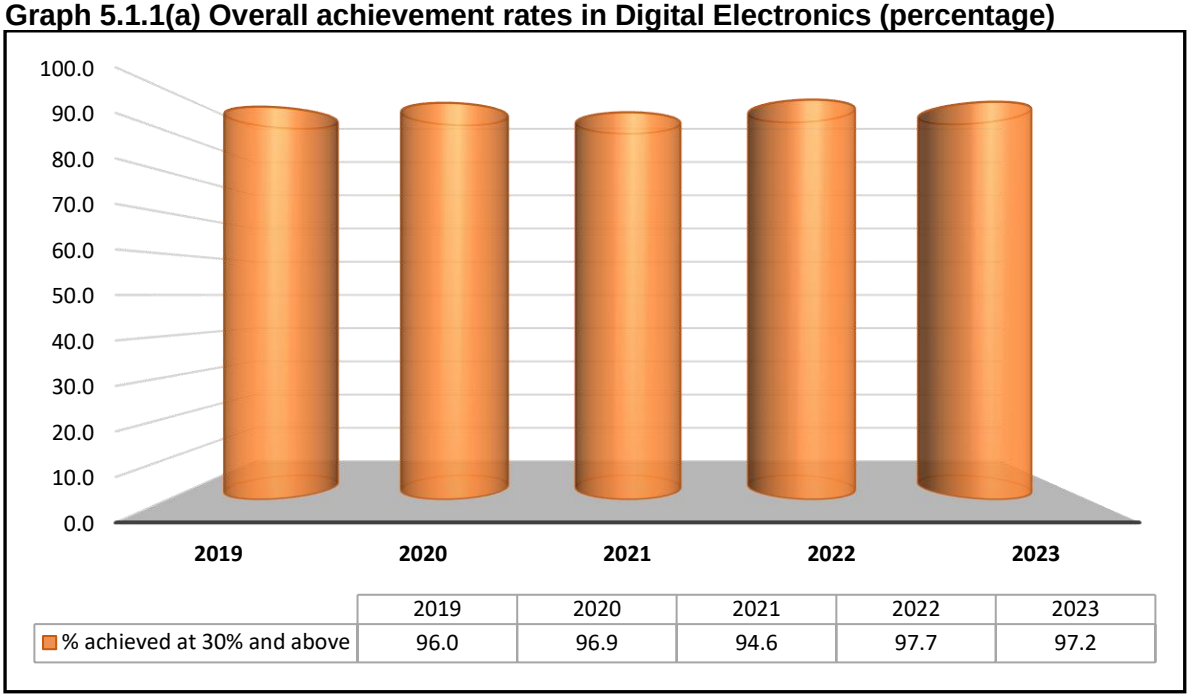
The percentage of distinctions (over 80%) was 1,3% in 2023. This converts into 5 distinctions in total.

The various commendable intervention strategies employed by teachers, subject advisors and provincial education departments were continued in 2023. The resourcefulness and diligence of the above-average candidates also contributed to the overall improvement in the subject.

Table 5.1.1 Overall achievement rates in Digital Electronics

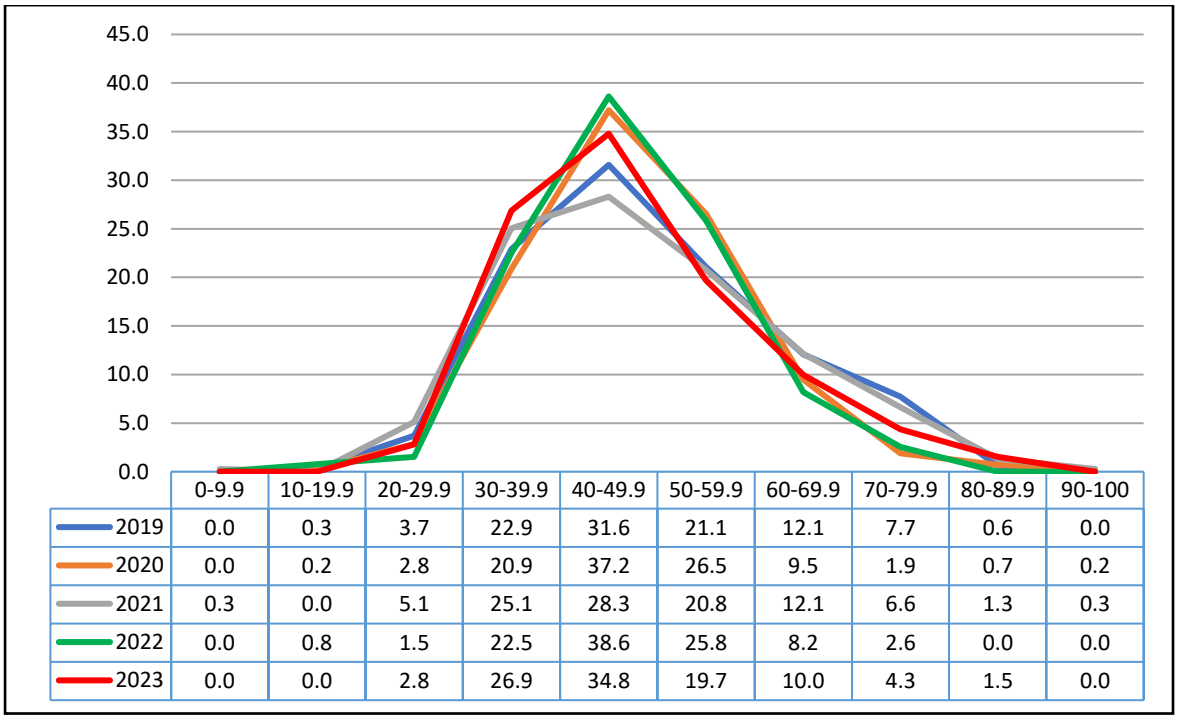
Year	No. wrote	No. achieved at 30% and above	% achieved at 30% and above
2019	323	310	96,0
2020	422	409	96,9
2021	371	351	94,6
2022	391	382	97,7
2023	391	380	97,2

Graph 5.1.1(a) Overall achievement rates in Digital Electronics (percentage)



	2019	2020	2021	2022	2023
% achieved at 30% and above	96.0	96.9	94.6	97.7	97.2

Graph 5.1.1(b) Performance distribution curves in Digital Electronics (percentage)



	0-9.9	10-19.9	20-29.9	30-39.9	40-49.9	50-59.9	60-69.9	70-79.9	80-89.9	90-100
2019	0.0	0.3	3.7	22.9	31.6	21.1	12.1	7.7	0.6	0.0
2020	0.0	0.2	2.8	20.9	37.2	26.5	9.5	1.9	0.7	0.2
2021	0.3	0.0	5.1	25.1	28.3	20.8	12.1	6.6	1.3	0.3
2022	0.0	0.8	1.5	22.5	38.6	25.8	8.2	2.6	0.0	0.0
2023	0.0	0.0	2.8	26.9	34.8	19.7	10.0	4.3	1.5	0.0

Recommendations on Digital Electronics; Electronics and Power Systems

(a) Learners should be cautioned:
- To write neatly and legibly
- Not to cramp their calculations
- To follow the general instructions provided in the question paper.

(b) Some candidates encountered challenges in manipulating formulae.
The following are suggested for teachers:

- Provide manipulation exercises to strengthen the skill in all the calculations.
- Encourage learners to:
  - Identify and use the relevant formulae provided on the formula sheet.
  - Substitute values correctly and write the answer with the correct unit.

(c) Teachers are encouraged to attend developmental workshops and seminars that are organised by various stakeholders.

(d) Schools and teachers are encouraged to download the load-shedding App and prepare a standby practical timetable.

General comments

To improve learner performance and to be more productive and efficient, the following areas, namely *switching circuits, digital and sequential devices, and microcontrollers*, need to be covered as it was evident from previous examinations and the 2023 examination, that most candidates continue to struggle in these areas. The grave concern remains that misconceptions will negatively impact on the subject and its performance. Therefore, a concerted effort needs to be made from all stakeholders, to break through the barriers of misconception and allow the subject to flourish.

5.1.2 OVERVIEW OF CANDIDATES' PERFORMANCE IN DIGITAL ELECTRONICS

General comments

Although new suggestions have been included, some of the recommendations from the *2022 Diagnostic Report* have been retained due to their continued relevance.

(a) An overall poor performance was recorded in the following areas: switching circuits, digital and sequential devices, and microcontrollers.

(b) It was evident from candidates' responses that they lacked relevant content knowledge and the necessary skills to answer the questions.

General suggestions for improvement

(a) The use of past question papers may serve as one of many teaching and learning resources if used properly. These papers may be used for learner assessment, revision purposes and, to a certain extent, teachers may use these papers for self-diagnostic assessment. Every learner must have access to past examination papers from November 2018 to November 2023 as these are based on the current CA*P*S content.

(b) Revision of relevant Grades 10 and 11 content is advisable. This is because prior knowledge from the Grade 10 and 11 syllabi serves as a foundation to equip and prepare learners to respond to Grade 12 content. It is, therefore, essential that this prior knowledge be incorporated into lesson preparations/planning.

(c) At the end of each topic in the *CAP*S, there are practical experiments that should be performed to enhance the understanding of the subject content. Teachers are encouraged to perform these practical tasks, which will in turn, prepare learners for practical assessment tasks (PATs).

(d) Questions based on recall of content were poorly answered by the majority of the candidates. Weekly informal assessment tasks should be used to reinforce basic concepts and principles. Factual Paraphrasing writing skills should be instilled. This can be used effectively for content relating to definitions, functions, labelling and operations as listed in the CAPS and the Examination Guidelines.

5.1.3 ANALYSIS OF CANDIDATES' PERFORMANCE IN EACH QUESTION IN DIGITAL ELECTRONICS

QUESTION 1: MULTIPLE-CHOICE QUESTION

Common errors and misconceptions

The majority of the candidates performed better in this question.

Suggestions for improvement

Learners should:

- Not rush when choosing the correct answer/option as this type of question has distractors. They should rather read the whole question carefully, understand what is asked, and eliminate incorrect options before selecting the correct answer.
- As they read the questions and possible answers, they should underline the keywords and the concepts/phrases that might guide them in selecting the correct answer.
- Answer the question without looking at the options.

QUESTION 2: OCCUPATIONAL HEALTH AND SAFETY

Common errors and misconceptions

(a) In Q2.1 most candidates did not understand the keyword 'incident' when responding to the question. They responded to trivial/insignificant events instead of catastrophic events.

(b) In Q2.2 some candidates' responses focused only on injury to people and not damage to property.

(c) In Q2.3 most candidates' responses focused on the application and functions of the emergency master switch and not why its location is important for safety, while other responses referred only to its accessibility.

(d) In Q2.4 the majority of the candidates confused human rights responses with victimisation and discrimination. Answers to Q2.1 were also found in Q2.4. Most candidates could not distinguish between the different types of burn wounds; hence their responses were on any of the types of burns.

(e) In Q2.5 many candidates responses referred to 'what to do when discovering that a person is receiving an electric shock 'instead of the treatment of the person who was already shocked and has been removed from the place of shock'.

Suggestions for improvement

NB: Teachers should remember that this section is crucial:

- In preparing learners for the industrial world
- For learners to understand and manage the potential risk in and around their

surroundings including at their school and homes

(a) Teachers should give attention to industrial OHS videos/online resources to enhance their teaching from Grades 10, 11 and 12.

(b) OHS should be integrated into practical tasks and infused into teaching rather than being taught in isolation.

(c) Arrange field trips to workplaces, e.g. mining industries, factories, generation stations, etc.

QUESTION 3: SWITCHING CIRCUITS

Common errors and misconceptions

Curriculum specialists and teachers are advised to attend to this concern, as in 2022, the majority of the candidates did not answer this question. This was also the case in 2023 with the errors made and with similar misunderstandings in answering these questions.

(a) In Q3.1 a large number of candidates explained how the input to the two circuits differ.

(b) In Q3.2.1 most candidates explained the function of the resistors as 'to limit current flow, while others wrote it as 'pull up resistors'.

(c) In Q3.2.4 some candidates calculated output voltage from the circuit above because of the word deduce.

(d) In Q3.2.5/Q3.7 and Q3.4.3 many candidates lost marks by not indicating the following respectively:
- The correct:
  - Output wave orientation
  - Triggering points
  - Charging and discharging point/value
- Indication of the period of charging and discharging of the capacitor.

(e) Answering the narrative type of question is still a challenge as shown in Q3.3.3 where the majority of the candidates could not attempt this question.

(f) In Q3.4.1 few candidates knew the meaning of a duty cycle.

(g) In Q3.4.2 some candidates wrote discharging time was longer instead of the charging time and others did not motivate whether the charging or discharging time was longer.

(h) In Q3.5.3 the majority of the candidates used 5 V instead of 9 V to draw one cycle of the input and output waveforms of the inverting Schmitt trigger circuit when R2 is set to 2,2 kΩ and the input waveform is sinusoidal.

(i) In Q3.5.4 some candidates wrote trigger voltage can be decreased by decreasing the resistor, without specifying which of the resistors between the two.

Suggestions for improvement

(a) It is important for teachers to understand that components in a circuit may perform different functions, e.g. in Q3.2.1 where the two resistors are used as potential dividers and not as limiting resistors.

(b) Learners should understand the following concepts:
- Triggering points and orientation of the output waveforms when input signals are applied in different switching circuits
- Active high trigger and active low trigger with reference to switching circuits
- The difference between integrator and differentiator when input signals are applied

(c) The explanation of a circuit must be coupled with calculations, drawing of input and the correlating output waveforms as in Q3.5.3.

(d) Focus on ensuring that:
- Learners' calculations follow instruction 6 of the question paper. This includes writing of the correct steps so that learners do not lose marks unnecessarily.
- Learners draw a fully labelled circuit. Teachers are encouraged to do the same during teaching of this topic. Learners use the teacher's work as the model and copy it.
- Learners' theoretical knowledge is strengthened through the integration of ICT showing simulations and circuits in lesson preparation. This, in turn, enhances teaching and learning.

(e) The difference between the verbs *calculate* and *determine* must be explained:
- Calculate: In this context involves the identification of formulae, the substitution of given values in the formulae and applying the mathematical operations to arrive at the answer, e.g. in Q3.5.2 and Q3.6.3.
- Determine and deduce: This does not involve doing calculations, but rather identifying information depicted in the given information, e.g. in Q3.3.2 learners were expected to determine the threshold voltage of the circuit when the supply voltage is 6 V. The same considerations applied to Q3.2.4.

QUESTION 4: SEMI CONDUCTOR DEVICES

Common errors and misconceptions

Most candidates answered this question poorly despite suggestions for improvement having been made in the *2022 Diagnostic Report.* This question continues to pose a problem for candidates.

(a) In Q4.1.1 most candidates responses were on the function of the resistor instead of the purpose of the feedback resistor.

(b) In Q4.1.2 the majority of the candidates misunderstood the word '*seldom*' when answering the question.

(c) In Q4.3.3 many candidates' responses stated the function of pin 4 instead of describing it. A few candidates erroneously swopped the inputs of both comparators.

Suggestions for improvement

(a) Teachers must emphasise to learners the writing of the number '*120 k*' (*k* as a prefix which means 1 000 or 10^3). This could be written as '*120 000*' when substituting in a formula. They should also be cautioned that 120 *k* is not equal to 120. Other related prefixes to the subject must be emphasised.

(b) Teachers should further emphasise the difference between the words 'function, use and purpose' as used in the question, as learners misconstrue the words as synonymous.

(c) Teachers are advised to further focus on explaining:
- Definition of concepts and terminologies
- Function of transistors and comparator
- Op-amp as:
  - Inverting and calculations
  - Non-inverting and calculations
- Advantages of using negative feedback on operation amplifiers
- Open loop and closed loop gain of amplifiers

QUESTION 5: DIGITAL AND SEQUENTIAL DEVICES

Common errors and misconceptions

(a) In Q5.1.1 most candidates responses were that 'all the anodes or cathodes are connected' instead of stating that they are connected to the positive or ground rails, while few candidates' responses were swopped.

(b) In Q5.2.1 the majority of the candidates did not write X = 5 V and Y = 0 V. Instead, they wrote 5 V and 0 V without X and Y, some wrote 5 V/-5 V or 15 V/- 15 V.

(c) In Q5.3 many candidates explained polarisation instead of explaining how the coherent picture is created on the LCD screen. Other candidates described the working principle of a seven-segment LCD display and the functional principle of one pixel instead of 1 000 pixels that forms a coherent picture.

(d) In Q5.5.1 most candidates used NOR gate on the final stage of the drawing instead of using NAND gates.

(e) In Q5.7 the majority of the candidates defined asynchronous and synchronous instead of giving examples of each.

(f) In Q5.8 most candidates did not explain negative edge triggering and propagation delay. Their response was, '*It is when the circuit reacts on the lagging edge of the clock pulse*'.

(g) In Q5.10.2 many candidates responses described the counting up and down of the counter, while others described the sequential functioning of the circuit. This is evidence that candidates did not read the question to the end.

(h) In Q5.11.4 most candidates were not able to describe how data flows through the register. They stated the uses and applications of registers.

Suggestions for improvement

(a) Explain to learners the working principle of the logic circuit in conjunction with the timing diagram. Also, explain the difference between active circuits, enable circuits and clock circuits, for each circuit will react differently on inputs.

(b) Relevant software like multisim is available and can be downloaded to assist learners when doing practicals to understand digital and sequential devices.

(c) Drawings done by learners should be of the same standard as done on the diagram/answer sheet attached to the question paper. All labels should be inserted, and all inputs must correlate to outputs with all information inserted.

QUESTION 6: MICROCONTROLLERS

Common errors and misconceptions

(a) In Q6.2.5 most candidates explained the operation of the RAM instead of answering the question.

(b) The majority of the candidates did not complete Table 6.5 and Table 6.7 of Q6.5 and Q6.7.

(c) In Q6.6.2 a large number of candidates explained how data was transferred from the Sender to the Receiver instead of how data is arranged.

(d) In Q6.10 most candidates did not provide a response to the question but rather left it blank.

(e) In Q6.11 most candidates omitted the Yes/No output on the decision element. They did not use a loop back to start. They further mixed the process symbol with the data symbol.

Suggestions for improvement

(a) Microcontrollers are theoretical chapters and if learners study this chapter, they should be able to obtain good marks.

(b) Sufficient time should be allocated to the topic during teaching to allow learners to assimilate information. The flow diagram for a program to execute a specific task should be practised using various scenarios of real-life topics.

(c) Learners need more exposure to the simulations that can be used, to enhance learning and conceptual understanding of the curriculum. This part of the examination required higher-order thinking and understanding. From candidates' responses, it was a confirmation that most schools did not perform experiments on microcontrollers.

(d) PICAXE editor for developing the flowchart must be used as learners struggle to answer this section of the question.

5.2 ELECTRONICS

The following report should be read in conjunction with the Electronics question paper of the November 2023 examinations.

5.2.1 PERFORMANCE TRENDS (2019–2023)

The number of candidates who wrote the Electronics examination in 2023 decreased by 87 in 2023.

The table below indicates consistent performance over the past five years with pass rates in the 91% to 96% range. The performance of the candidates in 2023 remains consistent with 96,0% of candidates passing at 30% (Level 2).

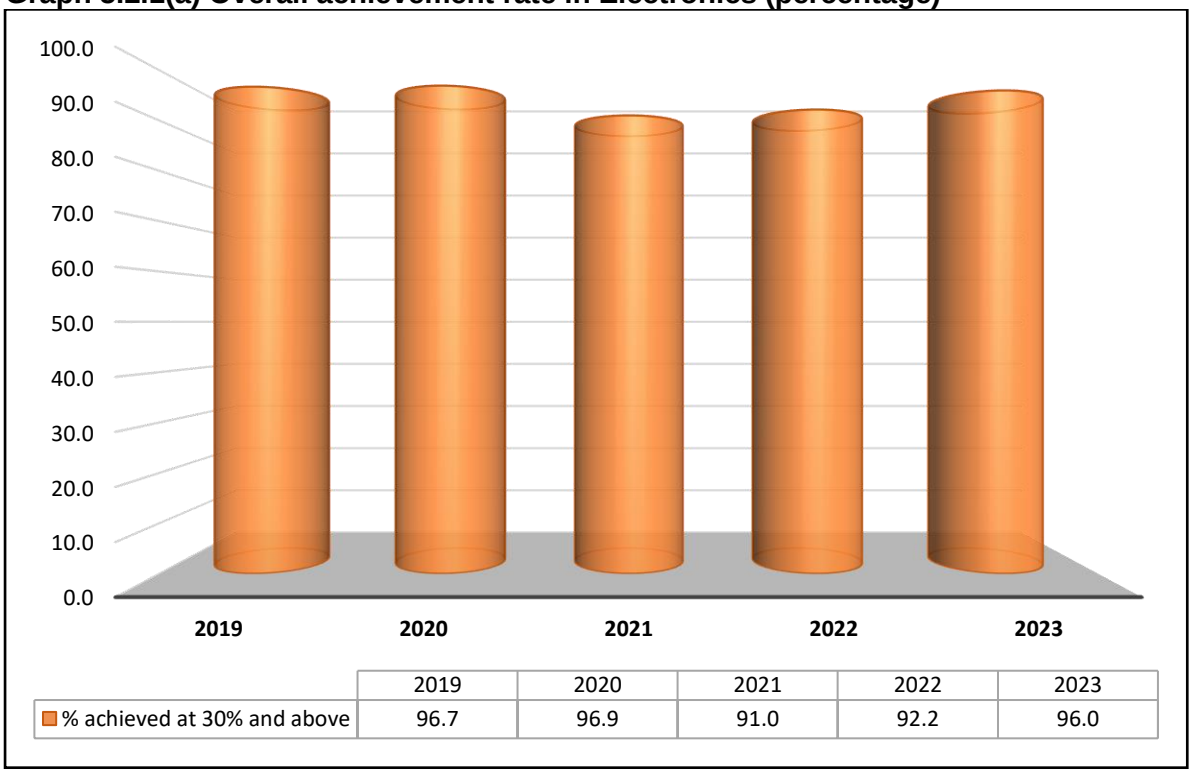
The percentage of distinctions (over 80%) was stable at 0,4% over the past two years. This converts into 5 distinctions in total.

The various commendable intervention strategies employed by teachers, subject advisors and provincial education departments were continued in 2023. The resourcefulness and diligence of the above-average candidates also contributed to the overall improvement in the subject.

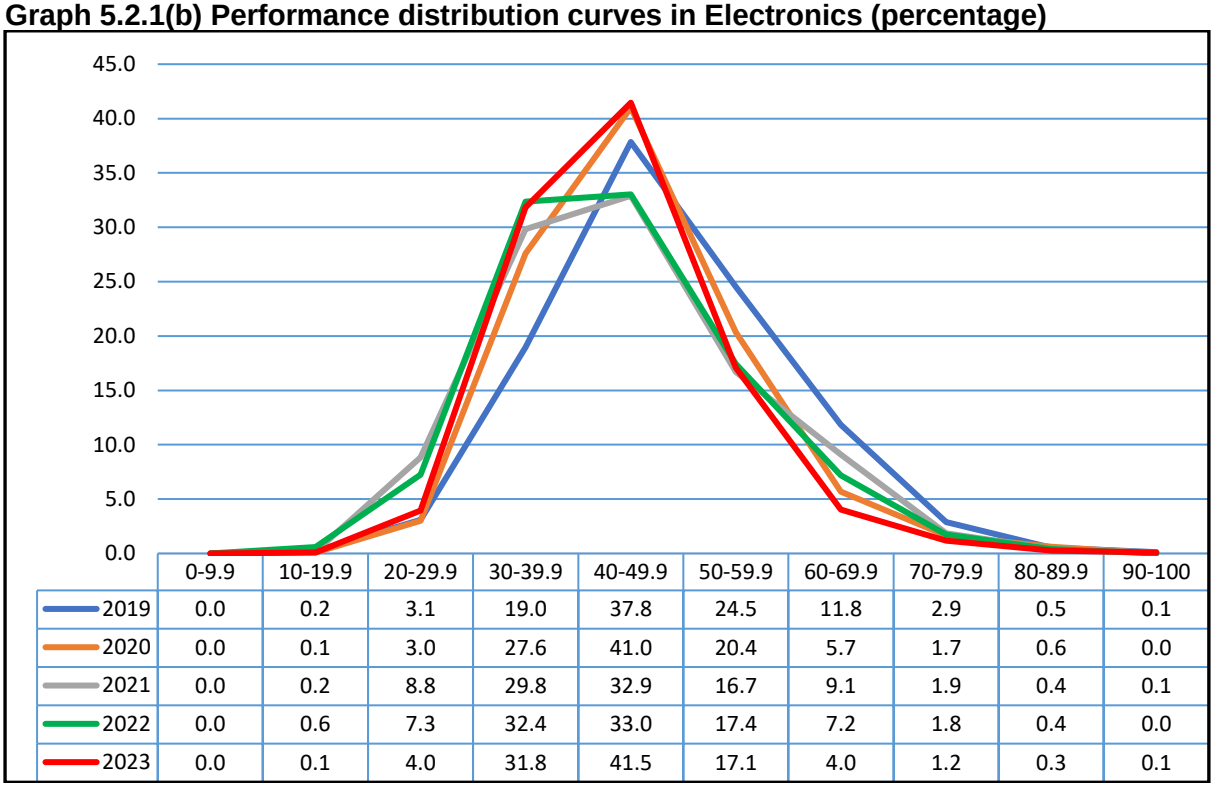
Table 5.2.1 Overall achievement rates in Electronics

Year	No. wrote	No. achieved at 30% and above	% achieved at 30% and above
2019	938	907	96,7
2020	968	938	96,9
2021	1 143	1 040	91,0
2022	1 199	1 105	92,2
2023	1 112	1 067	96,0

Graph 5.2.1(a) Overall achievement rate in Electronics (percentage)



Graph 5.2.1(b) Performance distribution curves in Electronics (percentage)



	0-9.9	10-19.9	20-29.9	30-39.9	40-49.9	50-59.9	60-69.9	70-79.9	80-89.9	90-100
2019	0.0	0.2	3.1	19.0	37.8	24.5	11.8	2.9	0.5	0.1
2020	0.0	0.1	3.0	27.6	41.0	20.4	5.7	1.7	0.6	0.0
2021	0.0	0.2	8.8	29.8	32.9	16.7	9.1	1.9	0.4	0.1
2022	0.0	0.6	7.3	32.4	33.0	17.4	7.2	1.8	0.4	0.0
2023	0.0	0.1	4.0	31.8	41.5	17.1	4.0	1.2	0.3	0.1

5.2.2 OVERVIEW OF CANDIDATES' PERFORMANCE IN ELECTRONICS

General comments

(a) Although new suggestions have been included, some of the recommendations from the *2022 Diagnostic Report* have been retained due to their continued relevance to improve performance, the following are suggested areas, namely: *switching circuits, semiconductors and amplifiers* may be covered in the first term of the academic year, as was evident that most candidates recorded low marks in these questions.

(b) A random sample of scripts reflected that Q1 (multiple-choice questions) and Q2 were well answered. However, these questions comprised only 12,5% of the entire paper. Q3 was also well answered. This question made up 17,5% of the question paper.

(c) Q4, Q5 and Q6 were poorly answered. These questions comprised 70% of the total of the question paper.

(d) In general, candidates made basic mistakes such as: not selecting correct formulae, not substituting correct values in formulae, omitting the correct units, and using incorrect prefixes of values when doing substitutions.

(e) Many candidates had difficulty, particularly in answering questions on the application of basic theory and skills acquired from lower grades.

General suggestions for improvement

(a) Use of past question papers may serve as one of many teaching and learning resources, if used properly. These papers may be used for learner assessment, revision purposes and to a certain extent, teachers may use these papers for self-diagnostic assessment. Every learner must have access to past examination papers

from November 2018 to November 2023 as these are based on the current *CAPS* content.

(b) Revision of relevant Grades 10 and 11 content is recommended. This is because prior knowledge from the Grades 10 and 11 syllabi serves as a foundation to equip and prepare learners to respond to Grade 12 content. It is therefore imperative that this prior knowledge be incorporated into teachers' lesson preparations/planning.

(c) For questions of a narrative nature, the responses in the marking guidelines are broken down into key areas of specific content and corresponding marks are then awarded. A general response will get only part marks. Learners must learn how to respond in the required fashion, which will hone their comprehension skills and eliminate vague one-word responses. Refer to Q4.4.2 and Q6.5.1 where the responses are broken down in bullet form and note the ticks/marks that are placed at key areas of specific content.

(d) At the end of each topic in the CA*P*S, there are practical experiments to be performed to enhance the understanding of the subject knowledge. Teachers are encouraged to perform these practical tasks, which will in turn, prepare learners for practical assessment tasks (PATs).

5.2.3 ANALYSIS OF CANDIDATES' PERFORMANCE IN EACH QUESTION IN ELECTRONICS

QUESTION 1: MULTIPLE-CHOICE QUESTION

Common errors and misconceptions

(a) In Q1.4 many candidates had challenges in identifying conditions that were common in a series RLC resonance circuit and a parallel RLC resonance circuit.

(b) Most responses of candidates to Q1.8 showed a lack of understanding of the effect of applying the negative feedback to operational amplifier circuits.

Suggestions for improvement

Learners should:

- Not rush when choosing the correct answer/option as this type of question has distractors. They should rather read the whole question carefully, understand what is asked, and eliminate incorrect options before selecting the correct answer.
- As they read the questions and possible answers, they should underline the keywords and the concepts/phrases that might guide them in selecting the correct answer.
- Answer the question without looking at the options.

QUESTION 2: OCCUPATIONAL HEALTH AND SAFETY

Common errors and misconceptions

(a) In Q2.1 most candidates provided 'an unsafe act' as the answer.

(b) In Q2.2 the majority of the candidates defined danger as 'anything that may cause injury to a person and to property' rather than, 'injury to a person and damage to property'.

(c) In Q2.3 many candidates' responses focused on the application and functions of the emergency master switch and not why its location is important for safety, while other responses referred only to its accessibility.

Suggestions for improvement

NB: Teachers should remember that this section is crucial:

- In preparing learners for the industrial world
- For learners to understand and manage the potential risk in and around their surroundings including at their school and homes

(a) Teachers should give attention to using industrial OHS videos/online resources to enhance their teaching in Grades 10, 11 and 12.

(b) OHS should be integrated into practical tasks and infused into teaching rather than been taught in isolation.

(c) Arrange field trips to workplaces, e.g. mining industries, factories, generation stations, etc.

QUESTION 3: RLC CIRCUITS

Common errors and misconceptions

(a) In Q3.3.1 many candidates were able to state that the supply current is leading the supply voltage but could not motivate their answer.

(b) In Q3.4.3 most candidates could not fully draw the labelled phasor diagram of the parallel resonant circuit. Most omitted, $I_R = I_T = 3$ A, the phase angle 'θ' and the anticlockwise direction of rotation. They lost three marks.

(c) In Q3.5.4 the majority of the candidates' responses' was that 'the circuit is at resonance', without considering other related factors, e.g. an increase in current as a result of an increase in supply frequency that causes the voltage across the inductor and the capacitor to be much greater than the supply voltage.

Suggestions for improvement

(a) The 2023 Practical Assessment Task (PAT) shows the simulation of the RLC series circuit. Teachers are advised and encouraged to perform these simulations including parallel RLC circuits as they help learners to comprehend the concepts of RLC better than being taught only theoretically.

(b) Teachers should give attention to the importance of drawing the phasor diagrams of series/parallel RLC circuits. Greater emphasis should be on the direction of rotation, phase angle and the relationship between supply voltage and current.

QUESTION 4: SEMICONDUCTOR DEVICES

Common errors and misconceptions

Many candidates answered this question poorly despite suggestions for improvement having been made in the *2022 Diagnostic Report.* This question remains challenging.

(a) In Q4.1.2 most candidates could not answer this question. Their responses to this question had an effect on answering Q4.1.3. They could not identify the channel in which the current should flow and the effect an increase in V_{GS} had on the current.

(b) In Q4.2.1 the majority of the candidates could not identify the output characteristic curve of the n-channel MOSFET.

(c) In Q4.2.2 few candidates were unable to label the characteristic curve of Figure 4.2.

(d) The majority of the candidates could not answer Q4.4.1 and Q4.4.2. It was evident that:
- The concept of RC time constant was not understood, and this concept was dealt with in Grade 10 as charging rate and time constant.
- How UJT and SCR as a component in a circuit operates.

(e) Most candidates could not answer Q4.5.2 and Q4.5.3. It was a confirmation that candidates lack:
- Transistor theory which was dealt with in Grade 11 and analytical skills to interpret the circuit diagram
- Theory of Darlington transistor/pair of transistors respectively

(f) In Q4.6.1 more candidates' responses were on the function of the resistor instead of the purpose of the feedback resistor.

(g) In Q4.6.2 most candidates did not understand the word '*seldom*' when answering the question.

Suggestions for improvement

(a) Teachers must emphasise to learners the writing of the number '*120 k*' (*k* as a prefix which means 1 000 or 10^3). This could be written as '*120 000'* when substituting in a formula. They should also be cautioned that 120 *k* is not equal to 120. Other related prefixes to the subject must be emphasised.

(b) Teachers should further emphasise the difference between the words 'function, use and purpose' as used in the question, as learners tend to think the words are synonymous.

(c) Teachers are advised to focus on the following:
- Prior knowledge of the learners and their learning style, e.g. knowledge of the diode and transistors, use of video and charts to demonstrate.
- Definition of concepts and terminologies
- Basic construction of transistors and their circuit symbols
- Functional operation, operating voltages, and regions of operation
- Understanding of the transfer and output characteristics
- Transistor used as a switch and as an amplifier.
- Op-amp as:
  - Inverting and calculations
  - Non-inverting and calculations
- Advantages of using negative feedback on operation amplifiers
- Open loop and closed loop gain of amplifiers

QUESTION 5: SWITCHING CIRCUITS

Common errors and misconceptions

In 2021 and 2022 many candidates could not answer this question. This was also the case in 2023 with the errors made and with similar misunderstandings in answering these questions.

(a) In Q5.1 some candidates referred to the bistable multivibrator as having two switches while the astable multivibrator had no switch.

(b) In Q5.2.1 a few candidates' responses were R_1 and R_2 were 'pull-up resistors', while other responses were 'limiting resistors'.

(c) In Q5.2.5/Q5.7 and Q5.4.3 candidates lost marks by not indicating the following respectively:
- The correct:
  - Output wave orientation
  - Triggering points
  - Charging and discharging point/value
- Indication of the period of charging and discharging of the capacitor.

(d) Answering the narrative type of question is still a challenge as shown in Q5.3.3 where many candidates did not attempt this question.

(e) Q4.4.1 and Q5.4.2 used the same principle of RC time constant, by implication candidates did not answer Q4.4.1. Application of basic knowledge acquired in lower grades plays a significant role in answering questions in sub-sequence grades.

(f) In Q5.5.4 some candidates wrote that the trigger voltage can be decreased by decreasing the resistor, without specifying the resistors between the two.

Suggestions for improvement

(a) Learners should know that components in a circuit may perform different functions, e.g. in Q5.2.1 where the two resistors are used as potential dividers and not as limiting resistors.

(b) Learners should understand the following concepts:
- Triggering points and orientation of the output waveforms when input signals are applied in different switching circuits
- Active high trigger and active low trigger with reference to switching circuits
- The difference between integrator and differentiator when input signals are applied

(c) The explanation of a circuit must be coupled with calculations, drawing of input and the correlating output waveforms, as in Q5.5.3.

(d) Focus on ensuring that:
- Learners' calculations follow the instruction 6 of the question paper. This includes writing of the correct steps so that learners do not lose marks unnecessarily.
- Learners draw a fully labelled circuit. Teachers are encouraged to do the same during teaching of this topic. Learners use the teacher's work as the model and copy it.
- Learners' theoretical knowledge is strengthened through the integration of ICT showing simulations and circuits in lesson preparation. This, in turn, enhance the

teaching and learning.

(e) The difference between the verbs *calculate* and *determine* must be explained:
- Calculate: In this context involves the identification of formulae, the substitution of given values in the formulae and applying the mathematical operations to arrive at the answer, e.g. in Q5.5.2 and Q5.6.3.
- Determine and deduce: This does not involve doing calculations, but rather identifying information depicted in the given information, e.g. in Q5.3.2 learners were expected to determine the threshold voltage of the circuit when the supply voltage is 6 V. The same considerations applied to Q5.2.4.

QUESTION 6: AMPLIFIERS

Common errors and misconceptions

In 2021/2022 many candidates did not answer this question. This trend continued with the 2023 candidates. It was the most poorly answered question, with some of the candidates registering zero marks or not attempting it at all. This could suggest that most candidates lack content knowledge and the skills to answer the question.

(a) In Q6.2 most of the candidates had difficulty comparing a Class A amplifier and a Class B amplifier with reference to their sound production. Others wrote *phase shift* as their responses.

(b) In Q6.3.1 some candidates did not know how to determine the value of V_{RL} in Figure 6.3 when the transistor was ON. A few wrote 0 V and others left blank spaces.

(c) In Q6.3.2 the majority of the candidates could not describe what changes were made to the circuit when the load line AB was changed to load line CD. Others wrote *the load line has moved*.

(d) In Q6.5.1 most candidates could not discuss the operation of the RC-coupled amplifier during the negative half-cycle of the input signal. For those who attempted it, their answer was incorrect and some of the learners left blank spaces.

(e) In Q6.5.2 the majority of the candidates had difficulty drawing the full cycle of the output waveform when the transistor is driven into saturation. They drew triangular or square waveforms, and the distortion of the waveform was not drawn.

(f) In Q6.6.2 many candidates could not explain why transformer-coupled amplifiers are more efficient than the RC-coupled amplifiers. Some did not attempt to answer the question.

(g) In Q6.6.3 some candidates could not describe how the output impedance of the first stage could be matched to the input impedance of the second stage of a two-stage transformer-coupled amplifier. Other candidates did not attempt to answer and left blank spaces.

(h) In Q6.7.2 the majority of the candidates could not explain how the complementary push-pull amplifier circuit overcomes the problem of cross-over distortion. A few candidates did not attempt to answer the question and left blank spaces.

(i) In Q6.7.3 most of the candidates were not familiar with drawing the output waveform of the complementary push-pull amplifier. Some candidates drew triangle or square

waveforms.

Suggestions for improvement

(a) More revision on building the circuits needs to be reinforced. The learners need to draw the various circuits multiple times to reinforce their knowledge.

(b) Leaners must master definitions and categories of amplifiers.

(c) Teachers should focus on:
- Skill analysis of circuits so that learners can correctly identify circuits and the function of each component in the circuit diagrams.
- Building amplifier circuits during practical lessons and displaying the input and output signals on an oscilloscope. Teachers should focus on changing the value of the input signal and the value of components to show their effect on the output of the circuit.
- Emphasising the characteristic curves of amplifiers with the circuit analysis and function of different components as a whole and not separately.
- Making use of educational software to demonstrate abstract concepts, especially in amplifier circuits. Display the voltages across components on an oscilloscope to make this abstract concept visual.
- Building oscillator circuits during practical lessons to demonstrate and explain the operation of these types of circuits. Teachers can also use educational software to build these circuits, which will explain and demonstrate their operations.
- Demonstrating the function of the components by either disconnecting them or replacing them with other components to show the importance of such specific components.
- Emphasising the calculation and demonstration of oscillation frequency using different component values.

(d) Regarding Q6.5.2, emphasis should be placed on the drawing of the output waveforms when the transistor is driven into saturation.

(e) The practical building/demonstrating of amplifier and oscillator circuits and the checking of the waveforms on the oscilloscope is an effective way of reinforcing the understanding of the theory.

5.3 POWER SYSTEMS

This report should be read in conjunction with the Power Systems question paper and marking guidelines of the November 2023 examinations.

5.3.1 PERFORMANCE TRENDS (2019–2023)

The number of candidates who wrote the Power Systems examination in 2023 increased by 31 in 2023.

The table below indicates consistent performance over the past five years with pass rates in the 94% to 96% range. The performance of the candidates in 2023 remains consistent with 96,0% of candidates passing at 30% (Level 2).

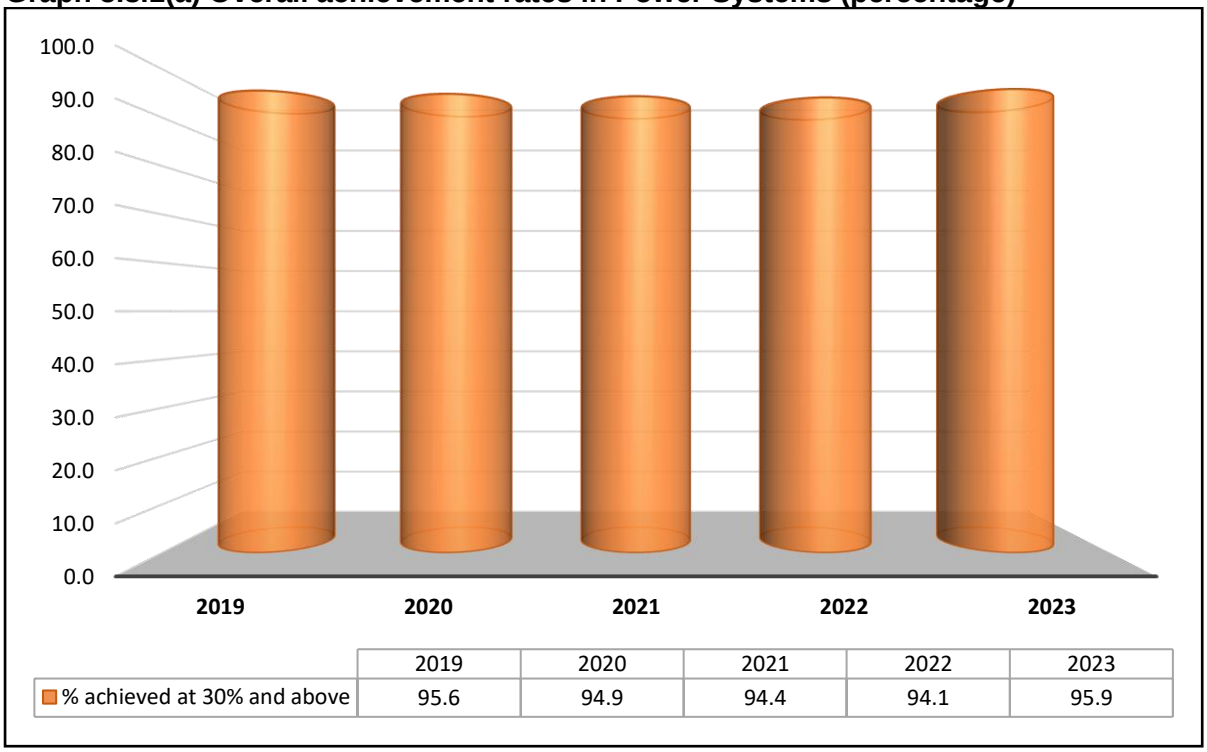
The percentage of distinctions (over 80%) increased marginally at 0,6% in 2022 and 1,1% in 2023. This converts into an increase in the total number of distinctions from 35 to 65.

The various commendable intervention strategies employed by teachers, subject advisors and provincial education departments were continued in 2023. The resourcefulness and diligence of the above-average candidates also contributed to the overall improvement in the subject.

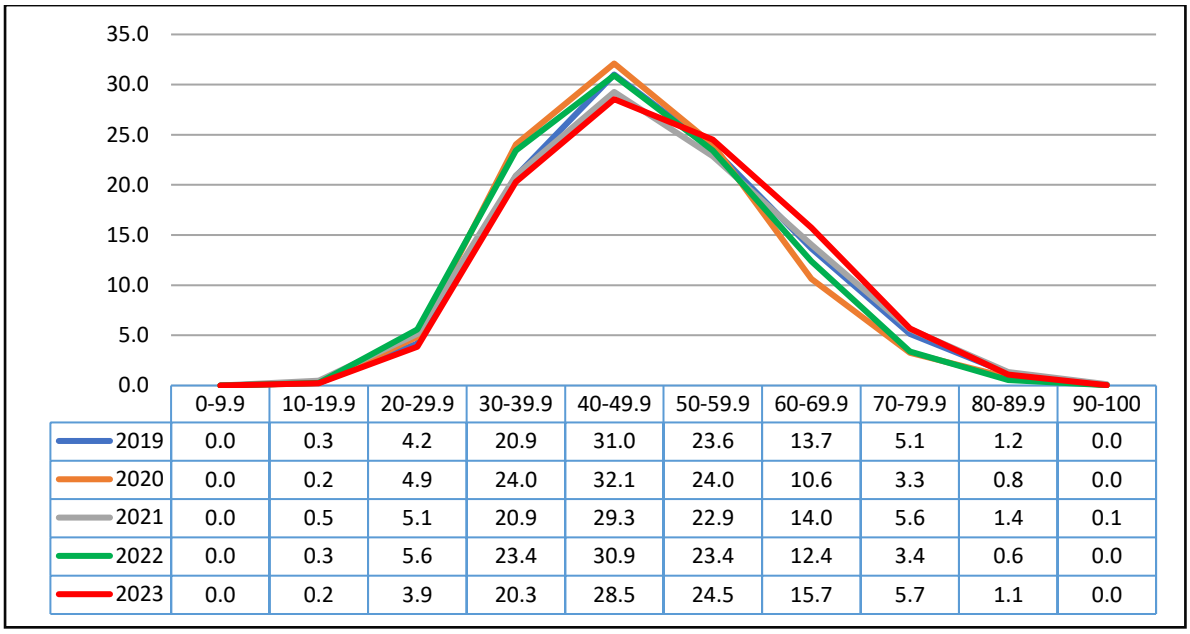
Table 5.3.1 Overall achievement rates in Power Systems

Year	No. wrote	No. achieved at 30% and above	% achieved at 30% and above
2019	4 796	4 583	95,6
2020	4 623	4 387	94,9
2021	5 675	5 357	94,4
2022	5 907	5 561	94,1
2023	5 938	5 694	95,9

Graph 5.3.1(a) Overall achievement rates in Power Systems (percentage)



Graph 5.3.1(b) Performance distribution curves in Power Systems (percentage)



	0-9.9	10-19.9	20-29.9	30-39.9	40-49.9	50-59.9	60-69.9	70-79.9	80-89.9	90-100
2019	0.0	0.3	4.2	20.9	31.0	23.6	13.7	5.1	1.2	0.0
2020	0.0	0.2	4.9	24.0	32.1	24.0	10.6	3.3	0.8	0.0
2021	0.0	0.5	5.1	20.9	29.3	22.9	14.0	5.6	1.4	0.1
2022	0.0	0.3	5.6	23.4	30.9	23.4	12.4	3.4	0.6	0.0
2023	0.0	0.2	3.9	20.3	28.5	24.5	15.7	5.7	1.1	0.0

5.3.2 OVERVIEW OF CANDIDATES' PERFORMANCE IN POWER SYSTEMS

General comments

Although new suggestions have been included, some of the recommendations from the *2022 Diagnostic Report* have been retained due to their continued relevance.

(a) Based on a sample of the candidates' responses, it is evident that most candidates still had difficulty answering questions of a narrative nature and experienced challenges with interpreting the requirements of the question.

(b) A lack of content knowledge and insight into the concepts posed a challenge to candidates who had to answer questions that required them to explain basic operations of circuits.

(c) The application of mathematical principles and the expression of responses after analysing circuits, require further attention.

(d) Selection of the relevant formula/formulae from the formula sheet, manipulation of the formula, correct substitution, calculation and the writing of the correct unit was still a challenge.

(e) Omission of labels in drawings resulted in a loss of marks.

General suggestions for improvement

(a) Use of past question papers may serve as one of many teaching and learning resources if used properly. These papers may be used for learner assessment, revision purposes and to a certain extent, teachers may use these papers for self-diagnostic assessment. Every learner must have access to past examination papers from November 2018 to November 2023 as these are based on the current *CAPS* content.

(b) Revision of relevant Grades 10 and 11 content is advisable. This is because prior knowledge from Grade 10 and 11 syllabi serves as a foundation to equip and prepare learners to respond to Grade 12 content. It is therefore essential that this prior knowledge be incorporated into teachers' lesson preparations/plannings.

(c) At the end of each topic in the *CAPS* document, there are practical experiments to be performed, which enhance the understanding of the subject content. Teachers are encouraged to perform these practical tasks, which will in turn prepare learners for the practical assessment tasks (PATs).

5.3.3 ANALYSIS OF CANDIDATES' PERFORMANCE IN EACH QUESTION IN POWER SYSTEMS

QUESTION 1: MULTIPLE-CHOICE QUESTION

Common errors and misconceptions

(a) In Q1.2 a large number of candidates had difficulty identifying the reference quantity in the *parallel RLC circuit*.

(b) In Q1.9 the majority of the candidates did not understand the relationship between primary phase current and secondary phase current in transformers.

(c) In Q1.10 most candidates were not familiar with the concept of slip when the motor speeds up.

(d) In Q1.12 most candidates did not know why a star-delta starter reduces start-up current.

Suggestions for improvement

(a) Emphasis should be placed on how to approach a multiple-choice question by developing the skill of analysing and interpreting the questions for a correct possible answer. Learners should be able to reason out the correct and eliminate the wrong options and distractors.

(b) As mentioned on page 93 in the *Diagnostic Report* of 2022, learners should:

- Not rush when choosing the answer. They should rather read carefully and eliminate incorrect answers until they have identified the most relevant and accurate answer.
- Be encouraged to read textbooks and other relevant sources as guided by the teacher to gain insight and content knowledge, to answer all the questions.
- Answer the question without looking at the options.

(c) Teachers are advised to include multiple-choice questions in formal and informal assessment tasks to expose learners to this type of question.

QUESTION 2: OCCUPATIONAL HEALTH AND SAFETY

Common errors and misconceptions

(a) In Q2.3 most candidates provided answers referring to the function of the emergency switch and not its location.

(b) In Q2.4 candidates confused a third-degree burn with first- and second-degree burns.

(c) The majority of the candidates responded to the 'first steps when' a person is electrocuted and not 'first aid steps after' a person has been electrocuted as required in Q2.5.

Suggestions for improvement

(a) Emphasis should be placed on the difference between a local Health and Safety Representative and an external Health and Safety Inspector, their duties and what should be reported to them.

(b) It is good practice to underline the keywords in a question before answering it, this will assist in formulating an answer that speaks to the key concept in a question.

(c) The following suggestions, as stated on page 93 in the *2022 Diagnostic Report*, are still relevant.

- Teachers should develop activities on the definitions as stated in the OHS Act as well as explanations of concepts and terminologies.
- The usage of OHS videos to enhance teaching is key, as all unsafe actions, conditions and scenarios are sometimes better shown in the industry. This will guide learner responses and eliminate one-word, vague responses.
- Knowledge and understanding of concepts, terminology and jargon of the subject is important.
- Learners must be encouraged to read technical literature (journals, technical books and other relevant guides) to familiarise themselves with the language and the syntax (the order or arrangement of words and phrases to form proper sentences) associated with the subject to overcome the language barrier.

QUESTION 3: RLC CIRCUITS

Common errors and misconceptions

(a) In Q3.2 many candidates could not interpret the waveform graphs and therefore could not link the theory associated with it.

(b) In Q3.3.2 most candidates left out the labelling of ($V_C - V_L$) and V_T. Learner responses showed a lack of correct labelling and arrowheads not drawn on the end of each phasor as well as the direction of rotation being omitted.

(c) In Q3.4.3 the majority of the candidates used incorrect and incomplete labelling in the phasor diagram. Most candidates' phasors did not include arrowheads and they swopped the placement of I_C and I_L on the phasor diagram. Most candidates did not indicate the phase angle = 0° or $I_R = I_T$. The direction of rotation was omitted by most.

(d) In Q3.5.1, Q3.5.2 and Q3.5.3 several candidates used the wrong SI unit in their answers, some candidates calculated the Q-factor in Q3.5.1 correctly but added a unit (Ω) which is incorrect as Q-factor is a ratio without a unit.

(e) The explanation of concepts posed a challenge to most candidates as they did not know why the voltage across the inductor was greater than the supply voltage when the circuit was at resonance. Only a few learners had an idea why the voltage across a capacitor and inductor can be higher than the power supply voltage at resonance.

Suggestions for improvement

(a) Electrical terminology must be introduced to learners not only as a definition in words but also linked to the understanding of the theory it defines. This includes how it describes that phenomenon, how it relates to its application in circuits and how the variables on characteristics curves can be understood.

(b) Phasor diagrams must be drawn by convention where the orientation is the same as the standard phasor diagram. All relevant information must be given. All phasors should end with an arrowhead and the direction of rotation must be indicated.

(c) Teachers are encouraged to emphasise the effect of varying the frequency of the supply in an RLC circuit, the characteristics curve and phasor diagrams of resonance circuits and the conditions of series/parallel resonant circuits.

(d) It is evident that poor comprehension skills posed a problem. Revision programmes must include exercises requiring explanation, definitions and application of RLC circuits as well as practical application. Teachers require content training.

(e) Circuit responses are represented on phasor and characteristic curve graphs and changing component values or parameters in that circuit will affect the graphs and the operation dynamics of the circuit. With simulations, learners must be able to see and understand.

(f) Marking of all informal and formal activities should be done strictly according to NSC marking principles to emphasise the importance of correct numbering, labelling, accurate substitution, and SI units.

QUESTION 4: THREE-PHASE AC GENERATION (SPECIFIC)

Common errors and misconceptions

(a) In Q4.1.2 most candidates explained the term *power factor* instead of *power factor correction*.

(b) In Q4.2 a few candidates' responses were on the advantages of power factor correction to the consumer and not to the supplier.

(c) In Q4.3 number of candidates were uncertain about the distribution network, as their responses were vague in differentiating between power transmission and power distribution. They did not mention the stepping up of voltage for transmission and stepping down for distribution.

(d) In Q4.4.4 some candidates' phase sequencing was incorrect, as they omitted the direction of rotation and used phase values instead of line values when labelling the phasor diagram. Other candidates did not show arrowheads on the phasor diagram.

(e) In Q4.6.2 most candidates responses were vague as they could not interpret a reading of 0,9.

Suggestions for improvement

(a) Learners are encouraged to read the questions fully and underline the keywords or concepts before attempting to answer the questions. This will assist them to structure their responses correctly concerning narrative-type questions.

(b) The skill of analysing the questions can be honed throughout the year by practising. In interpreting and understanding questions, the focus should be placed on the following verbs: 'explaining and differentiating of terminologies', e.g. in Q4.1.1, Q4.1.2 and Q4.4 and Q4.5.3 respectively.

(c) Candidates should be guided by the mark allocation of a question to assist in determining the number of facts needed for a particular response. The word *differentiates* and other related words should be used in class during activities for learners to familiarise themselves with and how to structure their responses accordingly. When differentiating between two concepts one should mention two facts from each that are not common to both, and it should be something that distinctly differentiates the two. Educational videos can be used to strengthen teaching and learning by visualising abstract concepts.

(d) Calculations should be assessed strictly during all informal and formal activities in the classroom. Incorrect SI units should be strictly assessed in Grades 10, 11 and 12 in all activities.

QUESTION 5: THREE-PHASE TRANSFORMER (SPECIFIC)

Common errors and misconceptions

(a) In Q5.1 the majority of the candidates named coolants or cooling methods of transformers instead of parts within the cooling system.

(b) In Q5.3 most candidates did not mention the application of a star-delta transformer in transmission networks but in industries and factories.

(c) In Q5.4 many candidates confused *eddy current losses* with *copper losses* or *stray losses*.

(d) Several candidates could not name the cooling method for very large transformers in Q5.6, they mentioned the cooling methods for normal transformers.

(e) In Q5.8.4 candidates lost marks because of the following:
- Incorrect labelling of the drawing
- Not drawing the primary and secondary windings of the transformer
- Drawing 'schematic' instead of 'diagrammatic' representation

It was evident from candidates' responses that some did not know what a diagrammatic representation was. Some candidates drew the correct type of drawing without any labels, which caused them to lose marks.

(f) In Q5.9 most candidates explained the relationship between the voltage and current on either the primary side or secondary side without considering the transformation ratio (TR). This was evident when others stated the relationship in the primary by also stating Ohm's Law.

Suggestions for improvement

(a) Candidates should be able to distinguish between 'parts of a cooling system' and 'cooling methods'.

(b) Emphasis must be placed on the reduction and counter measurements taken to minimise losses in transformers. Eddy current losses are reduced by manufacturing the transformer core out of steel laminations packed together.

(c) When performing calculations in transformers, learners should know when to use line values and phase values. Primary and secondary values should never be mixed when doing transformer calculations. Correct SI units are important when writing the answers and apparent power should not be confused with active or reactive power.

QUESTION 6: THREE-PHASE MOTORS AND STARTERS (SPECIFIC)

Common errors and misconceptions

(a) In Q6.1 many candidates only mentioned one part of the stator and not two.

(b) In Q6.2.3 most candidates did not include the correct SI unit in their answers. Some candidates confused small p with capital P and subsequently used the power value instead of the pole pairs in their calculation.

(c) In Q6.2.4 the majority of the candidates used the 'percentage slip formula' $\%\ \text{Slip} = \frac{n_s - n_r}{n_s} \times 100$ instead of the 'slip formula' $\text{Slip} = n_s - n_r$.

(d) Q6.3 was poorly answered by a large number of candidates as they explained how magnetic fields are being set up in the stator and not how the power is transferred to the rotor. Only a few candidates received full marks.

(e) In Q6.4 most candidates could not interpret the graph and swopped the breakdown torque with full load torque. They did not differentiate between *speed* and *torque*.

(f) In Q6.5.1, a number of candidates could not state the purpose of contacts A and B as interlocking contacts, because they confused these with latching circuits.

(g) In Q6.5.2 many candidates confused the main contactor with motors and contacts with contactors in their explanations. They mentioned that contacts are energising and de-energising instead of saying the contacts are closing and opening.

(h) In Q6.5.3 most candidates could not explain the effect of the fault on the operation of the circuit. They misinterpreted the question by explaining the operation of the circuit. They were unable to interpret that the contact is faulty and permanently closed. Some candidates only mentioned the effect on MC_1 without mentioning the effect on MC_2. Most candidates did not include how this affects the stopping or de-energising of the circuit.

(i) In Q6.6.1, Q6.6.2 and Q6.6.3 some candidates made substitution errors. They did not substitute the power factor correctly into the phase angle (θ) and lost 2 out of 3 marks. Some could not substitute the efficiency correctly. Candidates who used the alternative method substituted the efficiency as 90% while still using 100 on the right-hand side instead of 100%.

Suggestions for improvement

(a) Focus must be placed on information as found on a different nameplate of motors with its content thoroughly explained and demonstrated.

(b) Speed calculations should be practised repeatedly with all variants of the calculations regarding the speed of a three-phase motor.

(c) As stated in the *Diagnostic Report* of 2022 on page 98, teachers are advised to explain/describe/discuss the:
- Operation of each control circuit in chronological order
- Function of each component in the circuit
- Effect that an inserted fault will have on the operation of the circuit (also show it practically).

(d) Candidates must be given the opportunity in class to verbally explain the operating principles of motors and how power is transferred in induction motors. This provides them an opportunity to put their thoughts into words.

(e) The speed vs torque curve makes more sense when it is explained from the point of no-slip (far right-hand side on the graph) in Q6.4 where the rotor and synchronous speed are the same. At this point, there is no torque being developed as there is no relative movement between rotor bars and stator magnetic field. The moment the load is increased the rotor speed slows down and therefore the relative movement between the rotor conductors and stator magnetic field increases, which increases the torque up to what is known as full load torque. When the load increases the greater the difference between stator magnetic field and rotor conductors and the greater the torque developed. The torque will keep increasing as the load is increased up to a point which is known as the break down torque. The moment the load further increases the motor will be forced to stop and stall.

(f) Calculations should be practised repeatedly during all informal and formal activities. Teachers should mark these calculations strictly according to the NSC marking principles from Grade 10 and throughout the year in all informal and formal activities. Emphasis must be placed on correct formulae for the given information, accurate substitution, and the correct SI units.

(g) When substituting and using 90%, candidates should use 100% on the right-hand side. When substituting and using 90 (without the percentage) candidates should use only 100 (without the percentage) on the right-hand side. Some candidates substituted 0,9 and still used the 100 on the right-hand side. When substituting the efficiency with 0,9 the 100 on the right-hand side should not be used, it was already manipulated to make the 90 = 0,9. Refer to Q6.6.

QUESTION 7: PROGRAMMABLE LOGIC CONTROLLERS (PLCs) (SPECIFIC)

Common errors and misconceptions

(a) In Q7.1.1 most candidates explanations contained only 1 fact and most candidates referred to the size of the PLC unit itself.

(b) In Q7.2.1, Q7.2.2 and Q7.2.3 many candidates could not identify the logic gate that the ladder logic diagram represented. They drew the wrong symbol and consequently gave

the wrong truth table outputs.

(c) In Q7.3.1 a large number of candidates answered it as an ultrasonic or inductive proximity sensor.

(d) In Q7.3.2 the majority of the candidates explained the purpose of a light sensor in isolation to the automated garage door system.

(e) In Q7.3.3 many candidates explained the use of temperature sensors in isolation to the mining drill.

(f) In Q7.4.1 most candidates explained the timers regarding the hardwired timers found in motor control and about the PLC programmed timing functions.

(g) Although Q7.5.1 was fairly answered, the majority of the candidates lost marks because of incorrect labelling and using wrong symbols. The state of the overload and stop buttons was the opposite even though it should be the same as both field devices are closed contacts. They used the same symbol as in hardwiring for the lamps. These symbols are incorrectly shown in the prescribed textbook, page 176, but teachers should correct it with the learners as requested in previous years. Some candidates still opted to draw the ladder diagram incorrectly from right to left, which is wrong.

(h) In Q7.6.1 most candidates gave the response as an inverter.

(i) Q7.6.2 was poorly answered by most candidates who referred to general safety rules with reference to motors and not VSD.

(j) In Q7.6.3 candidates confused converter with inverter. Most candidates received full marks, while others did not mention the fourth fact of the changed or varied frequency sent to the motor to control the speed of the motor.

Suggestions for improvement

(a) Logic gates form the foundation of ladder programming and teachers should emphasise these basics and revise them before starting with PLC in Grade 12.

(b) Sensors and their applications should be explained to learners by making use of practical applications and video clips when showing and explaining the sensors as input devices to a PLC. These sensors should not be explained in isolation, but with reference to their application as inputs into a PLC-controlled system.

(c) When explaining the operation of a PLC and its output modules, emphasis should be placed on the reason why contactors and relays are used on its output.

(d) Timers in PLC should not be explained as hardware devices. This is a common mistake because the timers in the PLC chapter only refer to hardware timers and not the timer functions found in PLC programming. This is one of the advantages of PLCs because the timer is not a hardwired component but rather a function written into the ladder program itself.

(e) In the context of using sensors as input devices for Programmable Logic Controllers (PLCs), the term 'application' refers to the specific use or function of the sensors in an industrial/factory/mine to monitor and control a particular process or system or to measure temperature, pressure, or position and use data from these sensors to make decisions and control various aspects of the manufacturing process.

(f) The following points are still applicable as stated in the *2022 Diagnostic Report* on page 100. Emphasis must be placed on the conversion of hard wiring to a ladder logic diagram. Correct labelling of inputs and outputs and correct symbols are paramount. Note that ladder logic diagrams are drawn from:

- Left power rails with input instruction to right power rails with output instruction
- Top to bottom with rungs connected between the two power rails

The ladder logic diagram drawn should use the Engineering Graphics and Design (EGD) approach and not crude freehand drawings.

(g) VSD concepts should be well explained to learners. This is an abstract section of the curriculum that needs insight. Teachers should make use of educational videos to make abstract concepts visual to all learners.

CHAPTER 6

MECHANICAL TECHNOLOGY

Mechanical Technology encompasses three specialisation subjects, namely Automotive, Fitting and Machining and Welding and Metalwork. The first examination was conducted in 2018 for the specialisations. The following report should be read in conjunction with the respective question papers of the November 2023 NSC examinations.

A detailed analysis of performance trends is provided for each specialisation subject. It must be noted that the following General Comments are observations noted across all three subjects and are therefore stated at the outset.

General comments on Automotive; Fitting and Machining; Welding and Metalwork:

(a) Questions based on recall of content were poorly answered by the majority of the candidates. Weekly informal assessment tasks should be used to reinforce basic concepts and principles. This can be used effectively for content relating to definitions, functions, labelling and operations as listed in the *CAPS* and the *Examination Guidelines*.

(b) Several candidates encountered challenges in accurately manipulating formulae. The following steps are suggested:
- Identify and use the relevant formulae provided on the formula sheet.
- Apply the correct substitution and provide the answer with the correct unit and direction in terms of what is required by the question.

(c) The majority of candidates still experience challenges with questions that require application of mathematical principles.

(d) Candidates' must be made aware that their handwriting must be legible, and their calculations should not be cramped onto a section of the page. They must also be taught to follow the general instructions provided on the cover and to read questions carefully so that they are able to answer certain subquestions appropriately.

(e) Many candidates lacked knowledge of, or exposure to, the use of various tools and equipment.

(f) Some candidates still show a lack of fundamental knowledge and understanding, which they should have gained in Grades 10 and 11. This could be the fact that the majority of teachers relied on using previous years' question papers and not the variety of teaching and learning resources available within their disposal, such as the internet etc.

(g) The lack of content and skills knowledge demonstrated by the candidates in the 2023 examination showed the poor or inadequate preparation for learning and assessment.

(h) Loadshedding negatively impacted teaching and learning. Candidates were not exposed to sufficient practical work to complement the theoretical knowledge.

6.1 AUTOMOTIVE

The following report should be read in conjunction with the Automotive question paper of the December 2023 NSC examinations.

6.1.1 PERFORMANCE TRENDS (2019–2023)

The number of candidates who wrote the Automotive examination in 2023 increased by 110 compared to that of 2022.

The table below indicates consistent performance over the past five years with pass rates in the 94% to 96% range. The performance of the candidates in 2023 remains consistent with 96,3% of candidates passing at 30% (Level 2).

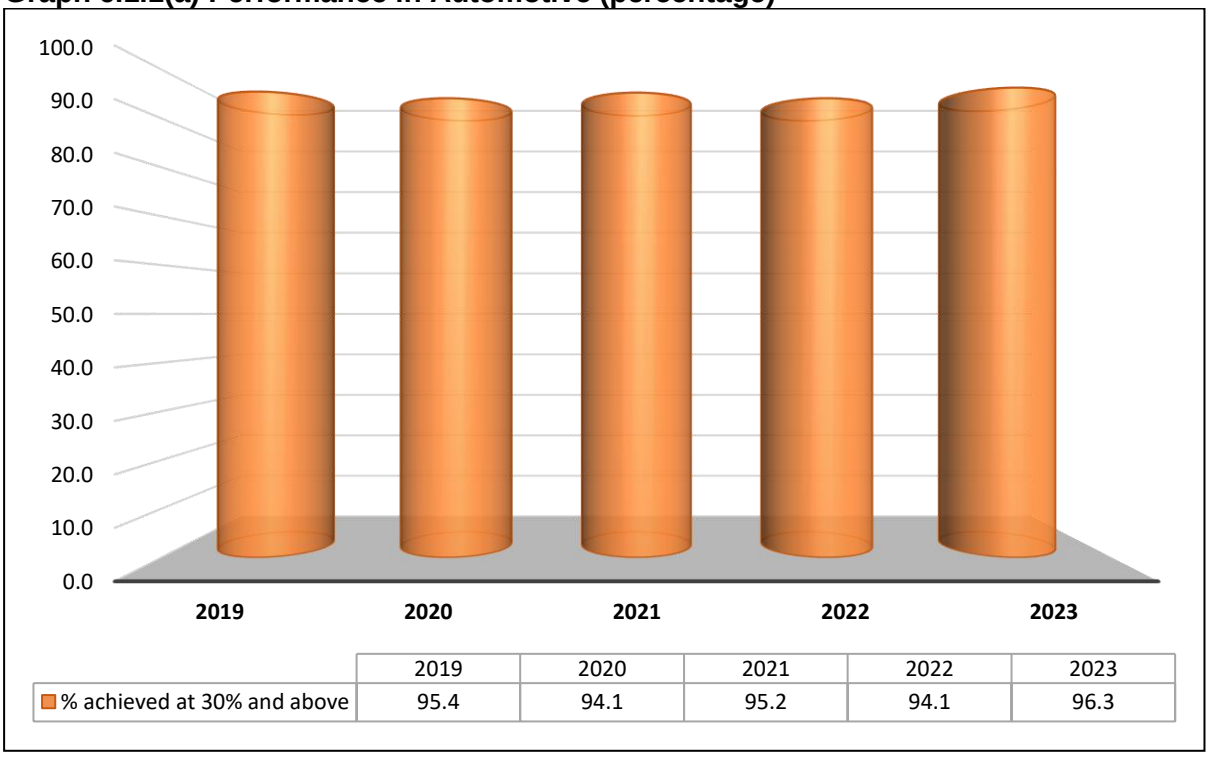
The percentage of distinctions (over 80%) improved from 0,7% in 2022 to 1,3% in 2023. Given the increase in the size of the 2023 cohort, this converts into an increase in the total number of distinctions from 25 to 48.

The various commendable intervention strategies employed by teachers, subject advisors and provincial education departments were continued in 2023. The resourcefulness and diligence of the above-average candidates also contributed to the overall improvement in the subject.

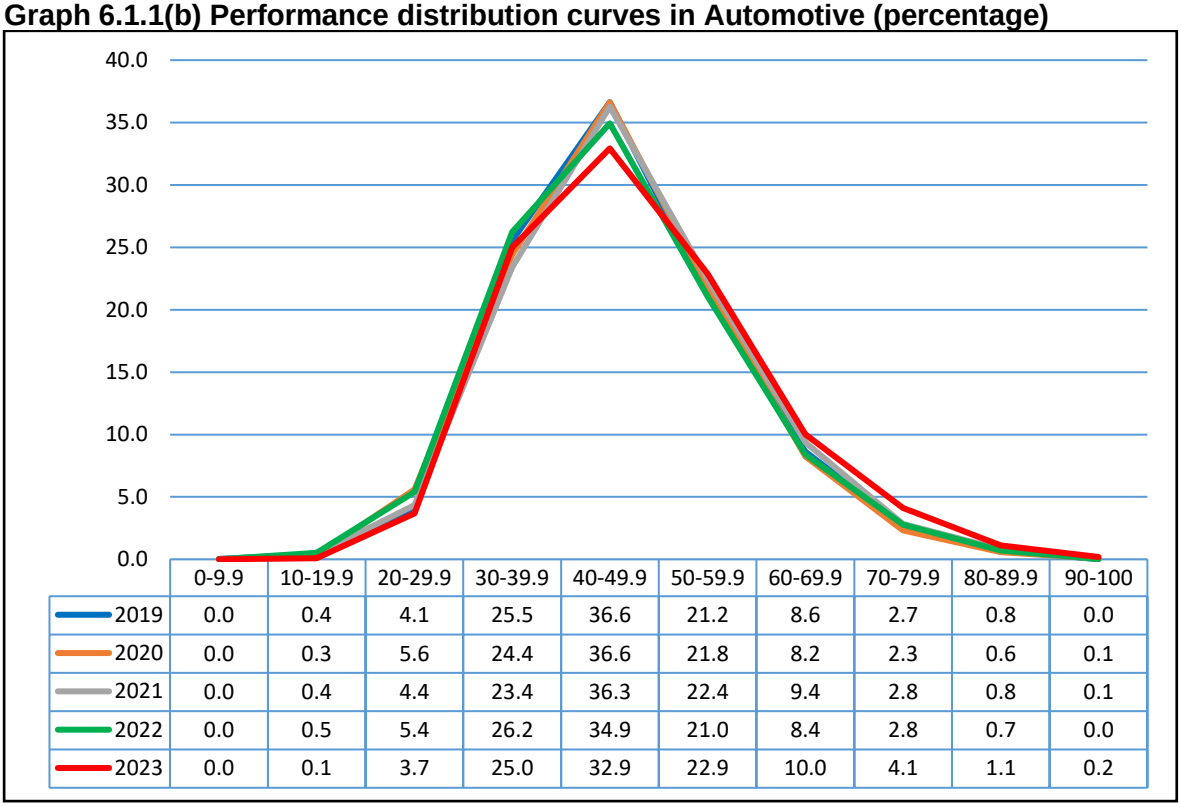
Table 6.1.1 Performance in Automotive

Year	No Wrote	No. achieved at 30% and above	% achieved at 30% and above
2019	2 784	2 657	95,4
2020	2 839	2 671	94,1
2021	3 330	3 171	95,2
2022	3 601	3 388	94,1
2023	3 711	3 572	96,3

Graph 6.1.1(a) Performance in Automotive (percentage)



Graph 6.1.1(b) Performance distribution curves in Automotive (percentage)



	0-9.9	10-19.9	20-29.9	30-39.9	40-49.9	50-59.9	60-69.9	70-79.9	80-89.9	90-100
2019	0.0	0.4	4.1	25.5	36.6	21.2	8.6	2.7	0.8	0.0
2020	0.0	0.3	5.6	24.4	36.6	21.8	8.2	2.3	0.6	0.1
2021	0.0	0.4	4.4	23.4	36.3	22.4	9.4	2.8	0.8	0.1
2022	0.0	0.5	5.4	26.2	34.9	21.0	8.4	2.8	0.7	0.0
2023	0.0	0.1	3.7	25.0	32.9	22.9	10.0	4.1	1.1	0.2

6.1.2 ANALYSIS OF CANDIDATES' PERFORMANCE IN EACH QUESTION IN AUTOMOTIVE

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Common errors and misconceptions

(a) Most of the candidates were not clear about the heat treatment process that relieves the internal stresses produced by machining, forging and welding in Q1.5.

Suggestions for improvement

(a) Intensive revision and remediation measures must be taken on the topics of safety and materials. The use of past question papers in weekly informal assessments is encouraged. This will also assist learners to answer multiple-choice questions, They must then apply their practical knowledge to the theory questions.

(b) Teachers are encouraged to teach learners the technique of arriving at the correct answer by the process of elimination in instances where they are unable to identify the correct alternative immediately.

QUESTION 2: SAFETY

Common errors and misconceptions

(a) In Q2.1 most of the candidates struggled to provide the checks that must be done on an injured person before removing them from the danger zone.

(b) In Q2.2 a large percentage of the candidates could not state the types of safety devices fitted to a power guillotine.

(c) In Q2.4 the majority of the candidates responded with PPE instead of safety devices fitted on the gas welding equipment.

Suggestions for improvement

(a) Teachers should engage with electronic media, such as video clips, to show learners how first aid training is a benefit in the workplace. Practical demonstrations will give learners an added advantage when answering these types of questions on first aid.

(b) Always expose learners to workshop practice relating to the safety of tools, equipment in the workshop and the workshop environment.

(c) Teachers must ensure that they integrate theory learned in previous grades when assessing learners about gas welding equipment.

(d) Teachers should revise safety from previous grades more intensively to ensure learners are empowered to portray their knowledge and understanding of safety in the workplace.

QUESTION 3: MATERIALS

Common errors and misconceptions

(a) Lack of theoretical knowledge and practical application with regard to heat-treatment processes was evident in many candidates' responses in Q3.3.

(b) In Q3.5 most of the candidates were not able to give the reason why steel is annealed during heat-treatment processes.

Suggestions for improvement

(a) Ensure that learners are exposed to different processes to enhance the properties of steel.

(b) The revision programme should incorporate activities requiring explanation, definition and application of heat-treatment processes. Schools need to organise educational excursions to foundries or other places where materials are processed in order to acquaint learners with metallurgy and to further improve their understanding of the processes involved.

QUESTION 4: MULTIPLE-CHOICE QUESTIONS

Common errors and misconceptions

(a) Most of the multiple-choice questions were incorrectly answered by a fair percentage of candidates. This was due to candidates' poor content knowledge.

Suggestions for improvement

(a) Learners should be given direction on the technique of arriving at the correct answer by the process of elimination in instances where they are unable to identify the correct alternative immediately.

QUESTION 5: TOOLS AND EQUIPMENT

Common errors and misconceptions

(a) In Q5.1.2 most of the candidates were unable to give reason for low compression in the cylinder.

(b) In Q5.1.3 the majority of the candidates found it difficult to provide the correct reasons why a card-type compression tester is preferred when performing a compression test.

(c) In Q5.4 many of the candidates were unable to identify what is measured by gauges 1 to 4 when bubble gauge is connected on the vehicle.

Suggestions for improvement

(a) Teachers must ensure that the purpose of each tool is emphasised in their lesson plans and during their weekly informal assessment to enhance better understanding of theory.

(b) Teachers are strongly advised to expose learners to all tools as prescribed in the *CAPS* for Automotive. They must also incorporate the correct training on how to use these tools.

(c) Practical skills in performing bubble gauge testing must be incorporated into the teaching of this content. Novice teachers need training in the use of specialised tools and equipment before imparting this knowledge to learners. Subject advisors must take the initiative to identify such teachers at an early stage, and design programmes to assist them.

QUESTION 6: ENGINES

Common errors and misconceptions

(a) In Q6.2.3 most candidates could not give the reasons why an internal combustion engine is fitted with a vibration damper.

(b) In Q6.3 some candidates could not name the various types of engine configurations.

(c) In Q6.8 the majority of the candidates could not give reasons why an engine is fitted with both a supercharger and a turbocharger.

Suggestions for improvement

(a) Teachers are encouraged to relate theory to practical demonstration while teaching engines using visual examples.

(b) Learners must be exposed to different engine configurations through videos and by visiting automotive manufacturing industries to enhance learners' understanding of the covered theory. This will ensure that learners are able to link theory with practice when identifying the types and operation.

(c) It is important that learners can distinguish between the turbocharger's and supercharger's operation when dealing with engines in the workshop. Also, teachers must develop worksheets to enhance this aspect in their teaching and learning process.

QUESTION 7: FORCES

Common errors and misconceptions

(a) Most candidates struggled to explain the difference between the indicated power and the brake power of an engine in Q7.1.

(b) In Q7.2.3 most of the candidates experienced difficulty calculating the new stroke length. They could not convert standard units to the required units. Many candidates were challenged by the mathematical concepts which are essential for such calculations.

(c) In Q7.4.1 and Q7.4.3 some candidates were not able to calculate both the torque developed and the indicated power using the information given in the instructions.

Suggestions for improvement

(a) Teachers are advised to design a worksheet to cater for definitions of terminology involving forces, such as *swept volume, clearance volume, compression ratio*, indicated power, *brake power* and *mechanical efficiency*.

(b) The manipulation of formulae forms the basis of calculations in the subject. Learners must be assisted to acquire this skill. Teachers should provide more calculation activities using examples from previous question papers and various textbooks.

(c) Discuss each step in the calculation using the indicated power and cylinder volume formulae. Teachers should illustrate the steps involved to do each subcalculation indicating the conversion of the unit separately and then applying these results in the main formula.

QUESTION 8: MAINTENANCE

Common errors and misconceptions

(a) Many candidates were challenged by Q8.1.1 and Q8.1.2. They were required to respond to the exhaust gas analysis.

(b) In Q.8.3 most candidates were unable to tabulate the faults and possible causes regarding the cylinder leakage test.

(c) Q8.6 most candidates struggled to explain step by step how to conduct a pressure test on a radiator cap.

Suggestions for improvement

(a) Teachers are encouraged to relate theory to practical demonstration while teaching engines using visual examples.

(b) When conducting the cylinder leakage test, teachers are advised to design a worksheet requiring learners to indicate faults and possible causes.

(c) A practical demonstration of how to do a pressure test on a radiator cap is a useful teaching technique in this regard.

(d) Teachers are also encouraged to use video clips relating to safety measures when conducting all types of tests.

QUESTION 9: SYSTEMS AND CONTROL (AUTOMATIC GEARBOX)

Common errors and misconceptions

(a) Many candidates were unable to describe the function of the torque converter in Q9.3.1.

Suggestions for improvement

(a) Teachers should use charts to show the labels of the torque converter, its advantages, functions, and its operation. If possible, use a sectioned automatic gearbox or an actual vehicle and videos to show learners the differences in the operation of the power transmission between automatic and manual vehicles.

QUESTION 10: SYSTEMS AND CONTROL (AXLES, STEERING GEOMETRY AND ELECTRONICS)

Common errors and misconceptions

(a) The majority of the candidates struggled to label the sketch of a wheel alignment angle in Q10.4.

(b) In Q10.7 most candidates did not label the air induction system fitted on an internal combustion engine.

(c) In Q10.11 the majority of the candidates did not know the main aims of an adaptive speed control fitted to a vehicle.

Suggestions for improvement

(a) Teachers should assign more drawing exercises to allow learners to master all wheel alignment angles, definitions and labels. Learners should be taken to a wheel alignment workshop for them to understand the alignment and setting of wheel alignment angles. Alternatively, videos can be used to achieve this objective.

(b) Teachers must do the practical application of a steering mechanism so that learners can have a better understanding of the topic.

(c) The use of videos is advised to show the basic operation of an adaptive speed control in comparison with a conventional system.

(d) Frequent weekly short informal assessment tasks to enhance learners' knowledge and drill revision work, must be an on-going feature of the assessment programme.

6.2 FITTING AND MACHINING

The following report should be read in conjunction with the Fitting and Machining question paper of the November 2023 examinations.

6.2.1 PERFORMANCE TRENDS (2019–2023)

The number of candidates who wrote the Fitting and Machining examination in 2023 increased by 82 compared to that of 2022.

The table below indicates consistent performance over the past five years with pass rates in the 96% to 98% range. The performance of the candidates in 2023 remains consistent with 97,0% of candidates passing at 30% (Level 2).

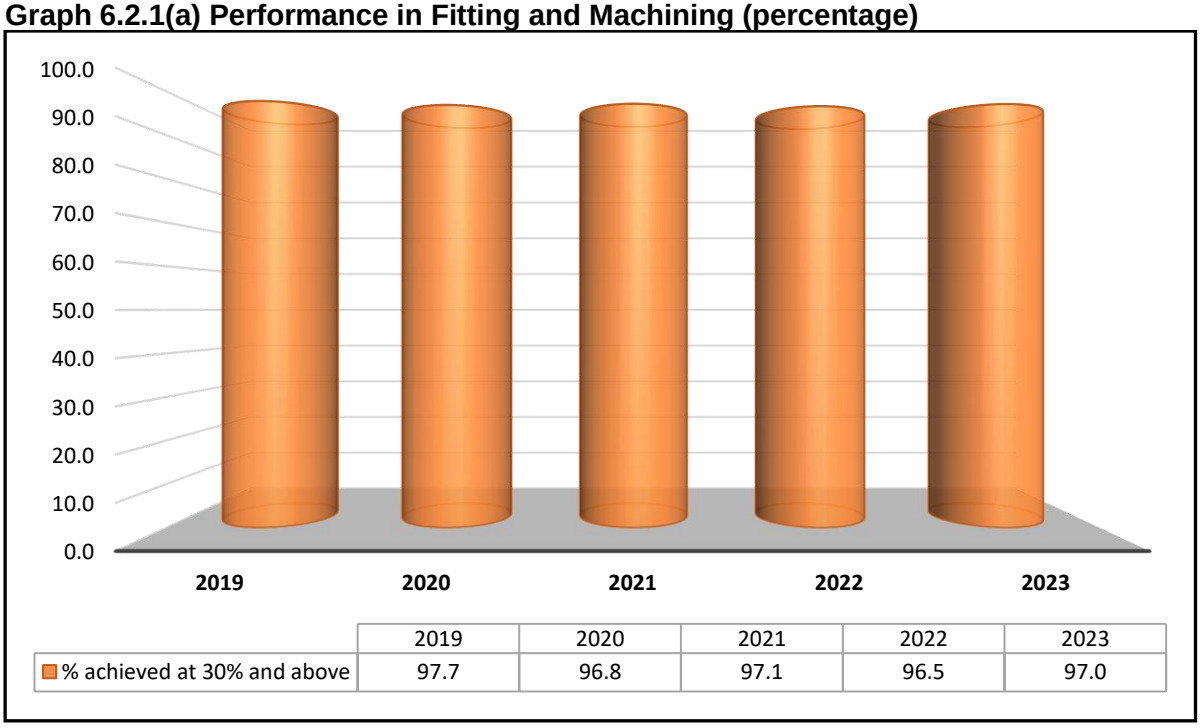
The percentage of distinctions (over 80%) improved marginally from 3,1% in 2022 to 3,2% in 2023. Given the increase in the size of the 2023 cohort, this converts into an increase in the total number of distinctions from 60 to 65.

The various commendable intervention strategies employed by teachers, subject advisors and provincial education departments were continued in 2023. The resourcefulness and diligence of the above-average candidates also contributed to the overall improvement in the subject.

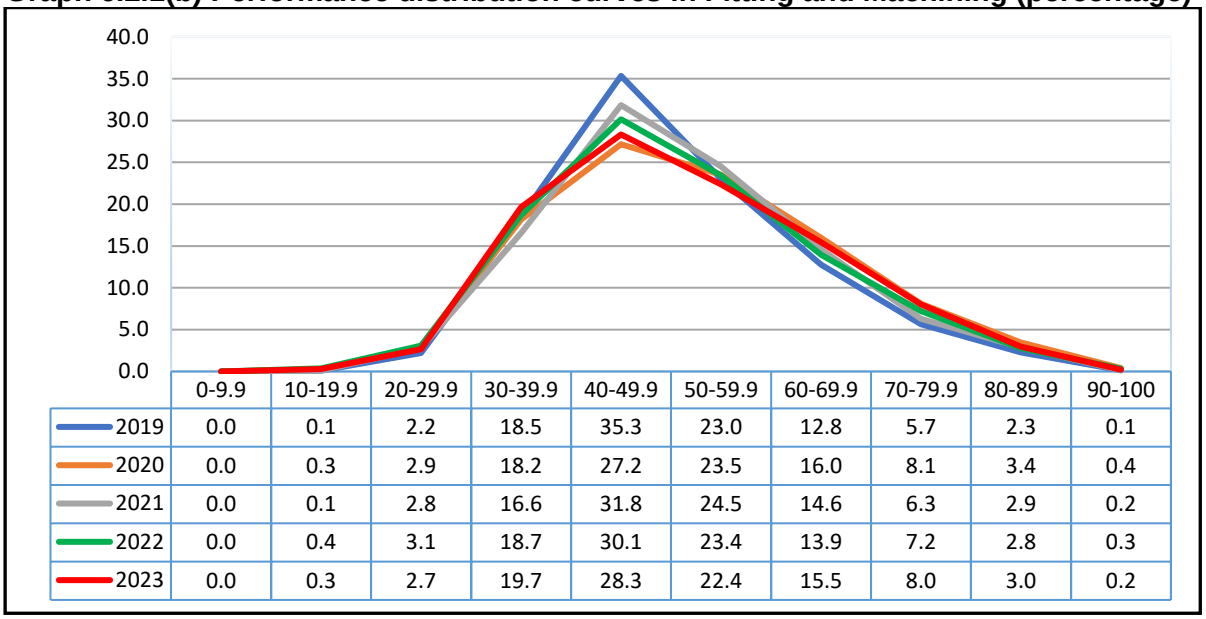
Table 6.2.1 Performance in Fitting and Machining

Year	No. wrote	No. achieved at 30% and above	% achieved at 30% and above
2019	2 012	1 966	97,7
2020	1 914	1 853	96,8
2021	1 991	1 933	97,1
2022	1 937	1 870	96,5
2023	2 019	1 959	97,0

Graph 6.2.1(a) Performance in Fitting and Machining (percentage)



Graph 6.2.1(b) Performance distribution curves in Fitting and Machining (percentage)



	0-9.9	10-19.9	20-29.9	30-39.9	40-49.9	50-59.9	60-69.9	70-79.9	80-89.9	90-100
2019	0.0	0.1	2.2	18.5	35.3	23.0	12.8	5.7	2.3	0.1
2020	0.0	0.3	2.9	18.2	27.2	23.5	16.0	8.1	3.4	0.4
2021	0.0	0.1	2.8	16.6	31.8	24.5	14.6	6.3	2.9	0.2
2022	0.0	0.4	3.1	18.7	30.1	23.4	13.9	7.2	2.8	0.3
2023	0.0	0.3	2.7	19.7	28.3	22.4	15.5	8.0	3.0	0.2

6.2.2 ANALYSIS OF LEARNER PERFORMANCE IN EACH QUESTION IN FITTING AND MACHINING

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Common errors and misconceptions

(a) Most of the candidates were not clear about the heat treatment process that relieves the internal stresses produced by machining, forging and welding in Q1.5.

Suggestions for improvement

(a) Intensive revision and remediation measures must be taken on the topics of safety and materials. The use of past question papers in weekly informal assessments is encouraged. This will also assist learners to answer multiple-choice questions. They must then apply their practical knowledge to the theory questions.

(b) Teachers are encouraged to teach learners the technique of arriving at the correct answer by the process of elimination in instances where they are unable to identify the correct alternative immediately.

QUESTION 2: SAFETY

Common errors and misconceptions

(a) In Q2.1 most of the candidates struggled to provide the checks that must be done on an injured person before removing them from the danger zone.

(b) In Q2.2 a large percentage of the candidates could not state the type of safety devices fitted to power guillotine.

(c) In Q2.4 the majority of the candidates responded with PPE instead of safety devices fitted on the gas welding equipment.

(d) Teachers should revise safety from previous grades more intensively to ensure learners are empowered to portray their knowledge and understanding of safety in the workplace.

Suggestions for improvement

(a) Teachers should engage with electronic media, such as video clips, to show learners how first-aid is a benefit in the workplace. Practical demonstrations will give learners an added advantage when answering these types of questions on first aid.

(b) Always expose learners to workshop practice relating to the safety of tools, equipment in the workshop and the workshop environment.

(c) Teachers must ensure that they integrate theory learned in previous grades when assessing learners with gas welding equipment.

QUESTION 3: MATERIALS

Common errors and misconceptions

(a) A lack of theoretical knowledge and practical application with regard to heat-treatment processes was evident in many candidates' responses in Q3.3.

(b) In Q3.5 most of the candidates were not able to give the reason why steel is annealed during heat-treatment processes.

Suggestions for improvement

(a) Ensure that learners are exposed to the different processes to enhance the properties of steel.

(b) The revision programme should incorporate activities requiring explanation, definition, and application of heat-treatment processes. Schools need to organise educational excursions to foundries or other places where materials are processed in order to acquaint learners with metallurgy and to further improve their understanding of the processes involved.

QUESTION 4: MULTIPLE-CHOICE QUESTIONS

Common errors and misconceptions

(a) It was disappointing to note that poor content knowledge was the reason for most of the multiple-choice questions being answered incorrectly by a fair percentage of candidates.

Suggestions for improvement

(a) Learners should be given direction on the technique of arriving at the correct answer by the process of elimination in instances where they are unable to identify the correct alternative immediately.

QUESTION 5: TERMINOLOGY – LATHE AND MILLING MACHINE

Common errors and misconceptions

(a) Inappropriate answers to Q5.2 revealed that a few of the candidates lacked the mathematical and manipulation skills required to answer the question.

Suggestions for improvement

(a) The subject teacher needs to integrate relevant sections with Mathematics (trigonometric equations) and Technical Mathematics.

(b) Teachers ought to offer learners a variety of weekly activities that encompass diverse questioning techniques, including substitution, formula manipulation, and calculations. This approach will enhance their proficiency in responding to tests and examinations.

(c) Learners must be encouraged to practise using the diagram in question papers to assist them in formulating the calculations.

(d) Engaging in hands-on tasks can help learners comprehend concepts, processes, as well as the pros and cons, leading to an enhancement of the quality of their responses to questions.

(e) Mathematical skills can only improve with practice. The following steps are suggested:
- Identify the formula
- Formula manipulation (if necessary)
- Substitution (correct values or units)
- Answer with unit of measure indicated

QUESTION 6: TERMINOLOGY – INDEXING AND DOVETAILS

Common errors and misconceptions

(a) Q6.2.1 and Q6.2.2 required candidates to calculate dovetail dimensions. Most candidates struggled to answer these questions correctly due to incorrect formulation of the formula.

(b) In Q6.3.1 most candidates could not perform the fraction calculations for Indexing.

(c) Q6.3.2 required the candidates to calculate change gears. Unfortunately, very few candidates could perform this calculation correctly.

(d) It was disappointing to note that many candidates still struggle with basic fraction calculations. This is a skill that is developed over time from previous grades.

Suggestions for improvement

(a) It is recommended that pertinent subject content be integrated with Mathematics and Technical Mathematics. Teachers should furnish learners with additional activities featuring diverse questioning techniques, including substitution, formula manipulation, and calculations, aiming to refine these skills.

(b) The use of diagrams (separate triangles) is suggested for the dovetail calculations.

(c) Learners must be offered practical exposure to the machines and equipment. Teachers are requested to use such opportunities to explain the calculations relevant to the tasks.

(d) Teachers should incorporate a greater number of calculation activities into their lesson planning when teaching this content. A mere one or two activities do not contribute significantly to the learner's ability to master calculations. This practice will augment learners' mathematical skills and refine their proficiency in manipulating formulas.

QUESTION 7: TOOLS AND EQUIPMENT

Common errors and misconceptions

(a) In Q7.1 most candidates were not familiar with the instrument to use when measuring the indentation diameter when conducting a Brinell Hardness test.

(b) Many candidates were not able to demonstrate the proper knowledge of the Brinell Hardness number in Q7.2.

(c) In Q7.5 many candidates could not distinguish between the difference of the barrels of a screw-thread micrometer and a depth micrometer.

(d) In Q7.7 most candidates demonstrated a lack of knowledge of the reading of a micrometer.

Suggestions for improvement

(a) Familiarity with the names and functions of the measuring instruments in use is crucial for learners. Teachers can design practical tasks aimed at enhancing measuring skills, employing tools such as Vernier callipers, micrometers and related accessories.

(b) Teachers should make more extensive use of electronic media and practical exercises to cover the content on testers used to determine specific properties of materials and the application of measuring equipment.

(c) Learners must be made aware of the use of the Brinell Hardness tester. Short class practical demonstrations are useful to achieve this goal.

QUESTION 8: FORCES

Common errors and misconceptions

(a) In Q8.1 the majority of the candidates neglected to use the hint provided in the question. Many candidates struggled with the direction needed in the final answer.

(b) In Q8.2 most candidates struggled with the overhanging distance of the beam as the question required reactions at support A and B, instead they calculated reaction B at A and reaction A at B.

(c) Many candidates did not convert answers to the correct units before and after completing the calculation, as required in the question, e.g. MPa and mm.

(d) Numerous candidates found Q8.3 challenging due to calculations involving exponents. They struggled to specify the necessary units of measure, and a significant portion faced difficulties in working with formulas related to stress calculations.

Suggestions for improvement

(a) It is commended that drawing a diagram is an effective way that will assist learners in determining the direction of the resultant. Teachers must make more extensive use of this technique.

(b) Learners must be directed to a common understanding of the principle used to calculate reactions. 'Calculate A, take moments about B' and 'Calculate B, take moments about A'

is a recommended example to achieve this outcome.

(c) Learners should be encouraged to perform calculations systematically. The following steps is considered to be effective by the few that actually make use of this:
- Identify/Use the correct formula (this may be on the formula sheet)
- Manipulate the formula, if necessary, depending on the information available
- Substitution of correct values or units, as per the question
- Express the final answer with the relevant unit of measure

(d) Learners must ensure that they use exponents and the correct derived unit in the answer.

(e) Diverse calculation methods should be explored and elucidated for learners. Practice in manipulating formulae is essential, and the significance of each element in the formula should be expounded upon comprehensively.

(f) Different scenarios must be practised. These can easily be incorporated in homework and weekly assessment activities.

QUESTION 9: MAINTENANCE

Common errors and misconceptions

(a) Both Q9.2 and Q9.3, that consist of belt drive content, were poorly answered by many candidates. It was disappointing to note that this content was not adequately covered, or not at all in some cases.

(b) The maintenance section primarily contains factual information that needs to be studied. In Q9.5 majority of the candidates demonstrated a lack of knowledge and comprehension of this topic in their responses.

(c) The inappropriate answers of the majority of the candidates was also a clear indication that they lacked practical experience in Q9.6 which expect from the candidates to distinguish between the thermo-hardened or thermoplastic composites.

(d) A considerable proportion of candidates faced challenges in delineating the uses of various materials. This not only indicates a deficiency in studying the chapter but also reflects a lack of general knowledge.

Suggestions for improvement

(a) Resources on this content are readily available on the internet. It is recommended that teachers make use of videos and other visual resources during the lessons.

(b) It should be acknowledged that a complete understanding of maintenance procedures cannot be attained solely through textbooks or notes. Observation or practical application is essential.

(c) Teachers should develop additional practical tasks involving maintenance procedures, preferably presented in bullet points. Emphasising the accurate use of maintenance-related terminology is also crucial. The integration of theory and practice in the workshop is imperative.

QUESTION 10: JOINING METHODS

Common errors and misconceptions

(a) In Q10.1 many candidates lacked relevant knowledge with regard to screw thread terminology.

(b) Most of the candidates generally displayed a weakness in the mathematical skills that were necessary to answer questions Q10.2.1 to Q10.2.4 leading to candidates to obtaining inaccurate calculations.

Suggestions for improvement

(a) Teachers need to make sure that lesson plans include clear direction on ensuring that learners know and understand screw-thread terminology.

(b) Learners should participate in additional practice sessions involving calculations to build confidence in responding to this question type. Routine activities should be incorporated at strategic intervals throughout the academic year.

(c) Learners must be encouraged to work systematically through the calculations according to the following steps:
- Identify the relevant formula
- Manipulation of the formula (if necessary)
- Substitution (correct values or units)
- Answer with unit of measure.

QUESTION 11: SYSTEMS AND CONTROL

Common errors and misconceptions

(a) Q11.1.1, Q11.1.2 and Q11.1.3 were very poorly answered by a large percentage of candidates due to an apparent lack of mathematical skills and knowledge on hydraulics. Candidates lost marks: when the first calculation was incorrect, subsequent calculations would also be incorrect. It was evident that candidates could not calculate displacement of the piston.

(b) It was evident in Q11.3 that a fair percentage of candidates lacked the necessary theoretical knowledge on the usage of pneumatic systems.

(c) In Q11.4.1 and Q11.4.2 many candidates were not able to apply the formula correctly and also expressed the answer in the incorrect unit of measure, in their attempts.

(d) In Q11.6 many candidates did not calculate the *rotation frequency* of the output shaft.

Suggestions for improvement

(a) Mathematical skills can only improve with practice. Teachers must create many opportunities to ensure learners have enough exercises and homework to master the calculations.

(b) Learners must work systematically through the calculations according to the following steps:
- Formula

- Formula manipulation (if necessary)
- Substitution (correct values or units)
- Answer with unit (Pay attention to requirements in the question)

(c) Practical application of this content will assist the learner in understanding the content. The subject needs to be integrated with Mathematics, Technical Sciences and Technical Mathematics.

(d) Teachers must ensure that they also teach the theoretical knowledge with regards to the systems covered in this chapter.

6.3 WELDING AND METALWORK

The following report should be read in conjunction with the Welding and Metalwork question paper of the November 2023 examinations.

6.3.1 PERFORMANCE TRENDS (2019–2023)

The number of candidates who wrote the Welding and Metalwork examination in 2023 increased by 3 compared to that of 2022.

The table below indicates consistent performance over the past five years with pass rates in the 88% to 93% range. The performance of the candidates in 2023 remains consistent with 93,3% of candidates passing at 30% (Level 2).

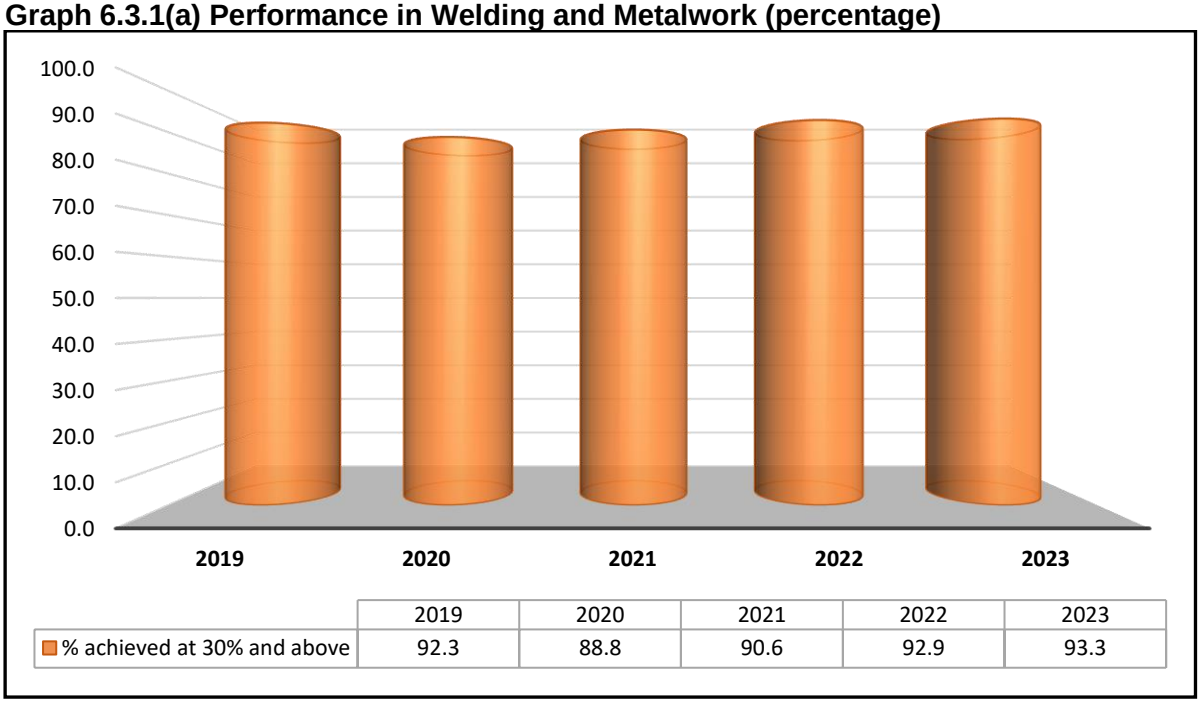
The percentage of distinctions (over 80%) was stable at 0,7% for the past two years. This converts into the total number of 17 distinctions.

The various commendable intervention strategies employed by teachers, subject advisors and provincial education departments were continued in 2023. The resourcefulness and diligence of the above-average candidates also contributed to the overall improvement in the subject.

Table 6.3.1 Performance in Welding and Metalwork

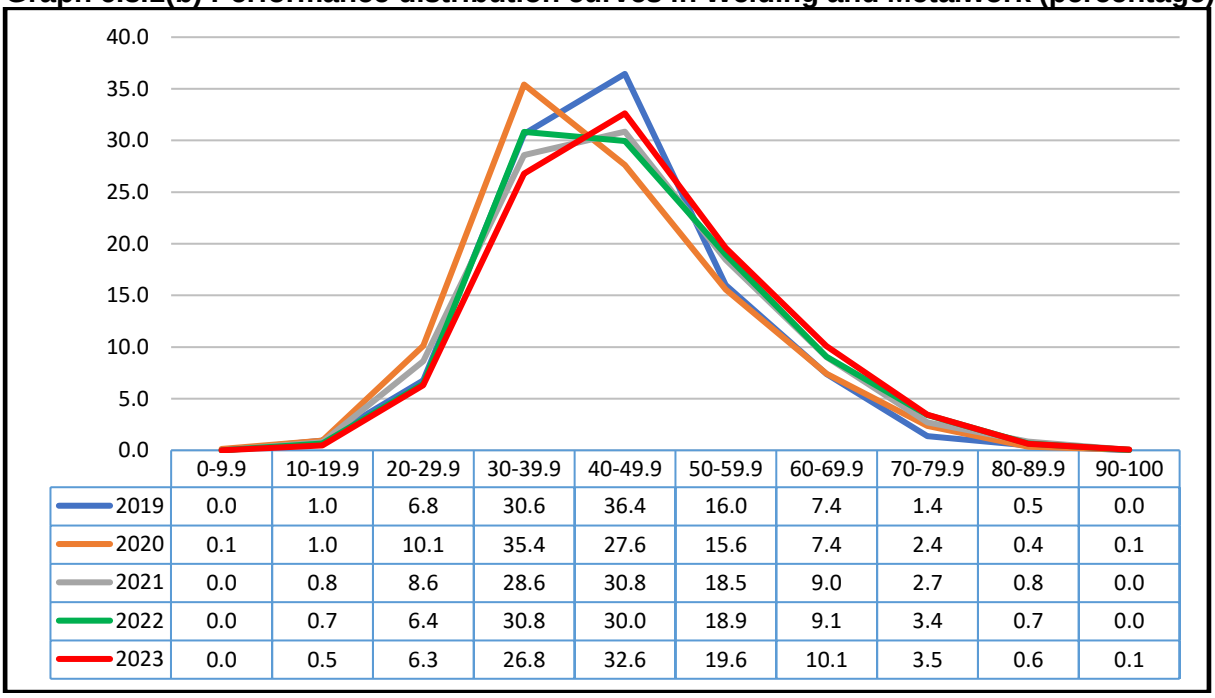
Year	No. wrote	No. achieved at 30% and above	% achieved at 30% and above
2019	1 682	1 552	92,3
2020	1 683	1 495	88,8
2021	2 308	2 091	90,6
2022	2 397	2 227	92,9
2023	2 400	2 238	93,3

Graph 6.3.1(a) Performance in Welding and Metalwork (percentage)



	2019	2020	2021	2022	2023
% achieved at 30% and above	92.3	88.8	90.6	92.9	93.3

Graph 6.3.1(b) Performance distribution curves in Welding and Metalwork (percentage)



	0-9.9	10-19.9	20-29.9	30-39.9	40-49.9	50-59.9	60-69.9	70-79.9	80-89.9	90-100
2019	0.0	1.0	6.8	30.6	36.4	16.0	7.4	1.4	0.5	0.0
2020	0.1	1.0	10.1	35.4	27.6	15.6	7.4	2.4	0.4	0.1
2021	0.0	0.8	8.6	28.6	30.8	18.5	9.0	2.7	0.8	0.0
2022	0.0	0.7	6.4	30.8	30.0	18.9	9.1	3.4	0.7	0.0
2023	0.0	0.5	6.3	26.8	32.6	19.6	10.1	3.5	0.6	0.1

6.3.2 ANALYSIS OF LEARNER PERFORMANCE IN EACH QUESTION IN WELDING AND METALWORK

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Common errors and misconceptions

(a) Most of the candidates were not clear about the heat-treatment process that relieves the internal stresses produced by machining, forging and welding in Q1.5.

Suggestions for improvement

(a) Intensive revision and remediation measures must be taken on the topics of safety and materials. The use of past question papers in weekly informal assessments is encouraged. This will also assist learners to answer multiple-choice questions. They must then apply their practical knowledge to the theory questions.

(b) Teachers are encouraged to teach learners the technique of arriving at the correct answer by the process of elimination in instances where they are unable to identify the correct alternative immediately.

QUESTION 2: SAFETY

Common errors and misconceptions

(a) In Q2.1 most of the candidates struggled to provide the checks that must be done on an injured person before removing them from the danger zone.

(b) In Q2.2 a large percentage of the candidates could not state the types of safety devices fitted to a power guillotine.

(c) In Q2.4 the majority of the candidates responded with PPE instead of safety devices fitted on the gas welding equipment.

Suggestions for improvement

(a) Teachers should engage in electronic media such as video clips to show the learners how first-aid is a benefit in the workplace. Practical demonstrations will give learners an added advantage when answering these types of questions on first aid.

(b) Always expose learners to workshop practice relating to the safety of tools, equipment in the workshop and the workshop environment.

(c) Teachers must ensure that they integrate theory learned in previous grades when assessing learners with gas welding equipment.

(d) Teachers should revise safety from previous grades more intensively to ensure learners are empowered to portray their knowledge and understanding of safety in the workplace.

QUESTION 3: MATERIALS

Common errors and misconceptions

(a) A lack of theoretical knowledge and practical application with regard to heat-treatment processes was evident in many candidates' responses in Q3.3.

(b) In Q3.5 most of the candidates were not able to give the reason why steel is annealed during heat-treatment processes.

Suggestions for improvement

(a) Ensure that learners are exposed to the different processes to enhance the properties of steel.

(b) The revision programme should incorporate activities requiring explanation, definition and application of heat-treatment processes. Schools need to organise educational excursions to foundries or other places where materials are processed in order to acquaint learners with metallurgy and to further improve their understanding of the processes involved.

QUESTION 4: MULTIPLE-CHOICE QUESTIONS

Common error and misconception

(a) Some candidates left open spaces at some of the questions. They neglected to at least attempt a response, which could have resulted in some marks being earned.

Suggestion for improvement

(a) Learners should be given direction on the technique of arriving at the correct answer by the process of elimination in instances where they are unable to identify the correct alternative immediately.

(b) Teachers should expose learners to multiple-choice questions in all informal assessments on a weekly basis. This will contribute to providing them with the necessary skills to approach these questions.

QUESTION 5: TERMINOLOGY

Common errors and misconceptions

(a) In Q5.2 and 5.3 many candidates lacked the necessary knowledge to correctly draw or interpret the welding symbols.

Suggestions for improvement

(a) Learners need to be exposed to more practical application of theory/welding symbols as this will improve the understanding and interpretation of the symbols.

QUESTION 6: TOOLS AND EQUIPMENT

Common errors and misconceptions

(a) In Q6.3.1 many candidates used a number of different terminologies for the welding machine.

(b) Candidates had difficulty in stating the advantage of MIG/MAGS welding over normal arc welding in Q6.3.2.

(c) In Q6.5 some candidates could not identify the types of rolling machines correctly.

Suggestions for improvement

(a) Teachers must focus on the correct terminologies with regard to the different equipment used in the welding and metalwork workshop.

(b) Teachers are advised to utilise electronic media to introduce the welding equipment that is not available in the workshop.

(c) Teachers should show learners the practical components of the workshop equipment and ensure that learners use machines in the workshop frequently. In addition, field trips must be organised to visit manufacturing sites/industries where this equipment is being fully used.

QUESTION 7: FORCES

Common errors and misconceptions

(a) In Q7.1.2 many of the candidates were unable to calculate the bending moments correctly and because of that mistake, the diagram in Q7.1.3 was also drawn incorrectly.

(b) In Q7.2 some candidates had difficulty in calculating stress and strain correctly because of a lack of mathematical skills. It was evident that these candidates could not manipulate the given formula.

(c) In Q7.3 many candidates were not familiar with the procedure to determine the magnitudes and nature of the members in a framework.

Suggestions for improvement

(a) Learners must be provided with opportunities to enhance their mathematical skills at regular intervals. Supporting subjects like Mathematics, Technical Mathematics and Technical Sciences should emphasise relevant sections related to forces.

(b) Diverse calculation methods should be explored and elucidated for learners. Practice in manipulating formulae is essential, and the significance of each element in the formula should be expounded upon comprehensively.

(c) Teachers must emphasise the procedure to determine the magnitudes and nature of the members in a framework. (Space diagram, Planning diagram, Vector diagram/scale and then tabulating the final answers).

(d) Learners must be directed to a common understanding of the principle used to calculate reactions. 'Calculate RL, take moments about RR' and 'Calculate RR, take moments about RL' is a recommended example to achieve this outcome.

QUESTION 8: JOINING METHODS – WELD INSPECTION

Common errors and misconceptions

(a) In Q8.5 many candidates had difficulty in stating methods to reduce transverse cracks.

(b) In Q8.8 some candidates did not know how to conduct an ultrasonic test on a welded joint.

Suggestions for improvement

(a) Teachers should expose learners to practical work in order to bring the theoretical subject matter closer to the learners' understanding.

(b) Teachers are encouraged to use previous examination papers for revision especially when preparing learners for tests and examinations.

(c) Teachers should emphasise the use of videos and other electronic media during class lessons. Field trips should be arranged to where welding inspections are conducted.

QUESTION 9: JOINING METHODS – STRESSES AND DISTORTION

Common errors and misconceptions

(a) In Q9.1 most candidates were unable to state the factors that have an effect on shrinkage in a welded joint.

(b) Many candidates had difficulty in explaining the meaning of *'peening'* in Q9.2.

(c) In Q9.4 many candidates were not familiar with the effects of hot working on steel.

(d) In Q9.7 some candidates could not state the effects of the rate of cooling on a welded joint.

Suggestions for improvement

(a) Learners should be exposed to videos during lessons as well as simulations on the effects of cooling rate on a welded joint, as well as the effects of hot working on steel.

(b) This section consists of factual information and teachers should conduct thorough revision to ensure that learners become familiar with the content. Practical exposure will also improve the understanding of the content.

QUESTION 10: MAINTENANCE

Common errors and misconceptions

(a) In Q10.2 the majority of the candidates were unfamiliar with the negative impact of overloading of equipment in the welding and metalwork workshop.

(b) In Q10.5 many candidates were unable to state a method to reduce friction when drilling holes.

Suggestions for improvement

(a) Learners should be exposed to the different equipment and their working principles to enhance understanding of the required maintenance. Informal assessment tasks will support the teaching and learning process.

(b) Teachers must involve learners in the maintenance of the equipment and make learners responsible for specific maintenance tasks in the workshop.

(c) Schools must be sufficiently equipped with the relevant equipment and tools to ensure that practical lessons can take place to develop skills and reinforce the theory.

QUESTION 11: DEVELOPMENT BY CALCULATIONS

Common errors and misconceptions

(a) Q11 required specific mathematical knowledge and skills from the candidates to be proficient on how to perform calculations. Candidates struggled with this question because they demonstrated a lack of the specific mathematical knowledge and skills.

Suggestions for improvement

(a) Different methods to derive an answer should be explored as learners might not understand one method, but may be able to understand an alternative method.

(b) Teachers must make use of past exam papers for revision and remedial work in preparation for the assessment tasks planned. Also, integration with Mathematics could assist in improving long-term performance.

(c) Teachers should incorporate a greater number of calculation activities into their lesson planning and assessment when teaching this content. This practice will augment learners' mathematical skills and refine their proficiency in manipulating formulae.

CHAPTER 7

ENGINEERING GRAPHICS AND DESIGN

This Diagnostic Report has been compiled based on empirical data collected during the marking process of the November 2023 NSC Engineering Graphics and Design examination and the reports received from the nine provincial education departments.

7.1 PERFORMANCE TRENDS (2019–2023)

The number of candidates who wrote the Engineering Graphics and Design examination in 2023 decreased by 873 compared to that of 2022.

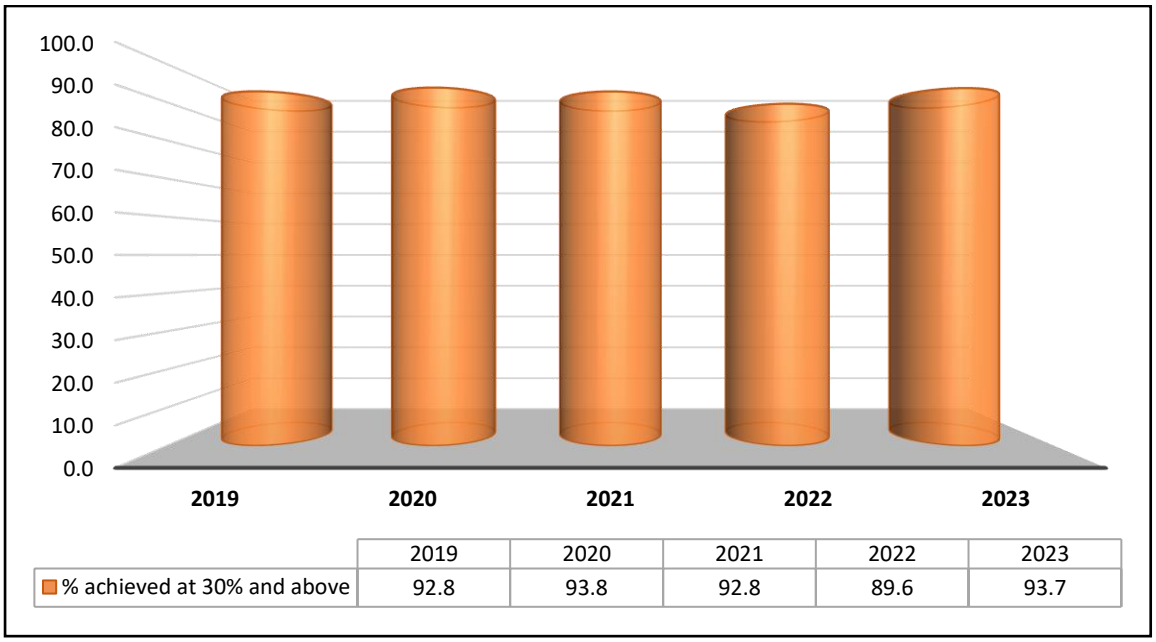
There was a pleasing improvement in the pass rate at 30% (Level 2) from 89,6% in 2022 to 93,7% in 2023. The percentage of distinctions over 80% (Level 7) reflected a corresponding improvement over the past two years from 3,9% to 5,6%. This converts into a total of 2 128 distinctions compared to 1 516 distinctions in the previous year.

The various commendable intervention strategies employed by teachers, subject advisors and provincial education departments were continued in 2023. The diligence of the average and above-average candidates have contributed to the overall improvement in the subject.

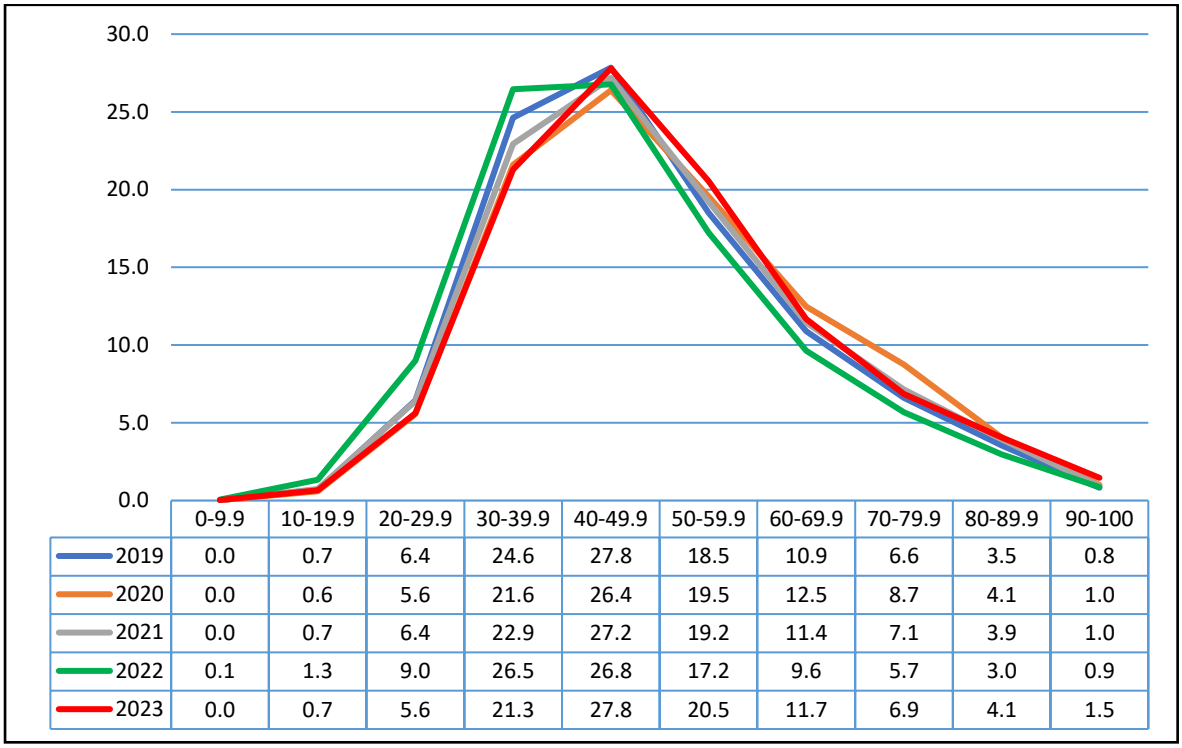
Table 7.1.1 Overall achievement rates in Engineering Graphics and Design

Year	No. wrote	No. achieved at 30% and above	% achieved at 30% and above
2019	32 280	29 969	92,8
2020	32 538	30 529	93,8
2021	37 131	34 463	92,8
2022	38 879	34 830	89,6
2023	38 006	35 603	93,7

Graph 7.1.1 Overall achievement rates in Engineering Graphics and Design



Graph 7.1.2 Overall achievement rates in Engineering Graphics and Design (percentage)



	0-9.9	10-19.9	20-29.9	30-39.9	40-49.9	50-59.9	60-69.9	70-79.9	80-89.9	90-100
2019	0.0	0.7	6.4	24.6	27.8	18.5	10.9	6.6	3.5	0.8
2020	0.0	0.6	5.6	21.6	26.4	19.5	12.5	8.7	4.1	1.0
2021	0.0	0.7	6.4	22.9	27.2	19.2	11.4	7.1	3.9	1.0
2022	0.1	1.3	9.0	26.5	26.8	17.2	9.6	5.7	3.0	0.9
2023	0.0	0.7	5.6	21.3	27.8	20.5	11.7	6.9	4.1	1.5

7.2 OVERVIEW OF CANDIDATES' PERFORMANCE: PAPERS 1 AND 2

(a) Quality of candidates' performance

It appears that the 2023 cohort of Engineering Graphics and Design candidates have performed slightly better in both Paper 1 and Paper 2 than the candidates of 2022. Consensus among the provinces is that both papers were of a good standard and that the poor performance of many candidates can be attributed in a large part to the educational environment that has persisted since 2020.

It must be noted that all the questions in both Engineering Graphics and Design papers were designed to be accessible to every candidate, whether this applied to the candidates with challenges or the top achievers. The quality of responses from the top candidates in many centres across all the provinces is evidence that, despite the systemic challenges that have affected every candidate since 2020, and especially the 2023 cohort, many learners were adequately prepared for and coped with the complexities and the content of this examination. The inability of some of the weaker candidates to deal effectively with even the less challenging parts of questions is a clear indication of the deficiencies within the teaching and learning processes.

A concerning observation is that there continues to be entire centres in every province where the majority of candidates performed well and centres where the majority of candidates performed poorly. This suggests that the teacher plays a significant role in a candidate's performance.

It is evident that the lack of understanding of the basic concepts and techniques covered in the Grade 10 *Curriculum Assessment Policy Statements (CAPS)*, displayed by many candidates in all the provinces indicates that the topics were never thoroughly

covered initially and consequently this has had a knock-on effect, impacting negatively on the NSC examination performance.

(b) **Pertinent factors that cause poor results**:

Poor results in many centres are an indication that challenges in teaching and learning are still prevalent. The following factors continue to be identified as reasons for poor performance:

- **Laziness in reading the questions to identify relevant information:** A focus of Engineering Graphics and Design is reading and understanding instructions that relate to graphic information used to solve problems in preparing drawings.
- The instructions are kept as simple as possible and follow a standard structure which remains relatively constant from year to year. Many weaker candidates still appear to simply look at the graphics and assume what the expected response should be: they consequently either prepare the incorrect response or run out of drawing space. Some candidates also display poor comprehension skills by providing incomplete responses or responses that do not address the requirements of the question.
- **Language barriers linked with poor comprehension skills:** Some candidates may possibly have found difficulty in understanding the requirements of the questions because of language barriers or possibly not being familiar with the terminology. Learners need to be taught to *read with understanding*. Learners must also be taught the correct terminology used in the subject.
- **Planning an answer:** This goes hand-in-hand with *reading with understanding*. When candidates do not read and understand the requirements of a question, they cannot plan the answer. Often candidates rush into answering a question and later discover that they have not left sufficient space on the drawing sheet to place the required views.
- **The use of prepared drawing sheets:** It appears that many teachers still make use of prepared drawing sheets for their day-to-day tasks, course drawings, tests and even examinations. As convenient as it may be for the teacher, the use of prepared drawing sheets removes the essential practice the learner needs in the fundamental aspects of the curriculum and often disadvantages candidates in the examination. Prepared drawing sheets disadvantage the weaker learner and this is evident when a learner cannot, for instance, construct a simple polygon.
- **Lack of meaningful revision of relevant Grade 10 and 11 content:** Every examination question is based on content that is derived from concepts taught in previous years. It is therefore essential that the fundamental concepts of every topic are continually reinforced. Teachers must factor these aspects into their teaching, assessment and intervention programmes by ensuring that learners practise even the most fundamental aspects of the drawings.
- **Lack of formative testing:** Teachers are expected to plan and implement an informal assessment programme to support formal assessment tasks. Short, formative tests must be used to build confidence in all topics. Self-marking or peer-marking is an effective tool in providing immediate feedback. Learners will also gain an understanding of the mark allocation and will be able to identify errors or valid alternative responses promptly.
- **Drawing fitness:** Engineering Graphics and Design is essentially a knowledge-based subject. However, an essential and unique requirement of the subject is a high level of skill and practice needed to draw quickly, accurately and neatly so that learners are able to complete a paper in the time allocated. This concept is referred to as *drawing fitness*. Drawing fitness is achieved through regular practice at preparing drawings under examination conditions and within time limits.

General suggestions for improvement

Limited instruction time in each term necessitates that teachers build the following practices into their *annual teaching plan (ATP)*:

(a) **Prior knowledge:** The teaching of every topic should commence by revising the basic concepts and terminology pertaining to it. This would ensure that learners are able to make connections between old and new knowledge.

(b) **Understanding and planning:** In order for learners to plan the layout of a drawing, they must first read and understand the requirements of the question, in other words, *read with meaning*. Teachers also need to mediate the language barriers as part of the *English Across the Curriculum (EAC)* initiative.

- Due to the specific nature of the subject, learners must be informed of the necessity of reading instructions carefully and in so doing, understanding what needs to be drawn. Learners should be encouraged to:
  i. Read each word of the instruction;
  ii. Underline or highlight key words in the instructions;
  iii. Identify where the relevant source information can be found;
  iv. Plan the layout of the drawing;
  v. Identify where it would be most appropriate to start an answer.
- Often poor or incorrect answers result from learners not taking cognisance of the specific requirements and instructions of questions. This is a common problem because skim-reading has become a habit.
- Teachers are advised to demonstrate and teach the skill of interpreting and analysing past examination questions to their classes at appropriate times during the Grade 10–12 years. This should assist learners in developing these skills.

(c) **Time management:** Training in time management must be an on-going process. This should be applied even when preparing course drawings, or when sitting for tests and examinations. The mark allocation of a question provides a time guide and learners must practise the skill of working to the suggested time allocations.

(d) **Use of past NSC examination papers:** Past question papers serve as one of many teaching and learning resources and must be incorporated into the planning and teaching process. Recent past examination papers provide a reliable trend on questioning patterns and style. Past examination papers, with their marking guidelines, are easily accessible on the Department of Basic Education (DBE) website. All learners should have this resource readily available to them.

(e) **Use of textbooks:** A mandatory requirement for all Engineering Graphics and Design learners is a *CAPS* compliant textbook. Teachers can select from a number of DBE-approved textbooks.

(f) **Practice and drawing fitness:** Ongoing and regular practice is essential in developing and maintaining a high level of skill and the ability to draw quickly, accurately and neatly. Preparing a drawing requires the constant manipulation of drawing instruments, which is both tiring and time-consuming. In order to be able to complete an examination paper in the allocated time, learners must be *drawing fit* and this is only achieved through physically drawing and more specifically, drawing within specified time limits.

7.3 ANALYSIS OF LEARNER PERFORMANCE IN EACH QUESTION IN PAPER 1

QUESTION 1: CIVIL ANALYTICAL

The subquestions in Q1 covered a variety of civil concepts, in particular: the *site plan*, *civil title panel* and the *SANS 10143 Code of Practice for Building Drawing*. The weaker candidates, who seemed to be poorly prepared for the examination, continued to be challenged by some of these topics, while many of the stronger candidates, who were well-prepared, were able to show insight and understanding and achieved good marks.

The first few questions were generally answered very well by a large percentage of the candidates as each of these subquestions were set at a lower cognitive level and at an easy to moderate level of difficulty.

The middle set of subquestions were less predictable and therefore slightly more challenging as they required recall and knowledge of the *SANS 10143* and were set at a middle cognitive level.

The last few questions were set to be more challenging as they examined the application of the *SANS 10143* content and mathematical concepts in a civil context and were at a higher cognitive level. Although these questions should have been reasonably predictable, it was once again disappointing to note that many of the more able candidates were still unable to answer them correctly.

Common errors and misconceptions

(a) Many candidates were challenged by questions that come from the *SANS 10143 Code of Practice for Building Drawings.* The answers to both Q1.13 (*identification of adjacent building on Lot 24*) and Q1.16 (*what colour must the new walkways be indicated on the site plan*), can be found in either the *SANS 10143* or any of the DBE-approved textbooks. It appears that either the contents of the *SANS 10143* were not adequately covered or that the candidates were not in possession of a mandatory textbook.

(b) Many candidates had a problem determining '*which elevation of the new fast-food outlet faces 7th avenue*' in Q1.17. It is crucial that learners are taught that in civil drawing the *geographic direction* that the surface of a structure faces determines its elevation. This is different from *orthographic projection* where the direction from which an object is viewed determines the view.

(c) Very few candidates were able to convert from metres to millimetres and vice versa. This knowledge was required in Q1.15, Q1.18 and Q1.21. In Q1.18, for example, the dimension *4,8* m should have first been converted to millimetres (*4 800* mm) and then subtracted from the dimension given on the drawing, which was already in millimetres: (4 800 - 3 000 = 1 800 mm)

(d) It was disappointing to see how few candidates were able to differentiate between *perimeter* and *area*. Q1.19 required the perimeter of the boundary to be calculated using a basic mathematical calculation by adding lengths, which were all given in millimetres. The answer then had to be converted into metres. Q1.20 was a difficult higher cognitive level question requiring more mathematical ability by first dividing the building into calculable rectangles, then adding together the areas of each rectangle.

ANSWER 19
Show ALL calculations.
APPLYING CORRECT FORMULA ✓

P = AB + BC + CD + DE + EF

= 40 + 48 + 23,34 + 7,5 + 44,56

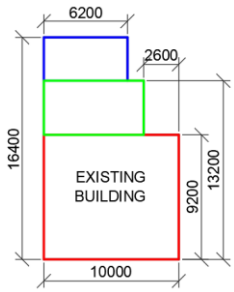
= 163,4 m ✓ ANSWER IN METRES ✓

ANSWER 20
Show ALL calculations.
APPLYING CORRECT FORMULA ✓

A = (10 x 9.2) + (7,4 x 4) + (6,2 x 3,2)

= 92 + 29,6 + 19,84

= 141,44 m² ✓ ANSWER IN SQUARE METRES ✓



(e) The printing of the answers on many scrips was unacceptable. Often the printing was presented in pen and was very often illegible. The *SANS 10143* stipulates the type of printing that must be used on drawings. This must be adhered to in all aspects of drawing.

(f) Neatness and proportion are two fundamental requirements that candidates are expected to adhere to when they draw in *neat freehand*. Candidates often overlook these criteria when preparing freehand drawings. All work in Engineering Graphics and Design must be presented neatly. Q1.21 clearly states that the drawings must be presented in *neat* freehand and in a *First-angle Orthographic Projection*. Most candidates appeared to have disregarded both these instructions, with the freehand line work of candidates being generally poor. Candidates must take care when drawing graphic symbols or conventions.

Suggestions for improvement

(a) Teachers must be in possession of the *SANS 10143 Code of Practice for Building Drawings* and regularly refer to the contents. Every learner must be in possession of a DBE-approved textbook. The civil content must be taught and can be reinforced by giving learners short formative tests which will also serve as useful revision of work.

(b) Learners acquire knowledge according to the way they are taught. It is unfortunate that many teachers appear not to be conversant with or to use the correct terminology in the classroom. The only way that learners will learn the correct technical terms and terminology is if the teacher uses them continually and correctly.

(c) If learners are taught to read with understanding, this will help them to comprehend the requirements of a question and then possibly answer it appropriately. Learners must be taught to provide relevant and detailed responses to questions. Teachers can assist learners by providing them with a wide variety of questions on civil content, and in particular, past NSC examination papers with the marking guidelines.

(d) Learners must practise applying the mathematical formulae for determining perimeter and area. Including these calculations in short formative tests can serve as reinforcement and revision. Learners should be taught and they must practise converting millimetres to metres and vice versa.

(e) The quality of a learner's line work is assessed in the Practical Assessment Task (PAT). This does not mean that freehand work should be presented poorly in an examination. There are far too many candidates who present unacceptably untidy and meaningless freehand drawings. All work presented in freehand must be graphically and proportionally correct, meaningful and neat. Printing must also be prepared correctly and neatly. This requires practice and monitoring by teachers.

(f) Subject advisors should convene regular content workshops with their drawing teachers to help those teachers who are experiencing challenges with content and offer support where it is required.

QUESTION 2: SOLID GEOMETRY

A number of provinces reported that there was a slight improvement in the ability of the candidate to construct regular polygons and to copy the given information. However, there were still far too many centres in every province where the candidates experienced a number of challenges.

It is important to note that the question was designed to allow the weaker candidate to project three views of the right regular hexagonal prism and the slightly more able candidate to place the right square-hole in its designated position through the hexagonal prism. The top candidates should have been able to place and draw the right regular pentagonal pyramid. All the candidates should have been able to project, cut and hatch the cut surface of the part that they drew.

Common errors and misconceptions

(a) *Orthographic projection* is a fundamental concept that is introduced in the Grade 10 year. Many candidates were unable to differentiate between first-angle and third-angle *orthographic projection*, incorrectly placing the left view on the left of the front view. Many then truncated the incorrect piece of the solid in the sectional view. It remains unclear as to whether this was a reading problem, a planning problem or a lack of understanding of the concept. Point 3 under *Instructions and Information* on the cover page of the examination paper states: '*ALL drawings are in first-angle orthographic projection*'.

(b) The first bullet of the *Instructions* on the question states clearly: '*Planning is essential*'. The lack of ability to plan resulted in candidates experiencing challenges when positioning the views. This question required careful planning in order to fit the views into the correct position on the drawing sheet.

(c) Candidates continued to have difficulty constructing polygons, particularly when having to construct a polygon that has been rotated out of the 'simple' position. The pentagon required the candidate to construct the hexagon first, then measure, using a protractor correctly, the external angle of 72º off the 60º common base edge.

(d) It was most unfortunate that far too many candidates in all the provinces were unable to project, determine and draw the sectioned left view. It must be noted that when hatching the cut surface of different solids, the hatching on each surface must lie in alternate directions.

(e) What did appear to be a problem with the candidates not *reading with meaning* was the substantial number of candidates who did not include the hidden detail in the answer. The question clearly stated that the candidate must: '*Show ALL hidden detail*'.

Suggestions for improvement

(a) One of the topics in the Grade 10 *CAPS* (page 8) is first-angle and third-angle orthographic projection. It is not only important that these topics are taught but that the teacher regularly emphasise the difference between the angles.

(b) Planning is an essential skill in drawing and takes time to master. As long as teachers insist on giving their learners prepared answer sheets, where learners simply have to produce the required answer, candidates will continue to struggle with planning in an examination. The use of prepared answer sheets must be discouraged, as it diminishes the learners' ability to start an answer because they have been deprived of the regular practice they need in drawing the basic elements.

(c) Understanding the abstract concepts of drawing and projection starts in Grade 10. Drawing and projecting right regular prisms and pyramids are the fundamental building blocks that form the basis for all technical drawing and require continuous practice and understanding, perception and graphic problem-solving skills. The inability of candidates to construct a Grade 10 polygon reinforces what has been mentioned above. If the teacher uses prepared answer sheets with the basics already drawn for the learner (because it is 'easier' for the teacher), the learner will never get the opportunity to practise constructing the polygon.

(d) The ability to visualise a three-dimensional object drawn on a two-dimensional surface is challenging for many learners. This skill is developed through ongoing and regular practice by preparing drawings of relevant complexity. Adding numbers or letters to the base corners of a polygon is a method teachers can encourage their learners to use. This will assist learners either in speeding up their drawing or arriving at a solution without necessarily being able to visualise the answer. It is important to note that the *SANS 10143 Code of Practice for Building Drawings* along with *SANS 10111* stipulates that adjacent surfaces must be hatched in alternate directions.

(e) Teachers must encourage their learners to *read with meaning*, in other words, not only must the learners read the given instructions but they must also understand what they have to do.

(f) Subject advisors should identify underperforming schools, as informed by the analysis of results, and support teachers by providing relevant material on an ongoing basis, rather than engaging in damage control prior to the examinations.

QUESTION 3: PERSPECTIVE DRAWING

The perspective question was not answered as well as it had been answered previously. What is rather disappointing and somewhat concerning is that all the issues that were raised in last year's analytical report are exactly the same issues that were found during the marking of this year's examination.

Common errors and misconceptions

(a) Far too many of the candidates were unable to determine the position of the two vanishing points accurately. This was the easy lower cognitive level part of the drawing, with the result that whatever was drawn from that point on, was incorrect.

(b) There were still many candidates who moved the position of the given *Horizon Line (HL), Picture Plane (PP)* or/and *Ground Line (GL)*. Moving these lines could possibly alter both the cognitive levels and levels of difficulty of the question.

(c) Many candidates were unable to determine height lines correctly and were therefore unable to determine the height of the receding parts of the *drive-through ticket booth*.

(d) A large number of candidates produced poor quality line work that was inaccurate and untidy. This made it difficult to assess whether the candidates understood what was supposed to be drawn.

(e) The receding portion of the *drive-through* was poorly attempted with the semi-circular portion of the structure not being attempted by many of the candidates. Many of those who attempted the semi-circular base used an inaccurate method to determine the perspective curve and the quality of their perspective curves was poor.

Suggestions for improvement

(a) Determining the vanishing points correctly is fundamental to preparing the perspective drawing and is considered to be at the easy, lower cognitive level. Teachers must ensure that all learners are able to perform the basics by teaching the fundamentals of perspective drawing along with the methodology and terminology pertaining to the topic. Ongoing and regular practice is necessary in developing and maintaining a high level of skill and the ability to draw accurate and neat perspective drawings.

(b) It must be made clear to the learners that the position of the given *Horizon Line (HL), Picture Plane (PP)* and *Ground Line (GL)* must not be moved. Projection or construction lines are B-type lines that must be visible. Learners must be informed not to erase the construction lines as they are important to show the method used to determine the answer when marks are allocated.

(c) The height of an object can only be determined in the picture plane. This is why it is important for the teacher to reinforce the method of first determining the height of an object in the picture plane, then applying the method of moving the object to its correct perspective position. This is done by joining the heights of an object to the correct vanishing point.

(d) Teachers need to address challenges in drawings such as inaccuracy, untidy and incorrect line work as well as poor printing techniques before they become issues which cannot be fixed. This should start in Grade 10 and continue through to Grade 12.

(e) Drawing a perspective semi-circle is a challenging process which requires in-depth knowledge and skills to project correctly and accurately. It is expected that even the weaker candidates who experience challenges with drawing, should demonstrate some basic knowledge by being able to divide the views of the semi-circle into 30˚ segments.

(f) The complexity of a perspective drawing increases as the drawing is built up by the ever-increasing number of lines used to find the points in perspective. Learners need to be taught to work through the drawing systematically so that they do not waste time determining the same points multiple times.

(g) It is imperative that teachers provide learners with relevant course drawings which are at the level of complexity that is expected of the Grade 12 learner and ensure that the learner engages with these drawings meaningfully.

QUESTION 4: CIVIL AND ELECTRICAL ASSEMBLY

The civil assembly question involves working with complex graphic detail, numeric data and verbal information that require in-depth understanding, the ability to read with meaning and the application of civil drawing practices as contained in the *SANS 10143 Code of Practice for Building Drawings.*

The answer is divided into three subsections: the floor plan, which was well answered; the north-east elevation which was less well answered; and a detailed sectional view, which is drawn to a larger scale than the other two views. The detailed sectional view proved to be challenging to most candidates.

The question was designed in such a way that all candidates who applied themselves and practised, using previous NSC examination papers, should have been able to complete at least part if not most of each subsection.

Many of the weaker candidates appeared to have become overwhelmed with processing the information and possibly found it challenging. It is imperative that candidates answer Q4 as it carries the bulk of the marks.

It was encouraging to see that the question was attempted by the majority of candidates and showed a slight improvement in results.

Common errors and misconceptions

(a) FLOOR PLAN

Common errors drawing windows and doors:

- Windows were not drawn using the given dimensions shown in the window schedule but simply drawn to fill the gap in the wall on *Answer Sheet page 6*. The window sill was omitted by most candidates.
- In some instances the doors were not drawn to the correct size and the arc of the door swing was drawn in freehand. The arrow indicating which sliding door opens was omitted.

Common errors drawing electrical layout:

- When candidates added the electrical fittings to the floor plan, it was often poorly executed, showing a lack of knowledge. The symbols were often haphazardly placed and poorly drawn.
- The irregular curve connecting the light fitting to the light switch was incorrectly joined to the 'flag' and not to the circle.
- Labelling of the fluorescent light was poorly attempted.

Common errors drawing fixtures:

- It was disappointing to note that most of the candidates still drew fixtures as shown in the fixture table rather than converting them to the required *SANS 10143* symbols. The purpose of the table of fixtures is only to inform the candidates of the measurements.
- The fixtures were not drawn accurately using drawing instruments.

Common hatching errors:

- There was a general improvement in the quality and correct application of hatching from previous years. There were, however, still many candidates who

applied mechanical hatching to the walls and did not clearly show the double parallel lines at 45° as required.

Common errors with the labels:

- The majority of candidates did not label the floor finishes which can be attributed to not reading the instructions as the room designations were given. Labels must always be printed neatly to the correct size and using the correct font.

(b) NORTH-EAST ELEVATION

Common projecting errors:

- The method of projection from one view to another view is a fundamental drawing technique practised every lesson. It raised a red flag when a substantial number of candidates could not project the window, sliding door and window or the front step with side walls off the floor plan. There were many candidates who could not apply a scale or transfer measurements correctly either.

Common errors drawing the roof:

- There was a general problem with accuracy in determining the 20° roof angle on the north-east elevation. It must be noted that as accuracy is a fundamental and essential drawing skill, a deviation of only 1° is permissible on any angular measurement.
- The height of the roof was often incorrectly determined because many candidates cannot determine an angle using a protractor.
- The ridge cover (parallel line) proved to be an even greater challenge even though the measurements were given.
- There were fewer candidates who drew the fascia board and gutter incorrectly; they often used the break lines as shown. However, there was still a large number of candidates who showed a lack of knowledge in the application of break lines. This error also demonstrated that candidates were either not reading the question carefully or that the learners had not been prepared adequately for the examination.

Common errors drawing the window, door and front steps:

- The height of the window was often incorrectly determined and the window sill omitted by many of the candidates. It is difficult to assess whether this was a reading, measuring, accuracy or knowledge mistake as any of these could have been the reason for the error.
- The window opening lines as well as the window sill were mostly omitted or poorly attempted.
- The height of the finished floor level *(FFL)* was not always determined correctly.
- Many candidates appeared not to be able to correctly measure the height of the stairs and did not include the side walls.

Common errors with the labels:

- Labelling of the *FFL* and *north-east elevation* were often omitted. Most of the candidates' printing was of a very poor quality.

(c) DETAILED SECTION

- The detailed section covers the full range of cognitive levels but leans somewhat more towards the middle to higher cognitive levels. Fewer candidates attempted the detailed sectional view, prepared to scale 1 : 20, than the other two views. Many of those who attempted this drawing applied the scale correctly.

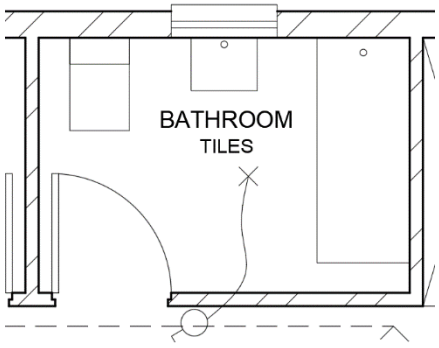
- The roof detail is Grade 12 content and was not well answered. Many candidates showed very little knowledge of the roof detail. Of those candidates who attempted to draw the 8 roof components, on the detailed section, many did not draw all the components accurately or correctly. The most common errors were that candidates either left off components or drew them to the incorrect scale or angle. This is an indication that either the learners were not given sufficient practice drawing roof detail or were not taught how to draw roof detail.
- The window behind the cutting plane was attempted by very few candidates who had varying degrees of success positioning it or drawing it correctly. It must be stated that the window was intended to be drawn by only the top candidates as it fell into the category of the difficult higher cognitive level.
- Hatching the different components on the sectional view was generally messy and often not presented according to *SANS*.

Suggestions for improvement

The basic format of this question has remained relatively constant for a number of years. One of the underlying problems is that this topic is covered very early in the first term. To refresh their memory, learners must be given revision drawings, preferably using past *NSC* examination papers, throughout the year.

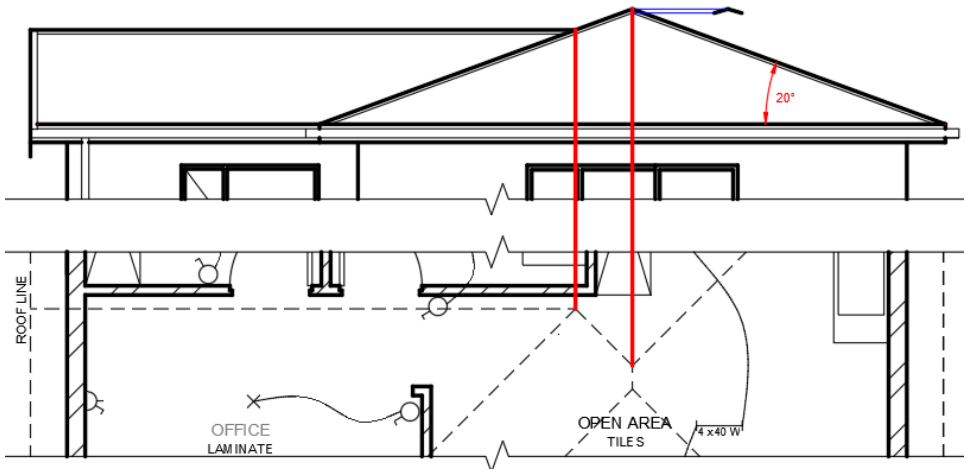
(a) FLOOR PLAN

- Weaker learners must be advised to start Q4 by completing the floor plan and to follow the instructions correctly. Learners must be taught how to print the required labels correctly, taking note that the requirements may change from year to year. Learners must be taught how to add the electrical layout to a drawing by using the correct fittings and drawing the connections to the circular part of the light switch and not the 'flag'. Learners must also be taught how to draw doors and windows correctly, to the correct size and how to complete the hatching detail according to the *SANS 10143*. It must be pointed out that the window and door frame should be drawn as a set of parallel lines situated in the middle of the wall. The window sill is then a single line that protrudes outwards beyond the wall.
- The tables on the question sheet that contain information should be used correctly. The window and door schedule gives the sizes of these features. The relevant electrical symbol must be selected from the table and correctly transferred to the drawing. The learners must have access to and learn the *SANS 10143* graphical symbol for the fixtures and apply them using the dimensions given in the table. The positioning of the text on the *incomplete floor plan* indicates the orientation and placement of the fixture. Hatching must be added using drawing instruments and not in freehand.



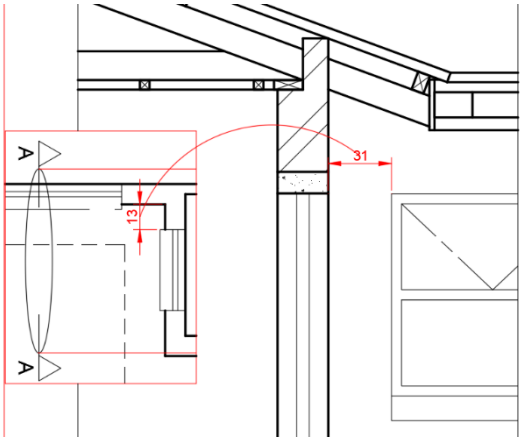
(b) NORTH-EAST ELEVATION

- In order to prepare an elevation, there are three general areas which the teacher needs to concentrate on. These are: basic projection techniques, drawing the roof and accuracy.
- Projecting requires selecting the necessary information off the floor plan and projecting it to the elevation.
- The **projection** of the roof off the floor plan is a Grade 12 topic and can be challenging. Once the detail and the method have been taught, the learner must practise projecting the roof.



(c) DETAILED SECTION

- The **detail** of a roof is Grade 12 content. Learners must be taught the order in which the roof components appear, then practise drawing them correctly and accurately.
- The same applies to the *SANS* hatching patterns used to differentiate the various elements in the sectional elevation.



(d) Teachers should have an ample supply of resources for the learners to prepare for this topic. The minimum requirements must be a copy of the *SANS 10143 Code of Practice for Building Drawings*, a DBE-approved textbook and past NSC examination papers.

(e) It is imperative that course drawings are set at an appropriate level so that learners can engage meaningfully with work at the required level.

(f) All drawings must be prepared using drawing instruments and learners are expected to be skilled in using them correctly. It must be noted that any work presented in freehand, unless specified in the question, is not marked, even if correct.

(g) Learners should not be expected to sit for an examination without being taught time management. This objective can only be realised by setting course drawings that must be completed within specified time constraints.

(h) Subject advisors must address the issue of *Language Across the Curriculum* by providing opportunities for teacher development on an ongoing basis.

(i) It is important that every topic should be introduced by first briefly revising previously taught concepts and terminology pertaining to that topic. This should enable learners to make connections between old and new knowledge. If learners get the basics right, the more challenging concepts will be easier to grasp.

7.4 ANALYSIS OF LEARNER PERFORMANCE IN EACH QUESTION IN PAPER 2

The candidates performed better in Paper 2 this year than they have in the past number of years despite the debate raging over why many candidates were unable to complete the paper in the given time. Were they not able to finish because the paper was too long? Were the candidates adequately prepared? Did writing in the second session, after they had sat for a challenging three-hour paper in the morning, affect their performance? The real reason for their failure to complete the examination remains undetermined. It is also not clear whether candidates managed their time optimally.

It was evident that all the questions were answerable, not necessarily by the same candidates. There were candidates in every province who managed to complete the paper and achieved very good marks. The paper was not longer or shorter than any previous year's paper.

QUESTION 1: MECHANICAL ANALYTICAL

The marks obtained by candidates across the country in Q1 showed a slight improvement from the 2022 results. However, there were still far too many candidates who displayed a lack of knowledge in certain areas, which suggests that either they were not prepared to sit for the examination or they may not have had a suitably qualified teacher to guide them through the work.

The first few subquestions were set at an easy to moderate level of difficulty, at the lower cognitive level, and did not pose a problem for the majority of candidates. The middle set of subquestions was less predictable and therefore a little more challenging as it required the recall of knowledge of the *SANS 10111 Code of Practice for Engineering Drawing.* These questions were set at a middle cognitive level and proved to be more of a challenge. The last few questions were the most challenging as they examined the application of the *SANS 10111 Code of Practice for Engineering Drawing* content with mathematical concepts in a mechanical context. These were set at a higher cognitive level. Although these questions were reasonably predictable, the responses remained disappointing.

All the questions covered a variety of mechanical concepts; the weaker candidates continued to be challenged by these topics. However, the more capable candidates who were able to show insight and understanding achieved good marks.

Common errors and misconceptions

(a) A matter of concern was the large number of candidates who displayed poor reading and comprehension skills when answering the subquestions. This was evident in answers that many of the candidates submitted that had no relevance to or bearing on the question being asked.

(b) A large percentage of candidates showed a lack of understanding regarding third-angle orthographic projection in Q1.14 (*identifying the view*) and Q1.20 (*the freehand drawing of the projection system used*).

(c) Many candidates failed to calculate the minimum or the maximum tolerance of the dimension at *J* (8 mm) in Q1.16 correctly. Whether candidates had a reading problem, a terminology problem, a mathematical problem, or a knowledge problem, is difficult to determine.

(d) Very few candidates managed to identify the (*0,2*) value on the machining symbol as the roughness value in Q1.18, which suggests that they were either not adequately prepared to write the examination or that they were not taught to read a machining symbol.

(e) A number of the subquestions in Q1 came directly out of the *SANS 10111*, covering concepts that are generally used in most aspects of the mechanical drawing. The relevant questions were: Q1.4, Q1.7, Q1.7, and Q1.11 to Q1.14 and Q1.17 to Q1.20. These questions ranged from easy lower cognitive level questions to difficult higher cognitive order questions. Many of the candidates displayed little, if any. knowledge of the contents of the *SANS 10111.*

Suggestions for improvement

(a) Teachers must address the issue of *language across the curriculum* by teaching learners to *read with meaning* which will help them to understand and apply terminology correctly. Teachers must make use of past NSC examination papers as a resource that benefits every learner by teaching them the terminology used in a drawing and the way in which questions are phrased.

(b) A thorough understanding of the concept of *third-angle orthographic proj*ection is fundamental for the learners to be able to complete this paper. It is important that the teacher regularly emphasises the difference between *first-angle and third-angle orthographic projection*, so the learner becomes familiar with the subtle differences between the two and can apply the concepts in any context. It is also necessary to be taught the orthographic symbol of projection.

(c) Calculating tolerance is a simple mathematical process that has been asked before. Learners must be taught how to identify and apply tolerance to a dimension and particularly the mathematical process of determining a tolerance. They need to practise the concept by applying it to a number of dimensions.

(d) It is essential that every drawing teacher has a copy of the *SANS 10111 Code of Practice for Engineering Drawings* in his/her classroom as the content is fundamental to all teaching of engineering (mechanical) drawing. It contains all the concepts that are used in most aspects of the mechanical drawing. It is also essential that every learner has a DBE-approved textbook.

(e) Engineering Graphics and Design is both a knowledge and a skills-based subject. Many different analytical exercises should therefore be completed so that learners can learn how to read and become familiar with technical terms. They also need to be taught how to analyse and interpret analytical drawings.

(f) To balance the predictable nature of this question, examiners will always strive to be restrictively creative when designing subquestions. Teachers can assist learners by providing them with a wide variety of questions on mechanical content, and in particular past NSC examination papers with marking guidelines.

(e) Subject advisors or subject coordinators should convene regular content workshops to help the teachers who are experiencing challenges with content and offer support where it is required.

QUESTION 2: LOCI

More candidates attempted Q2 in 2023 than they did in previous years, achieving marginally better results, which is a positive indicator. However, candidates appeared not able to *read* Q2.1 *with understanding* and showed little ability with regard to the cam in Q2.2.

There were centres in all the provinces where the candidates performed well above the average. However, there were far too many centres in every province where the candidates experienced challenges.

Common errors and misconceptions

2.1 THE MECHANISM

(a) Many candidates managed to copy the given schematic diagram correctly, which did not require reading or understanding but simply copying given information.

(b) Most of the candidates who managed to draw the schematic diagram correctly appeared not to understand how to determine the movement of the mechanism. Whether this was a reading issue, a lack of understanding issue or the lack of teaching of the technique of determining the loci issue, will only be known once the variables are removed.

(c) It appears that some candidates may have had problems with the terminology (*sliding rod, pin-jointed, crank and oscillate*) that described the movement of a mechanism. This was displayed by their inability to determine the *oscillating locus* of point E, or the *elliptical movement* of point C. The locus of point C was designed to be at a difficult higher cognitive level.

(d) A concerning trend was the number of candidates who divided the circle into 8 segments, not the standard 12, not showing the required construction needed to determine the loci.

(e) Candidates tended to not use the correct line types (centre line, construction line and outline).

2.2 THE CAM

(a) Despite presenting the cam in a slightly unfamiliar format, more candidates attempted the cam (Q2.2) than the mechanism (Q2.1), with many of them achieving good marks.

(b) Far too many candidates still had challenges with the construction needed to determine the *uniform acceleration and retardation* movement and could not divide the horizontal and vertical axes on the displacement graph into the same number of divisions as is required. What was concerning was that candidates still confused *uniform acceleration and retardation* movement with *simple harmonic motion.*

(c) The majority of candidates did not read the instructions carefully which was evident by their not labelling the graph or indicating the direction of rotation of the cam, both easy lower cognitive level additions.

(d) In many instances the line work was exceptionally poor. Candidates displayed no differentiation in the application of the different line types, including poor quality curves.

Suggestions for improvement

2.1 THE MECHANISM

(a) All the topics in the *CAPS* must be taught. If the *ATP* is adhered to there should be enough time to complete every topic. Ongoing and regular practice of the basic concepts is essential in developing and maintaining a high level of skill and ability.

(b) Understanding the movement of the mechanism is crucial to being able to determine the locus of a point on the mechanism. There are many commonalities between the various types of mechanisms and if these are explained to the learners, they should be less overwhelmed when they have to determine the movement of a point on a mechanism that they have not seen before.

(c) Teachers must explain the terminology that describes the movement of a mechanism to the learners in order for them to understand what is happening at each point during the movement.

(d) Candidates must be instructed not to erase the construction they use as it shows the method used to determine the answers. They should also be taught the correct use of line types as drawing is a universal language and the line type used informs the person reading the drawing of its intention.

2.2 THE CAM

(a) It is only once learners are familiar with a topic that they are able to address that topic in an unfamiliar format. This can easily be overcome by teachers using past NSC examination papers as a foundation for both their lesson plans and as revision.

(b) There are three motions of a follower that are taught at school. These are: *uniform motion, simple harmonic motion and uniform acceleration and retardation*. These have to be carefully explained to learners and then practised. The more practice the learners are able to get, the less the chances are that they will make unnecessary mistakes under stressful conditions.

(c) Learners acquire knowledge according to the way they are taught and it is unfortunate that many teachers appear not to be conversant with or use the correct terminology in the classroom. The only way that learners learn the correct technical terms and terminology is when the teacher uses them correctly and continually. If learners are

taught to read with meaning, it will help them understand the requirements of a question.

(d) Construction lines are lighter than outlines and must not be erased. These guide the marker on the possible method that the candidate used to determine the answer. Marks are often allocated for showing method.

(e) Subject advisors or subject coordinators should convene regular content workshops to help the teachers who are experiencing challenges with content and offer support where it is required.

QUESTION 3: ISOMETRIC DRAWING

Converting an *orthographic* drawing into an *isometric* drawing remains one of the more challenging topics in drawing. Most of the candidates attempted the *isometric* drawing with a large number of them obtaining satisfactory results. There are still some areas of concern.

Common errors and misconceptions

(a) Learners often have challenges converting a 2-dimensional (*orthographic*) drawing into a pictorial (*isometric*) drawing.

(b) Many candidates did not show the auxiliary views of the half hexagon or the 60º dovetail, both essential for determining the non-isometric lines. Some candidates who realised that auxiliary views had to be drawn, had challenges transferring the dimensions from the auxiliary view to the isometric drawing correctly and accurately.

(c) Candidates appeared to still be challenged by the isometric circle construction: many of them who managed to construct the isometric circle correctly, did not include the mandatory centre lines.

(d) The inclusion of the half-section in the drawing was of a higher cognitive level and was not attempted by a large proportion of the candidates.

(e) Many candidates demonstrated poor drawing skills as they drew inaccurately. In many instances, the line work was untidy and of a poor quality. Some candidates completed the isometric drawing in construction lines only and did not use the mandatory A-type lines.

Suggestions for improvement

(a) Acquiring the skill to prepare an isometric drawing requires much practice. The practice revolves mainly around developing the ability to convert a 2-dimensional, third-angle *orthographic* drawing into an *isometric* drawing by linking the features in each view and placing them in the correct place. This skill takes many learners a long time to acquire.

(b) Learners need to be taught that angled lines generally cannot be drawn as isometric without first drawing them as a flat auxiliary view. After drawing a box around the angled line on the auxiliary view, the box can then be transferred to the isometric drawing and the angled line added. This method requires a lot of practice.

(c) Constructing an isometric circle or semicircle is a Grade 11 concept. The method that must be used requires the learner to use a compass to draw the ellipse. Freehand curves are unacceptable and are therefore not marked. Learners must remember to draw centre lines in circular objects.

(d) It must be remembered that the sectioned surfaces in an isometric drawing follow the same hatching technique as in mechanical drawing where adjacent surfaces are hatched in alternate directions.

(e) Accuracy is a fundamental and essential skill in drawing. This is especially so in isometric drawing in order to get the different features on the drawing to align. Drawing equipment, if used regularly, needs to be replaced when the numbers and divisions become faded to the extent that they can no longer be seen.

(f) It is imperative that the teacher provides learners with a suitable number of relevant course drawings from Grade 10 to Grade 12 and at the expected level of complexity. It is important that Grade 12 learners engage with the work meaningfully, in order to fully prepare themselves for the examination. Teachers can assist learners by providing them with a wide variety of examples to expose them to as many different isometric questions as possible, and especially past NSC examination papers, with marking guidelines.

QUESTION 4: MECHANICAL ASSEMBLY

A mechanical assembly drawing requires the understanding of the interrelationship between graphic information and numeric data that includes the application of mechanical drawing practices as contained in the *SANS 10111 Code of Practice for Engineering Drawings,* and the ability to follow instructions.

The question was designed in such a way that all candidates who prepared themselves through adequate practice and using previous NSC examination papers, should have had access to at least part of each subsection.

It appeared that the question was answered more satisfactorily in this examination than in previous years. There was still an unacceptably large number of weaker candidates who appeared to have become overwhelmed with processing all the graphic and numeric information and who found this question very challenging.

Common errors and misconceptions

(a) Most candidates attempted this question with a wide variety of results. Many completed both the required views while the majority only managed one of the views. The reason for this is unclear. It could be attributed to one or more of the following: poor time management, not reading the question with understanding, a lack of practice or not being drawing fit.

(b) Candidates showed little understanding of third-angle orthographic projection through either placing the required views in the incorrect position or drawing the views by looking at them from the incorrect direction.

(c) Many candidates showed little to no understanding of the rules of sectioning which are comprehensively covered in the *SANS 10111 Code of Practice for Engineering Drawings* and all the DBE-approved textbooks.

(d) The construction of the M10 hexagonal bolt was particularly poorly executed. There were too many candidates who showed little to no knowledge of how to construct the required three faces of a hexagonal fastener.

(e) There was a significantly high number of candidates who simply redrew the individual parts of the assembly without assembling them, and who were heavily penalised for this. When candidates could not apply the concept of assembling mechanical parts correctly, they altered the cognitive level of the question significantly and undermined the essence of the question.

(f) There were unnecessary but general mistakes made by many candidates. These included omitting centre lines which should have been copied across from the parts sheet and poor planning.

(g) The presentation of the candidates' line work was well below the expected standards of competency and skill. Many candidates were also inaccurate with measurements which compounded their challenges.

Suggestions for improvement

(a) Teachers must have an ample supply of resource material to prepare for this topic. The minimum requirements would be a copy of the *SANS 10111 Code of Practice for Engineering Drawings*, a DBE-approved textbook and past NSC examination papers. Course drawings must be set at an appropriate level so that learners can engage meaningfully with the work at the required level. One of the underlying problems with mechanical assemblies is that it is covered very early in the year. It is therefore necessary for learners be given regular revision drawings throughout the year to prepare them for the end-of-year examinations.

(b) *Orthographic projection* is a fundamental concept that is introduced in the Grade 10 year. Many candidates were unable to differentiate between *first-angle and third-angle orthographic projection*, incorrectly placing the views or viewing them from the wrong direction. It remains unclear as to whether this was a reading problem, a planning problem or a lack of understanding of the concept. Point 3 under *Instructions and Information* on the cover page of the examination paper states: '*ALL drawings are in third-angle orthographic projection*'.

(c) The rules of hatching used to differentiate the various parts in a sectional view are contained in the *SANS 10111* and all DBE-approved textbooks. The rules of hatching, along with the various types of sectioning, must be addressed.

(d) The construction of a hexagonal fastener is a Grade 11 topic as mentioned on page 21 of the *CAPS*. Many learners at the end of their Grade 12 year are still unable to construct hexagonal fasteners considering that they appear in every mechanical assembly drawing, in every DBE-approved textbook and every past NSC examination paper.

(e) There is a heavy penalty imposed on candidates who are unable to assemble the individual parts of Q4 as they are only showing lower cognitive level functioning. Learners must be taught how to read the information given to them on the *exploded isometric* drawing, which shows the position of each part of the assembly, relative to all the others. The intention of the *exploded isometric* drawing is to help the candidate to visualise both the general shape of the parts, and the sequencing of the parts in the assembly.

(f) Accuracy is a fundamental aspect when preparing drawings. A tolerance of only 1 mm is allowed when marking a drawing. Learners must be regularly informed of the necessity to work accurately. All drawings must be prepared using drawing instruments

and learners are expected to be skilled in using them correctly. It must be noted that any work presented in freehand, unless specified in the question, is not marked, even if correct.

(g) Learners should not be expected to sit for an examination without being taught time management. This objective can only be realised by setting course drawings that must be completed within specified time constraints.

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