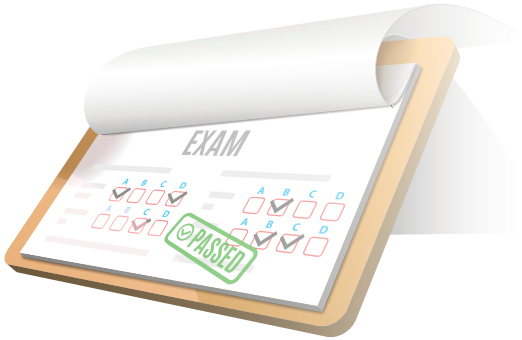


NATIONAL SENIOR CERTIFICATE 2022

DIAGNOSTIC REPORT

PART 3: TECHNICAL SUBJECTS

AVBOB MUTUAL SOCIETY
Massmart powered by Walmart
IDC Industrial Development Corporation Your partner in development finance
OLDMUTUAL
MTN
Connecting for Good Vodacom Foundation
basic education Department: Basic Education REPUBLIC OF SOUTH AFRICA
KAGISO TRUST Overcoming poverty
Know more. Be more. FUNDI
Read to Lead A Reading Nation is a Leading Nation
2030 NDP
STAY SAFE PROTECT SOUTH AFRICA TOGETHER WE CAN BEAT CORONAVIRUS

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Foreword from the Minister

The Grade 12 Class of 2022 is extraordinary – a description reserved for only the remarkable!

Since the pandemic began in 2020, the well-being of young people enduring unprecedented challenges was one of the major concerns of the Department of Basic Education (DBE).

The year 2020, when the Class of 2022 faced great uncertainty in their Grade 10 year, is most certainly not a year on which we will look back with undiluted pleasure.

Yet the Class of 2022 forged ahead, and despite the myriad of challenges, these champions sat for the November 2022 National Senior Certificate (NSC) Examinations and have produced results that attest to resilience and fortitude.

As we reflect, we recall the words of President Nelson Mandela who reminded us that *'everyone can rise above their circumstances and achieve success if they are dedicated to and passionate about what they do'*. The Class of 2022 mustered the courage and they have proven to the South African nation that success can be a reality amidst great adversity.

The NSC remains one of the most important barometers of the health of the South African education system.

The DBE is in the process of integrating more holistic indicators of success across the various components of the system and one of them is the model for Systemic Evaluation, which will provide a more in-depth and comprehensive report on the performance of the system.



All indications prior to COVID, confirmed that we are a system on the rise. COVID has been a setback but the Class of 2022 affirmed that we are clawing back the gains made during the pre-COVID years.

The Class of 2022 were the beneficiaries of significant learner support programmes implemented to ensure that quality education is offered to all our learners. The Grade 12 class of 2022 benefited from differentiated targeted learner support programmes; such as extra tuition over weekends, vacation classes, the provision of additional learning and teaching support material (LTSM), revision guides, School Based Assessment (SBA) exemplars, broadcast lessons, online and radio lessons, content, and pedagogy workshops for teachers.

The Learning Recovery Plan of the DBE, which resulted in a trimming of the curriculum and a revision of the assessment programme for all grades, has allowed the system to focus on core content and skills and explore other forms of assessment, which are more relevant.

At the centre of the Learning Recovery Plan, was an assessment of the learning deficits and the development of learning programmes to address these deficits. The system has also over the years, established a strong data-driven focus of monitoring and feedback; and hence, there is a continuous identification of gaps and weaknesses in the system, and the implementation of initiatives to address these gaps.

The DBE is committed to a comprehensive curriculum strengthening process that will take into cognisance learners' competencies that they need to thrive socially and economically in a fast-changing world.

Efforts are afoot to infuse a skills-based focus into the existing curriculum. In 2022, Marine Sciences was offered for the second time as an examinable subject in the Grade 12 NSC Examinations. Various technical vocational specialisations, including Civil Technology, Electrical Technology, Mechanical Technology, Technical Mathematics and Technical Sciences were offered for the fifth year, since their introduction in 2018.

The ultimate intention is to make schools not only sites of academic achievement, but also sites of vocational and occupational skills development.

As a Department, we will work without ceasing to support candidates who do not obtain their NSC certificate after their first attempt. All provinces and districts will encourage these candidates to enrol for the Second Chance Matric Programme.

We are making the attainment of the NSC, with its vocational specialisations, a national endeavour.

No matter the failure or the poor performance, there is a second chance, as expressed in Sesotho, *'Leboela le a ja'* – *'perseverance pays'*.

The Executive Committee (EXCO) of the Umalusi Council concluded that the 2022 NSC Examinations were administered largely in accordance with the Regulations Pertaining to the Conduct, Administration and Management of the National Senior Certificate Examinations.

In view of this, the Quality Assurance Council, Umalusi, approved the release of the results for the October/November 2022 Examinations.

This approval was preceded by a holistic and comprehensive verification of all examination-related processes. Umalusi further confirmed that the irregularities identified during the writing and marking of the examinations were not systemic and therefore did not compromise the overall credibility and integrity of the October/November 2022 Examinations administered by the DBE.

The nation owes its gratitude to parents, teachers, principals, teacher unions, communities, district and provincial officials, and social partners for their commitment to supporting the Class of 2022.

The work we do in basic education has a multiplier effect. A country's economy becomes more productive, as the proportion of educated individuals increases.

I am confident that by working together yet again, we can support the Class of 2023 in the manner that we supported their predecessors.



MRS AM MOTSHEKGA, MP
MINISTER OF BASIC EDUCATION
19 JANUARY 2023

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION, SCOPE AND PURPOSE

The Class of 2022 entered the formal schooling system in Grade 1 in January 2011 and they became the largest cohort to sit for the NSC Examinations. The class has had the advantage of being the ninth cohort to be exposed to examinations based on the Curriculum Assessment Policy Statement (*CAPS*).

Hence, we can infer that this class benefitted from the developments of the last nine years relating to the *CAPS*, which would have created a high degree of stability in the system with regard to the teaching, learning and assessment. The last three years have been unprecedented, and this called for extraordinary measures to be implemented to ensure teaching, learning and assessment were maintained in schools.

Against this background, the Class of 2022 is possibly the worst affected class in relation to the effects of the Covid-19 pandemic. These candidates bore the brunt of COVID-19 in that they were confronted with disrupted academic years in Grades 10 and 11. There was a change in the assessment in Grades 10 and 11 with a greater focus on SBA, which constituted 60% of the promotion mark. Controlled tests replaced formal examinations in these grades. Subsequently, candidates sat for formal examinations only in Grade 12. Moreover, the impact of severe load-shedding cannot be discounted.

These learners are the beneficiaries of the educational transformation that heralds the move towards an innovative and technologically enhanced curriculum. The Class of 2022 is the third cohort to be subjected to a revised Section 4 of the *CAPS*, including revisions and amendments to examination guidelines.

In addition, this is the second cohort to sit for the newly introduced Marine Sciences and the third cohort to sit for two question papers in Accounting and Business Studies. The Class of 2022 is also the fifth cohort to offer South African Sign Language at Home Language level (SASL HL), Technical Mathematics, Technical Sciences, Civil Technology (Construction /Civil Services/Woodworking), Electrical Technology (Digital Systems/Electronic/Power Systems) and Mechanical Technology (Automotive/Fitting and Machining/Welding and Metal Work).

The policy on progression and promotion, which states that a candidate should not spend more than four years in a phase, has had a direct impact on the Class of 2022. Hence, candidates who did not meet the promotion requirements in either Grade 10 or Grade 11, would be progressed to Grade 12 on condition that they pass four of the seven subjects in Grade 11, inclusive of the Language of Learning and Teaching (LoLT), attend school on a regular basis and comply with SBA requirements in all subjects. This is the third cohort that is not subject to the policy on Multiple Examination Opportunity. This implies that all progressed candidates in this class had to sit for examinations in all six subjects in the November 2022 Examinations.

The 2022 Diagnostic Report delves into key observations in candidates' performance. Therefore, it serves as a primary resource for teaching and learning in the ten high enrolment subjects, Afrikaans First Additional Language, English First Additional Language, the twelve official home languages, the Technologies, Technical subjects and Engineering Graphics and Design. This report needs to be used in conjunction with the 2016 to 2021 diagnostic reports.

The seven reports extrapolate key subject didactic principles and content matter that can be used effectively in the classroom in 2023.

The 2022 diagnostic report is formulated on qualitative reports compiled by chief markers, internal moderators, and subject specialists post the NSC marking process. In the ten 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 highlighted the areas of weakness in each of the identified subjects and articulated the remedial measures which should be adopted at school level to improve performance in these subjects. As a result, this National Diagnostic Report on candidates' performance provides teachers, subject advisors, curriculum planners and curriculum implementers with a picture of weaknesses and strengths in each of the key subjects.

Each subject's diagnostic report commences by presenting comparative data on the performance trends observed over a five-year period in the subject, from 2018 to 2022. It also provides an overall performance of candidates per question, in the respective question papers, in each subject. In all subjects, common errors, misinterpretations and misconceptions identified during marking and suggestions for improvement are also outlined.

It cannot be ignored that content coverage was compromised due to the pandemic and that teaching methodology needs targeted intervention in 2023. It is imperative that Subject Advisory Services devise intervention measures to address recurrent areas of weakness. This diagnostic report serves as a source of valuable baseline information for intervention in 2023. This also suggests that continued reference to previous diagnostic reports is essential since the areas of weakness identified in previous years may still be applicable in certain cases.

1.2 METHODOLOGY

In the ten high-enrolment subjects and English First Additional Language, 100 scripts per question paper were randomly selected from each province during the marking process. These scripts included samples of low, medium and high achievement scores.

The internal moderators and chief markers analysed and noted candidates' responses to each question. This entailed recording the marks obtained by candidates from the 100 scripts on a per question basis. The individual scripts were scrutinised to provide an in-depth understanding of the range of different responses and to note the strengths and weaknesses. Particular attention was given to common errors and misconceptions identified in the candidates' responses.

Based on the analyses, a detailed explanation is provided per question/subquestion under the following three main titles:

Section 1: Performance trends (2018–2022)

A comparative analysis of the performance of candidates over the last five years in terms of the number of candidates who wrote, the number and percentage of candidates who achieved at 30% and above, and the number and percentage of candidates 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 on changes over the medium term, as well as changes from year to year.

Performance distribution curves are also provided to graphically present the distribution of candidates' scores in the last three examinations. Any improvement or decline in the

performance can be observed from the position of the 2021 graph, relative to previous years. If the 2022 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 candidates' performance

This section summarises the performance of candidates in the question paper as a whole. It makes reference to generic areas, the extent 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 answered well or poorly (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 the nine provinces for each question paper in each subject, were consolidated. The findings are summarised in this report. It is recommended that this report be read in conjunction with the November 2022 NSC question papers and marking guidelines since particular references are made to specific questions, in the respective question paper. This will enable teachers to establish a baseline for the new cohort of Grade 12 learners in 2023; develop strategies for differentiated learning and provide a frame of reference for the development and design of school-based assessment during the course of the year.

1.3 LIMITATIONS

The diagnostic analysis of candidates' performance in this publication is limited only to the ten subjects with high Grade 12 enrolments, Afrikaans First Additional Languages, English First Additional Language and the twelve 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 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.

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 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 2022 question papers.

1.4 GENERAL FINDINGS AND AREAS OF CONCERN

The 2022 diagnostic reports for the ten key subjects covered in this publication (Part 1), indicate that the pass rate has improved in six of these subjects (Accounting, Agricultural Sciences, Economics, Geography, Life Sciences, Mathematical Literacy and Physical Sciences) at the 30% levels. The pass rate has however declined to varying degrees at the 30% level in the remaining key subjects. The pass rate for English First Additional Language increased at both the 30% level and at the 40% level. In the home languages (Part 2) the pass rate remained the same in isiNdebele, Tshivenda and Xitsonga, improved to varying degrees in three home languages (English, isiZulu and Sepedi) and declined in the rest. The most notable decline in the pass rate at 40% was observed in South African Sign Language Home Language.

The following areas of concern were identified in past diagnostic reports and they are, once again, highlighted as concerns in the 2022 NSC Examinations.

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The following areas of concern were identified in past diagnostic reports and they are, once again, highlighted as concerns in the 2022 NSC Examinations.

- Teachers and subject advisors need to be fully familiar with the changes in the *CAPS* and the content of the 2021 Examination Guidelines. In some instances, it was observed that the new topics were not addressed in teaching and learning.
- It was evident in candidates' responses that there is a general lack of reading and comprehension skills. It was noted that many candidates did not understand the vocabulary used in questions, extracts and comprehension texts. Districts and schools are encouraged to initiate reading projects/reading periods/vocabulary/dictionary exercises to expand their learners' vocabulary. In addition, teachers are encouraged to expose learners to a wide array of texts to build their vocabulary, improve their comprehension skills and sharpen their critical thinking skills.
- A significant percentage of the 2022 candidates responded adequately to questions that required lower-order thinking skills. However, many candidates performed poorly in questions that demanded analytical, evaluative, and problem-solving skills. In view of this, teachers are encouraged to expose learners to a wide array of exercises that also include questions that assess higher order thinking skills.
- In most home languages, it was noted that candidates were not able to recognise the demands of abstract topics and higher order questions. There is therefore a need to encourage abstract thinking in in languages. Challenging topics need to be included in the classroom and homework exercises to allow learners to get accustomed to employing the critical language skills required to think analytically and critically.
- In all languages, it was evident that many candidates were not aware of the various formats for transactional texts. It is advised that teachers revise the required formats

on a regular basis throughout the academic year. Informal writing must be taught as per the *CAPS* prescripts. Learners' writing skills will improve if informal writing activities become part of classroom and homework activities. This pertains to all grades and all subjects. A few suggestions to encourage writing in schools is to launch a letter writing competition, establish school newspapers and allow learners to write articles.

- There was a remarkable improvement in Accounting, Economics, Geography, Mathematical Literacy, Physical Sciences, Technical Sciences and Technical Mathematics but it can be deduced from weaker candidates' responses that focused intervention strategies need to be initiated and implemented to ensure that candidates have a solid understanding of the more complex topics.
- In 2022, performance declined significantly in SASL HL. It was evident that candidates were not familiar with the subject matter. Although dialectical skills are acknowledged, a worrying trend is that many candidates could not sustain a coherent conversation in SASL. Moreover, it was observed that candidates did not give sufficient responses in the writing papers and literature. It is imperative that literature needs to be studied in detail and candidates need to be accustomed to the register, style and conventions for transactional writing texts.

1.5 KEY RECOMMENDATIONS

1.5.1 Cognitive levels

Each assessment task and question paper must reflect the prescribed cognitive levels. School-based assessment tasks need to be in line with the *CAPS* requirements. Teachers are urged to:

i) encourage discussion about what is being taught;
ii) ask learners to reflect on their experiences;
iii) help learners to find new solutions to problems;
iv) assist learners to explore and understand how ideas are connected;
v) guide learners to substantiate their statements with solid arguments;
vi) use technology, visual demonstrations, practical activities and visualisation to improve learners' understanding of subject matter.

1.5.2 Examination Guidelines and the *CAPS*

It is imperative that teachers and subject specialists fully familiarise themselves with the changes introduced in the *CAPS*, and subsequently the 2021 Examination Guidelines. This requires teachers to be well informed of the new topics, format of question papers and restructured mark allocation affecting various topics.

1.5.3 Diagnostic Reports from 2015 to 2021

The diagnostic reports published from 2015 to 2021 are pertinent to gain a holistic grasp of candidates' performance and to identify weaknesses in the teaching and learning of the ten key subjects (Part 1). Part 2 of this diagnostic report, published for the first time in 2017, will serve as a teaching and learning tool in the language classroom, while Part 3 covers Technical subjects. Part 1, Part 2 and Part 3 must be used in preparing the Class of 2023 for the NSC Examinations.

1.5.4 Past question papers

Teachers are discouraged from teaching to the paper. However, past question papers should be used as a teaching and learning resource and they serve as one of the resources for revision purposes. It must be stressed that the *CAPS* and the Examination Guidelines for each subject must be followed to ensure that all topics are covered. It must also be noted that in instances where the format of a question paper has changed, candidates need to be made aware of such changes.

1.5.5 Language in teaching

Language Across the Curriculum (LAC) acknowledges the fact that language education does not only take place in specific subjects explicitly defined and reserved for it, such as the home languages, first additional languages and second additional languages. Language learning also takes place in each subject in school, whether teachers or learners are conscious of it or not.

In an effort to build learners' language proficiency and their confidence in decoding both the Language of Learning and Teaching (LoLT) and the language of assessment, teachers are encouraged to add their own language aspects, as these apply within the context of their schools or classrooms. The following points serve as a guide to teachers:

- It was observed in the marking of the October/November 2022 Examinations that candidates have a good grasp of subject matter and display an ability to respond appropriately to questions but are often restricted by inadequate language skills to formulate responses appropriately.
- Coupled with language skills, a lack of a solid understanding of examination techniques impacts negatively on candidates' performance. There needs to be greater emphasis on aspects of language competence and examination technique.
- In view of the point above, it is imperative that learners must have a firm understanding of action verbs that are used in the phrasing of questions. It is also essential that learners understand the meaning of each action verb in its context and in terms of the cognitive demand that is expected.
- Subject terminology and definitions must be clearly understood by learners. A firm understanding of subject matter can only be guaranteed if learners understand terminology and concepts used in the subject. It is suggested that a glossary of subject-specific jargon and their definitions is provided to learners.

1.5.6 Integrated intervention strategies

Integrated intervention strategies are used to address gaps in teaching and learning. Such strategies could include:

- At the start of the academic year, teachers should provide their learners with the topics to be covered during the year and the relevant websites that they could explore, as part of independent reading.
- Online and virtual study groups are valuable in facilitating revision activities and examination preparations as they promote communication and conversations around subject content. Platforms such as *Microsoft Teams, Zoom, Google Classroom, YouTube* and *WhatsApp* could be used to good effect.

- 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.
- Learners who cannot log on to digital portals could be issued with DVDs/USB drives, with the information from various websites. Hard copies of the information should be provided to learners who do not have access to electricity and/or technology.
- Teachers from different schools in each circuit or district could collaborate to support one another in presenting challenging topics to learners. In view of this, different schools can build an item bank of higher order questions which can be used as a resource for revision purposes.
- Challenging topics must be revisited regularly during the course of the academic year through extension activities. These topics should form the basis of extra classes where stronger candidates can be paired with weaker candidates in completing more complex assignments.

1.6 RESPONSIBILITIES

1.6.1 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.

1.6.2 Subject Advisors and district officials:

- Subject specialists should initiate a baseline assessment of the 2023 Grade 12 cohort, to establish learners' understanding of Grade 10 and Grade 11 topics that serve as foundation for Grade 12 topics.
- Subject advisers 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 Advisers should direct teachers to websites that will enhance teaching and learning.

1.6.3 Teachers

- Teachers should ensure that learners are provided with adequate resources to facilitate self-regulated learning. Learners must be in a position to study independently.
- In order 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 question papers.

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 2022 examinations.

2.1 PERFORMANCE TRENDS (2018–2022)

The number of candidates who sat for the Technical Mathematics examination in 2022 increased by 1 254 compared to that of 2021.

Although the table below indicates a negative trend over the years 2018-2020, a significant improvement in results is evident in the two years thereafter. The performance of the candidates in 2022 shows a substantial improvement when compared to the performance in 2021. Candidates who passed at 30% (Level 2) increased from 60,1% in 2021 to 81,8% in 2022. It is also very encouraging that 28,6% of candidates achieved over 50% this year in comparison to 17,2% of candidates doing so in 2021.

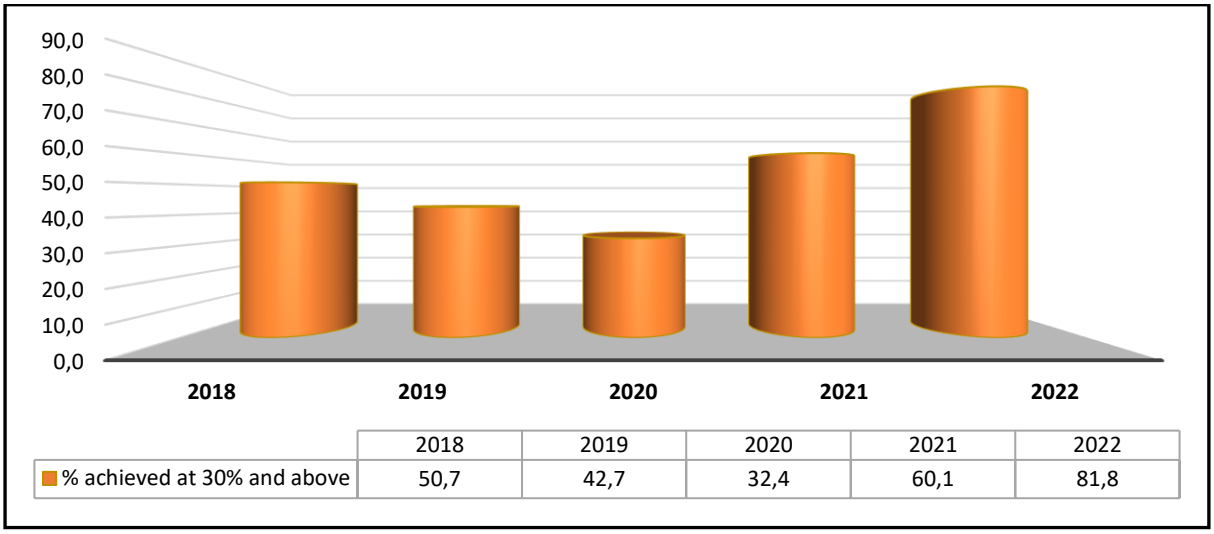
There was also an increase in the percentage of distinctions over 80% (Level 7) from 0,6% to 1,5%. Given the increase in the total number of candidates, this converts into an increase of 139 in the total number of distinctions.

In view of disruption to academic programmes in 2020 and 2021, the results achieved by this cohort are particularly commendable. Strategic intervention programmes at all levels (National, Provincial, Districts and Schools) ensured that learners were adequately prepared.

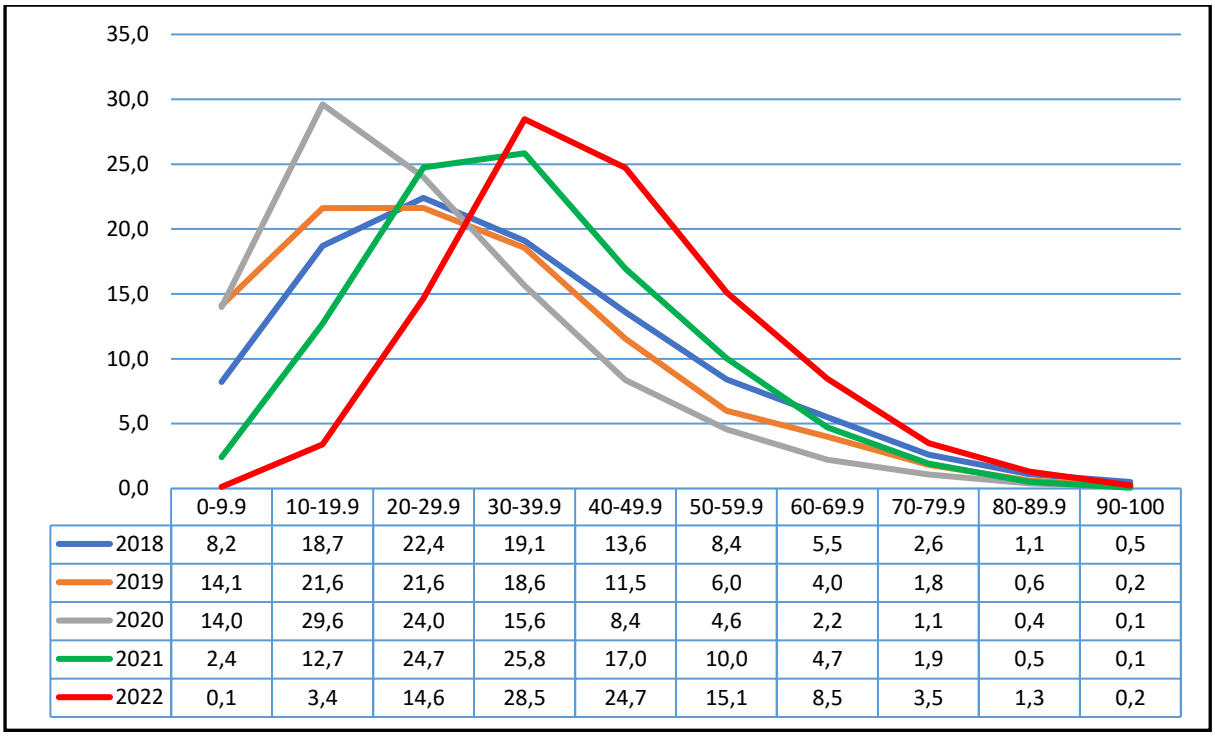
Table 2.1.1 Overall achievement rates in Technical Mathematics

Year	No. wrote	No. achieved at 30% and above	% achieved at 30% and above
2018	10 025	5 078	50,7
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

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
2018	8,2	18,7	22,4	19,1	13,6	8,4	5,5	2,6	1,1	0,5
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

General comments on Paper 1 and Paper 2

Revision of work from earlier grades will play an integral part in improving performance in the subject. There is still room for improvement in the performance of candidates if the challenges surrounding mathematical skills, conceptual understanding and integration of topics are addressed. As stipulated in the Technical Mathematics *CAPS*, 'Mathematical modelling is an important focal point of the curriculum' and 'Real-life technical problems should be incorporated into all sections whenever appropriate'. Adequate attention should be paid to this comment. Performance will be further enhanced if candidates improve their ability to solve problems.

2.2 OVERVIEW OF CANDIDATES' PERFORMANCE IN PAPER 1

General comments

(a) Most candidates performed fairly well in questions assessing topics done in the lower grades. They were able to score marks in questions requiring knowledge and routine easy level of difficulty. Some candidates displayed limited algebraic skills required to solve many mathematical problems.

(b) Performance in topics taught in Grade 12 was poor in comparison to performance in topics done in Grades 10 and 11. This was probably due to inadequate time being allocated for revision.

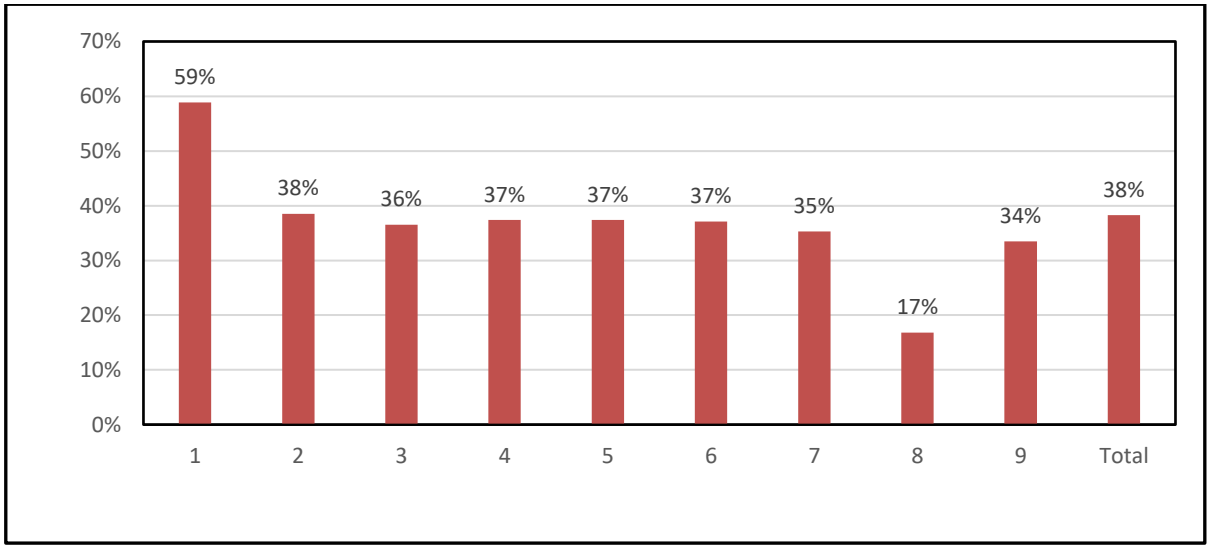
(c) Many candidates performed poorly in questions involving applications and problem solving. Higher-order questions such as the interpretation of graphs were either not answered or poorly answered. Candidates struggled to answer questions in which topics were integrated.

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

2.3 DIAGNOSTIC QUESTION ANALYSIS OF PAPER 1

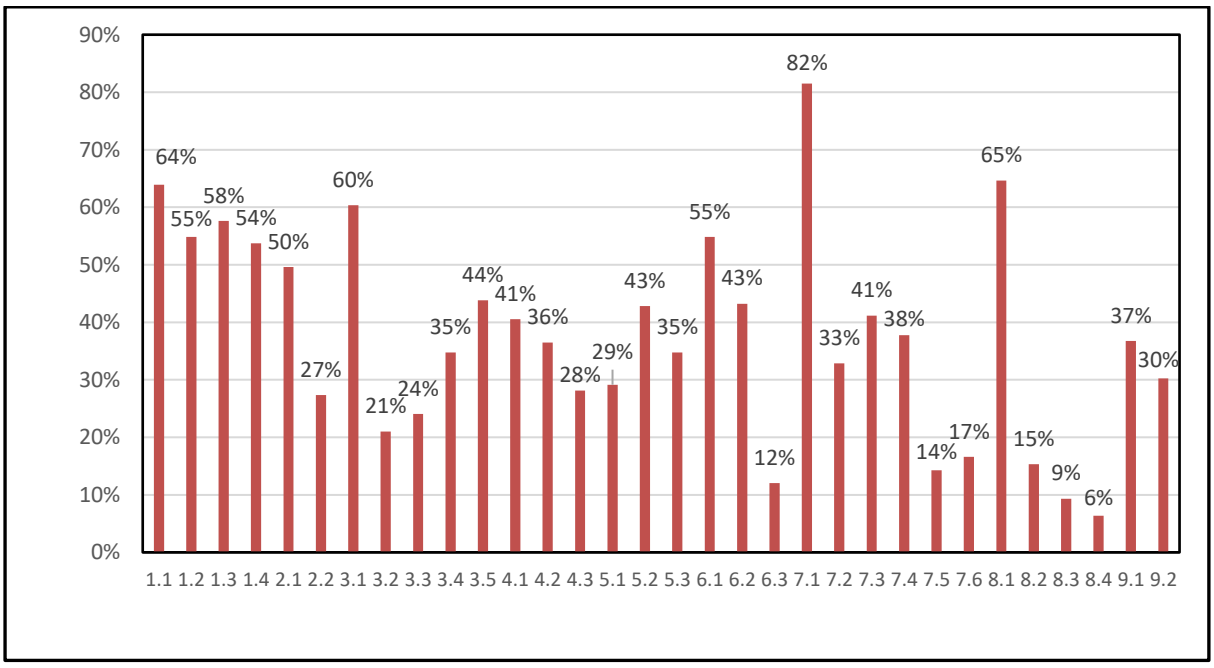
The following graph is based on data from a random sample of candidates. While this graph might not accurately reflect national averages, it is useful in assessing the relative degrees of challenge of each question as experienced by candidates.

Graph 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) Some candidates did not realise that the factors were given in Q1.1.1. Instead, they expanded and got to a standard quadratic form and then factorised again, incorrectly, or used a quadratic formula. Some omitted the negative sign in x = -7 and some ignored x = 0.

(b) In Q1.1.2 some candidates copied the formula incorrectly. A few candidates failed to substitute correctly in the formula. They displayed incompetency in using the calculator and rounding off to the required number of decimal places.

(c) Many candidates in Q1.1.3 failed to interpret the inequalities. They showed limited understanding of the set builder notation and the meaning of 'or' and 'and'. They failed to differentiate between *greater than* and *less than*.

(d) In Q1.2 some candidates did not realise that y is the subject of the formula in both equations. They tried to create a third equation by making x the subject in the linear equation which had a fraction in it and failed to simplify later to get their answer.

(e) Many candidates failed 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 did not follow the instruction of rounding off to the nearest centimetre.

(g) In Q1.4.1 some candidates were unable to convert a binary number to a decimal number and a few candidates used base 10 instead of base 2.

(h) In Q1.4.2 many candidates failed to multiply the binary numbers, and a few omitted the base 2.

Suggestions for improvement

(a) Revision of topics done in earlier grades, e.g. factorisation, products, solution of simultaneous equations and binary operations, is strongly advised. The use of brackets should be emphasised when substituting an equation in another equation and when there is a negative value to be substituted. Writing the correct notation should be emphasised and encourage the correct use of calculators.

(b) Learners should be exposed to different forms of literal equations, subject of the formula and the simplification thereof.

(c) In teaching inequalities, teachers should integrate Algebra with Functions so that learners have visual understanding of the region of the graph that is applicable to the inequality under consideration and explain the difference between 'or' and 'and' in the context of inequalities. Teachers should expose learners to different methods of solving inequality problems so that learners may choose the method best suited to solving the problem.

QUESTION 2: NATURE OF ROOTS

Common errors and misconceptions

(a) In Q2.1.1 many candidates solved the equation instead of using the discriminant and substitute the values of a, b and c into the discriminant to determine its numerical value.

(b) In Q2.1.2 some candidates failed to describe the nature of roots. They had challenges to differentiate between *real* and *non-real roots*.

(c) In Q2.2 many candidates failed to interpret the meaning of real roots in relation to $\Delta = b^2 - 4ac$. They also used the '=' sign instead of '>' for real roots. Candidates accepted the positive value of *q* but rejected the negative value. This was incorrect.

Suggestions for improvement

(a) Teachers should emphasise that the discriminant, $\Delta = b^2 - 4ac$, is used to determine the nature of roots of the quadratic equation. They should demonstrate and explain to learners that the discriminant, $\Delta = b^2 - 4ac$ originates from the quadratic formula $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$. In other words, the quadratic formula could be written as $x = \frac{-b \pm \sqrt{\Delta}}{2a}$.

(b) Teachers should demonstrate using a quadratic function, for instance where the roots are real, non-real, rational, irrational, equal and unequal.

(c) Learners should be exposed to applications involving the nature of roots, e.g. proving problems about nature of roots applicable to given conditions.

QUESTION 3: EXPONENTS, SURDS, LOGARITHMS AND COMPLEX NUMBERS

Common errors and misconceptions

(a) In Q3.1.1 some candidates failed to correctly apply laws of exponents and follow instruction to leave the answer with positive exponents.

(b) Few candidates had challenges writing numbers 48, 16 and 12 as products of perfect squares and prime numbers. They failed to apply logarithmic properties in Q3.1.2.

(c) Many candidates wrote $log\,25$ as $log\,5^5$ instead of $log\,5^2$ in Q3.2.1

(d) In Q3.2.2 some candidates did not apply logarithmic properties correctly. Many candidates failed to write *log* 2 in terms of *log* 5.

(e) Many candidates had difficulty in transposing the terms of the equation and thus failed to apply the log properties in Q3.3. They failed to convert log form to exponential form.

(f) In Q3.4.1 some candidates did not realise that for the conjugate, the sign of the imaginary number changes. They wrote $\bar{z} = -1 + 3i$ instead of $\bar{z} = -1 - 3i$.

(g) In Q3.4.2 most candidates failed to expand the polar form. Some omitted the brackets and wrote $\sqrt{2}\cos 135° + i\sin 135°$. Many candidates failed to write polar form in rectangular form.

(h) A number of candidates omitted the bracket in Q3.4.3 and ended up with $+i$ instead of $-i$.

(i) In Q3.5 some candidates did not apply the distributive property. Furthermore, they did not equate the real part to a real part and imaginary part to an imaginary part.

Suggestions for improvement

(a) Regular revision of all exponential, surd and logarithmic laws, which are taught to learners in earlier grades, is strongly suggested in Grade 12.

(b) Teachers need to encourage the correct use of brackets. Furthermore, they should strengthen the concept of factors and products and reinforce the method of converting from exponential form to surd and/or logarithmic forms and vice versa.

(c) Teachers should expose learners to different types of questions involving complex numbers. Learners must be encouraged to adhere to the given instructions.

QUESTION 4: FUNCTIONS

Common errors and misconceptions

(a) In Q4.1.1(a) and Q4.2.1 some candidates displayed limited knowledge of range and domain. They wrote incorrect notation.

(b) In Q4.1.2(a) and Q4.2.2(b) some candidates omitted the substitution by 0 to find the x-intercept. They failed to factorise the quadratic equation. They used quadratic formula and incorrectly substituted by swapping the values of *a*, *b* and *c*.

(c) Some candidates struggled with interpretation in Q4.1.1(b) and Q4.1.2. They were unable to find the coordinates of a point on the graphs and length.

(d) In Q4.1.3 many candidates failed to determine the numerical values of *m* and *c,* the gradient and *y*-intercept of a straight line.

(e) In Q4.1.4 many candidates had difficulty with interpretation. They used algebraic methods and multiplied the two equations, and this approach complicated the process of solving for *x*.

(f) Many candidates failed to write the equation of the asymptote in Q4.2.2(a). Furthermore, they were unable to differentiate between a function value, an asymptote, and a parameter. Some wrote the equation of the horizontal asymptote as $p = 0$ and some wrote it as $q = 1$ and some wrote $x \neq 0$ and $y \neq 1$.

(g) In Q4.2.3 some candidates could not sketch the graphs.

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

Suggestions for improvement

(a) Teachers should explain the meaning of inequalities and the definition and correct notation of the domain and range of a function.

(b) Transformation should be incorporated in the teaching of functions and graphs to illustrate the effects of the parameters, and any reflection thereof.

(c) Teachers should point out to learners that when a question requires the equation of the asymptote, it should be presented as $y =\ldots$ or $x =\ldots$, depending on the asymptotes that are required.

(d) Learners should be advised to use several points from a table to draw functions if they struggle with using the characteristics of graphs.

(e) Learners should be exposed to different ways of determining the equations of the graphs.

(f) Teaching of graphs should not be limited to the drawing of graphs; interpretation should be incorporated during the teaching and learning process. Teachers should expose learners to different questions involving two graphs on the same system of axes.

QUESTION 5: FINANCE, GROWTH AND DECAY

Common errors and misconceptions

(a) Many candidates failed to identify and use the correct formula in Q5.1.

(b) Many candidates had difficulty interpreting Q5.2. Some candidates 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. Some candidates failed to convert the exponential form to log form. Many candidates rounded off their final answer to n =8.

(c) In Q5.3 many candidates displayed a limited knowledge of the different compounding periods. Some candidates failed to identify and use the correct formula. They did not realise that R5 000 had to be added to the value of the investment after 24 months.

(d) Some candidates failed to use the calculator correctly and many did not make a conclusion.

Suggestions for improvement

(a) Revision of work done in earlier grades, e.g. fractions, percentages, interest, hire purchase, inflation and other real-life problems, is strongly suggested.

(b) Learners should identify the correct formula from the information sheet attached to the question paper.

(c) Teachers should explain to learners that in all formulae, P represents the initial value. In the case of a population, P represents the initial number and A represents the final number of species in the situation. Furthermore, emphasise that in scenarios that involve depreciation, the value of P will be greater than the value of A.

(d) Teachers need to demonstrate and explain to learners how to change the subject of the formula. Substitution of values in a formula and then changing the subject of the formula is advised.

(e) All compounding periods (annually, quarterly, monthly, semi-annually/half-yearly and even daily) should be taught to learners. The use of time-lines in order to better understand a complex problem involving several investments, deposits and withdrawals, is strongly advised.

(f) Learners should demonstrate competency in using a calculator and not round off too early in the calculation.

(g) Instil in learners that a good understanding of Financial Mathematics is best developed through practice.

QUESTION 6: CALCULUS

Common errors and misconceptions

(a) In determining the derivative using first principles in Q 6.1, some candidates:

- Incorrectly used the rules for differentiation;
- Failed to copy the definition correctly from the information sheet;
- Used incorrect notation by omitting $\lim\limits_{h \to 0}$, $f'(x) = \frac{f(x+h)-f(x)}{h}$

  by placing the = sign in the incorrect position $\lim\limits_{h \to 0} = \frac{f(x+h)-f(x)}{h}$ or

  by using the incorrect notation $f(x) = \lim\limits_{h \to 0} \frac{f(x+h)-f(x)}{h}$ or
- Failed to substitute correctly into the formula. Some omitted brackets when substituting for $f(x)$.

(b) In Q6.2.1 some candidates did not realise that π is a constant.

(c) Many candidates failed to expand before finding the derivative in Q6.2.2.

(d) In Q6.2.3 many candidates had difficulties simplifying the given expression. Some candidates converted $\sqrt[5]{x^4}$ to $x^{\frac{5}{4}}$ and $\frac{2}{5x^2}$ to $2 \times 5x^2 = 10x^2$.

A few candidates differentiated $8t^4x$ with respect to *t*.

(e) In Q6.3.1 many candidates failed to calculate the numerical value of *p*.

(f) In Q6.3.2 many candidates demonstrated limited knowledge of the relationship between the gradient of the tangent and the derivative of the curve at the point of contact. They substituted random values for *x* and *y* in *g(x) and* did not realise that $m = -21$.

Suggestions for improvement

(a) Learners should copy the formula for first principles correctly from the information sheet attached to the question paper.

(b) Teachers should emphasise that when using first principles, the correct notation should be used. The $\lim_{h \to 0}$ must be written down in each step and should only be left out when writing the final step, i.e. once the learner has substituted the value of *h*.

(c) Revision of simplification of expressions involving algebraic fractions should be done with learners.

(d) Teachers should expose learners to various notations used in differentiation. The 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. The difference between the *derivative* and an *integral* of a function should be explained and demonstrate the difference of each by calculating the *derivative* and *integral* of the same function.

(e) Revision of exponential and surd laws is encouraged before teaching differentiation which itself involves exponents and surd.

(f) The derivative function in relation to gradient at a point on a curve or gradient of a tangent should be clearly defined and demonstrated using relevant mathematical software.

QUESTION 7: CUBIC FUNCTION

Common errors and misconceptions

(a) In Q7.1 a few candidates wrote the coordinates of A instead of the length in Q7.1.

(b) In Q7.2 some candidates displayed limited understanding of the Factor Theorem. Many candidates omitted the 0 and substituted $x - 1$ and $k = 5$.

(c) Many candidates in Q7.3 struggled to get the quadratic factor; they used quadratic formula to determine the roots of a cubic function. Some candidates calculated the coordinates of the midpoint point.

(d) In Q7.4 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. 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. Most candidates did not equate the derivative function to zero.

(e) In Q7.5 many candidates were unable to identify the interval in which the gradient was less than or equal to 0. They failed to identify critical values and the use of correct notation.

(f) In Q7.6 many candidates did not realise that the function was shifted 2 units downwards, they failed to get the *y*-coordinate of point A.

Suggestions for improvement

(a) Learners should be given more activities on factorisation of polynomials.

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

(c) Learners should read the given information carefully and follow instructions.

(d) Teachers should expose learners to various forms of graphical representations and all aspects of the functions, including sketching and interpretation of the graphs.

(e) 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 points. Teachers should indicate to learners that calculating the *x*-coordinate of the turning point using $x = -\frac{b}{2a}$ only applies to quadratic functions.

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

(g) The use of a variety of available software to illustrate where the graph is decreasing, increasing or stationary is strongly suggested. This should greatly assist in the interpretation of functions. Software such as Geometer's Sketch Pad, Graph and GeoGebra are useful tools to demonstrate these concepts.

QUESTION 8: APPLICATION OF CALCULUS

Common errors and misconceptions

(a) In Q8.1 many candidates did not realise that for the initial temperature $t = 0$, they assumed random values of *t* and substituted into *T(t)*. Some candidates differentiated the function.

(b) In Q8.2 most candidates substituted $t = 4$ into *T(t)* instead of $T'(t)$.

(c) In Q8.3 many candidates did not realise that they needed to equate the derivative to 0 to solve for *t* and then substitute the value in *T*. Some candidates failed to differentiate with respect to *t*. A few managed to get the value of *t* but failed to substitute in *T.*

(d) The majority of candidates had challenges to interpret Q8.4. They demonstrated a lack of understanding that the temperature decreases when the derivative is negative or less than zero and consider the given restriction as well.

Suggestions for improvement

(a) Learners should be exposed to examples involving contextual applications, e.g. rate of change and calculus of motion.

(b) Teachers should explain the concept of *minima* and *maxima* in the context of optimisation. In optimisation, teachers need to explain that the first step is to find the derivative, equate the derivative to 0 and then factorise or use the quadratic formula to calculate the value of *t* and then substitute the value of *t* in the original function to find the temperature to be optimised.

(c) Learners should take into consideration any restrictions given in the question.

QUESTION 9: INTEGRATION

Common errors and misconceptions

(a) In Q9.1.1 some candidates integrated incorrectly; they wrote the integral as $\frac{3}{lnx}+C$

A few candidates omitted *C* when determining the indefinite integral. Some candidates used *differentiation* instead of *integration*.

(b) Some candidates wrote the integral as $4x+2lnx+C$ or $\frac{4lnx}{2lnx}+C\,dx$ in Q9.1.2.

(c) In Q9.1.3 most candidates failed to simplify $\frac{8x^4-x^2}{2x}$ to $4x^3-\frac{1}{2}x$.

(d) In Q9.2 candidates failed to write the correct notation for area when using integrals. Some candidates differentiated the expression. Candidates calculated the area bounded by the function and the *x*-axis between the *x*-intercepts even though it was given. A few candidates substituted the boundaries in the given function without integrating the function first. Many candidates did not realise that they had to find 20% of the area before concluding that the learner's statement is incorrect.

Suggestions for improvement

(a) Learners should be encouraged to 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*. Emphasise correct use of integral notation and that when determining indefinite integrals, the constant *C* must always be added.

(c) In the teaching of integration, learners should be taught to include the lower and upper boundaries when setting up the area notation for definite integrals. The use of brackets should be emphasised when substituting negative values.

(d) The calculation of the area bounded by a function and the *x*-axis should be demonstrated so that learners can observe how the value of the constant influences the area.

(e) Learners should be exposed to a variety of applications involving *integration* to enhance their understanding of the concept of integration.

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

(a) Candidates performed relatively well in Q1. This question was based on Analytical Geometry. Candidates performed extremely well in questions involving gradient and the equation of the straight line, which are concepts covered in Grade 10.

(b) Candidates performed poorly in Q8, Q9, Q10 and Q11 with Q8 and Q9 being the worst answered questions.

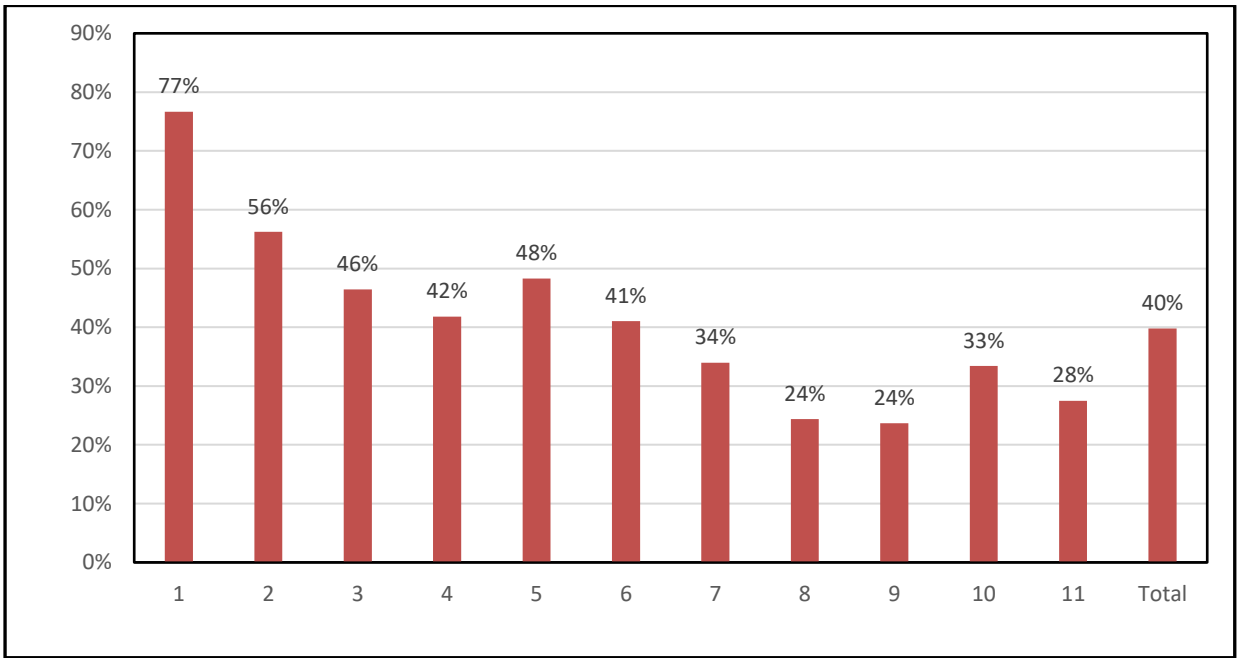
(c) Candidates did not adhere to the instructions stipulated in the question paper.

(d) Many candidates did not attempt the higher-order questions.

2.6 DIAGNOSTIC QUESTION ANALYSIS OF PAPER 2

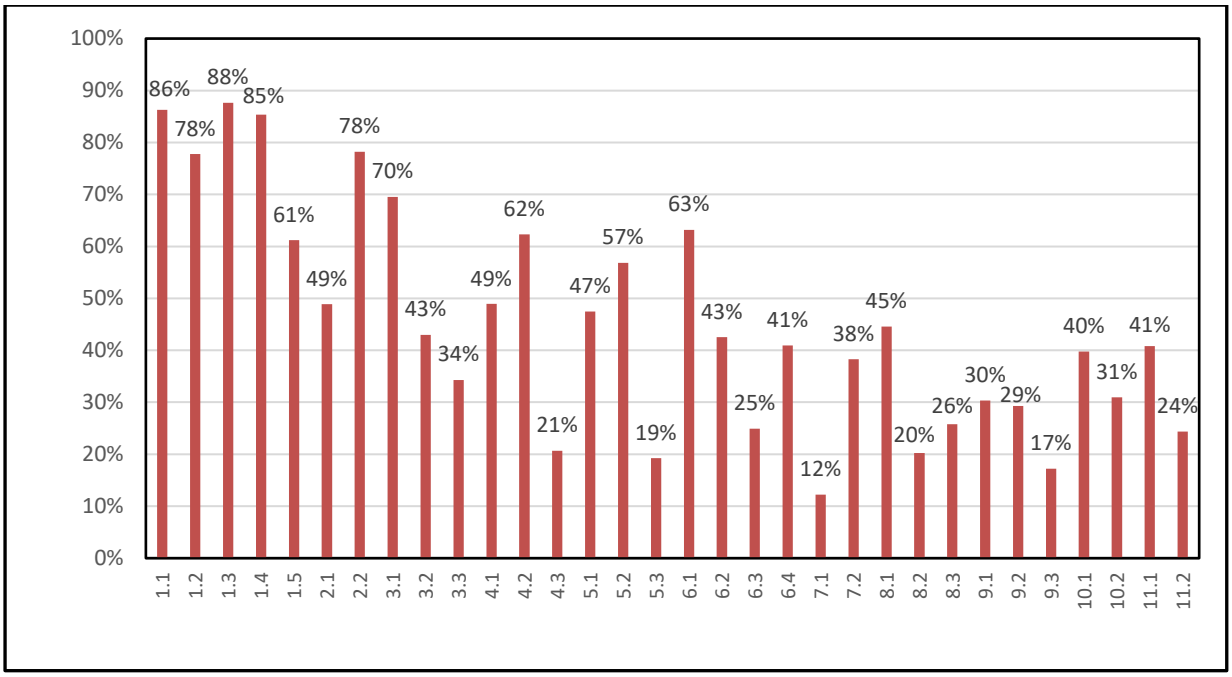
The following graph is based on data from a random sample of candidates. While this graph might not accurately reflect national averages, it is useful to assess the relative degrees of challenge of each question as experienced by candidates.

Graph 2.6.1 Average performance per question in Paper 2



Q	Topics	Q	Topics
1	Analytical Geometry – Lines	7	Euclidean Geometry - Circle, diameter ⊥ to chord
2	Analytical Geometry - Circle; Tangents; Ellipse	8	Euclidean Geometry - Circle - Cyclic quads
3	Trigonometry - General ratio's and equations	9	Euclidean Geometry - Proportionality and Similarity
4	Trigonometry - Angles reduction-Identities	10	Mensuration- Angular velocity, arc and sector
5	Trigonometry - Functions and graphs	11	Mensuration- Area and Volume
6	Trigonometry - 2D - sine and Area rule		

Graph 2.6.2 Average performance per subquestion in Paper 2



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

QUESTION 1: ANALYTICAL GEOMETRY

Common errors and misconceptions

(a) When answering Q1.2, candidates did not know that the m in the formula $\tan\theta = m$ is the gradient.

(b) In Q1.5.2 candidates did not determine the co-ordinates of the midpoint of ST first. Some candidates did not know the conditions for lines to be parallel.

Suggestions for improvement

(a) When learners are taught application of formula, it is important to explain what each letter represents.

(b) Teachers should emphasise that in determining the equation of the straight line, learners should use at least one point on that straight line.

(c) Teachers should emphasise the conditions for lines to be parallel and perpendicular.

QUESTION 2: ANALYTICAL GEOMETRY

Common errors and misconceptions

(a) In Q2.1.1 some candidates used the wrong equation, i.e. equation of straight line and equation of the semi-circle. Some worked out the value of r^2 and did not conclude by answering the question as $x^2 + y^2 = 5$.

(b) Most candidates did not realise that they were to use the Euclidean Geometry reason in Q2.1.2.

(c) In Q2.1.3 candidates' lack of basic knowledge that tangent is perpendicular to radius at the point of contact, was evident.

(d) When answering Q2.1.4, some candidates did not understand the meaning of 'hence' as they did not use the value they had calculated above.

(e) Some candidates could not calculate the gradient of AC, hence they could not determine the equation of AC.

Suggestions for improvement

(a) Learners should be trained to always connect different concepts or topics when answering questions.

(b) Integration of topics should always form part of daily teaching.

(c) Learners should be taught that 'hence' means that the question depends on or is answered using the information from the previous question(s).

QUESTION 3: TRIGONOMETRY

Common errors and misconceptions

(a) In Q3.1.1 some candidates multiplied with the wrong conversion ratio. They had challenges working with radians and degrees at the same time.

(b) Candidates in Q3.2 could not understand that *k* was the adjacent side angle of the triangle.

(c) In Q3.2.2 many candidates did not relate the expression to the given diagram.

(d) In Q3.3 many candidates did not know that the reference angle is a positive acute angle. They could not work with the negative angle to determine the correct quadrant hence they could not get the correct values of x.

Suggestions for improvement

(a) Learners should be trained to change easily from radian angle measure to degree angle measure and visa-versa.

(b) Learners should be taught how to draw a diagram to determine the opposite and adjacent angles given the coordinates of a point for different angles sizes.

(c) Teachers should emphasise the importance of answering questions that are based on only the diagram presented not in general.

(d) Learners should be taught that reference angle should be an acute angle and is used to determine the size of the angle in the relevant quadrant.

QUESTION 4: TRIGONOMETRY

Common errors and misconceptions

(a) Some candidates struggled with the reductions as they did not know when the trigonometric ratio would be positive and when it would be negative. Candidates thought of the distributive law and multiplied the function into the brackets.

(b) Applying reduction formulae and simplifying trigonometric expressions using identities in Q4.1.3 still proved to be a challenge.

(c) In Q4.2 candidates did not relate the identity with the one given in the formula sheet and incorrectly answered the question.

(d) Candidates proved the identity as if they were solving the equation in Q4.3. Instead of simplifying one side of the equation to look exactly the same as the other side, they assumed that the two sides are equal and determined the value of the unknown.

Suggestions for improvement

(a) Learners should know how to reduce angles in radians and degrees, and that the squared ratio is always positive irrespective of the quadrant where the angle is.

(b) Teachers should expose learners to a variety of problems that require reduction formulae for both angles in radians and degrees.

(c) Learners should be taught how to transpose as different prescribed identities to make any of the term or letter the subject.

(d) Teachers should teach learners how to prove identities, i.e. making one side of the equation to look exactly the same as the other side of the equation.

QUESTION 5: TRIGONOMETRIC FUNCTIONS

Common errors and misconceptions

(a) Most candidates were unable to determine the basic properties of the function in Q5.1, i.e. the period and amplitude.

(b) In Q5.2 many candidates were able to draw the given functions using point by point plotting not properties of the function.

(c) Some candidates were still unable to interpret information from the drawn graph. They were unable to determine the values of x for which the graph g is increasing.

Suggestions for improvement

(a) When teaching trigonometric functions, teachers should discuss basic properties of trigonometric functions, i.e. period and amplitude.

(b) As indicated in the previous report, teachers should explain the characteristics of each basic trigonometric function and how these characteristics change when the basic graph is transformed.

(c) Teachers should also explain when the function is increasing and decreasing as it is common to all functions.

QUESTION 6: TRIGONOMETRY

Common errors and misconceptions

(a) Some candidates calculated the angles using incorrect triangles with wrong reasons in Q6.1.

(b) In Q6.2 most candidates were unable to identify the correct triangle and were unable to correctly apply the sine rule. Hence, they did not get the lengths of AB.

(c) Some candidates in Q6.3 set down the sine rule correctly but when they substitute, they use the values of angles instead of the sine of angles, i.e.

$$\frac{AD}{sinB} = \frac{BD}{sinA}$$

$$\frac{AD}{39,5} = \frac{7,44}{35}$$

(d) Some candidates were unable to apply the area rule correctly. Instead of using the included angle, they used a different angle.

Suggestions for improvement

(a) Learners should be able to apply trigonometric rules to determine the unknown side or angle of any triangle given the length of one of the sides and two of the angles, or given two sides and the included angle.

(b) Teachers should expose learners to problems that requires learners to solve two triangles that share the common side by applying the rules in one of the triangles which has the relevant information to determine the length of the common side.

(c) Teachers should revise the sine rule and the difference between the trigonometric ratio and angle should be thoroughly explained.

(d) Learners should be taught when to apply the sine rule, cosine rule or area rule based on the given triangle information.

QUESTION 7: EUCLIDEAN GEOMETRY

Common errors and misconceptions

(a) Most candidates were unable to fill in the missing words of the statement of the theorem in Q7.1.

(b) Most candidates still struggled to apply Circle Geometry theorems when a combination of these theorems was required to answer a question.

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 when they practise the application of circle theorems.

QUESTION 8: EUCLIDEAN GEOMETRY

Common errors and misconceptions

(a) In Q8.1 candidates wrote one or two words which did not complete the theorem statement, i.e. interior, interior opposite and opposite angle.

(b) Most candidates struggled with the application of theorems in Q8.2.1. Reasons and statements given by candidates did not correlate.

(c) Most candidates did not know how to show whether a quadrilateral was cyclic or not, in Q8.2.2. Some just wrote reasons which were not related to the information in the diagram, i.e. parallel lines.

Suggestions for improvement

(a) Learners should be taught to identify information in relation to the theorems they learned.

(b) Learners should practise using the 'acceptable reasons' in classwork so that they get familiar with them.

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

(d) The 'Accepted Reasons' as stated in the *Examination Guidelines* must be consolidated and reinforced when teaching Euclidean Geometry. These reasons must be linked to Circle Geometry theorems with sketches to reinforce concepts.

(e) Learners should be encouraged to scrutinise the given information and the diagram for clues and in this way they should be able to identify which theorems could be used in answering the question.

(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 on their diagrams as they unpack and solve riders in subquestions.

QUESTION 9: EUCLIDEAN GEOMETRY

Common errors and misconceptions

(a) Most candidates were unable to provide the properties of a parallelogram.

(b) In Q9.2.2 and Q9.2.3 candidates were unable to apply the basics of the proportionality theorems to calculate the lengths of AD and DE.

(c) Most candidates struggled to prove that two triangles were similar in Q9.3, hence, the rest of questions. i.e. making deduction and determining the length of CF were compromised.

Suggestion for improvement

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

(b) Teachers should still expose candidates 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.

(c) Learners should be taught to prove that triangles are similar using values provided in the diagram.

QUESTION 10: CIRCLES, ANGLES AND ANGULAR MOVEMENT

Common errors and misconceptions

(a) In Q10.1.1 most candidates could identify the correct formula and the correct substitution but they struggled to convert the answer to the correct units.

(b) In Q10.1.2 most candidates used the correct formula but some made incorrect substitutions. Some candidates did not know what the different variables represented. For example the radius was used for the value of h.

(c) In Q10.2.3 most candidates did not realise that they were to add six lengths to answer the question. They could not calculate the lengths of the unknown sides.

Suggestions for improvement

(a) Teachers should still 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.

(b) Learners should be able to relate each variable in the formula to what it represents to avoid incorrect substitution.

(c) Learners should be exposed to higher-order questions that require integration of different topics as was the case in Q10.2.3.

QUESTION 11: MENSURATION

Common errors and misconceptions

(a) In Q11.1 many candidates struggled to convert kilometres to metres.

(b) In Q11.2 some candidates copied the mid-ordinate formula incorrectly and could not get the correct value of a. Even when they copied this formula correctly, they still had no idea how to interpret the o_{n-1}. They all subtracted 1 from the ordinates and got the incorrect value of q.

(c) Some candidates calculated the volume instead of the area. They proceeded to multiply the cost of the area using the volume.

(d) A number of candidates had no idea how to calculate percentage. They also could not differentiate between *capacity* and *volume*.

Suggestions for improvement

(a) Teachers should revise the metric system with learners to assist them to make correct conversions from one unit to the other.

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

(c) Learners should be taught to master the concept of volume and area.

(d) Teachers should revise basic concepts with learners, i.e. calculation of percentage, difference between capacity and volume.

CHAPTER 3

TECHNICAL SCIENCES

The following report should be read in conjunction with the Technical Sciences question papers of the NSC November 2022 examinations.

3.1 PERFORMANCE TRENDS (2018–2022)

The number of candidates who sat for the Technical Sciences examinations in 2022 increased by 1 111 compared to that of 2021.

Although the table below indicates a negative trend over the years 2018-2020, significant improvements in results are evident in the two years thereafter.

The performance of the candidates in 2022 shows an improvement when compared to the performance in 2021. Candidates who passed at 30% (Level 2) increased from 87,1% in 2021 to 89,9% in 2022. It is also noted that 27,3% of candidates achieved over 50% this year in comparison to 24,3% of candidates doing so in 2021.

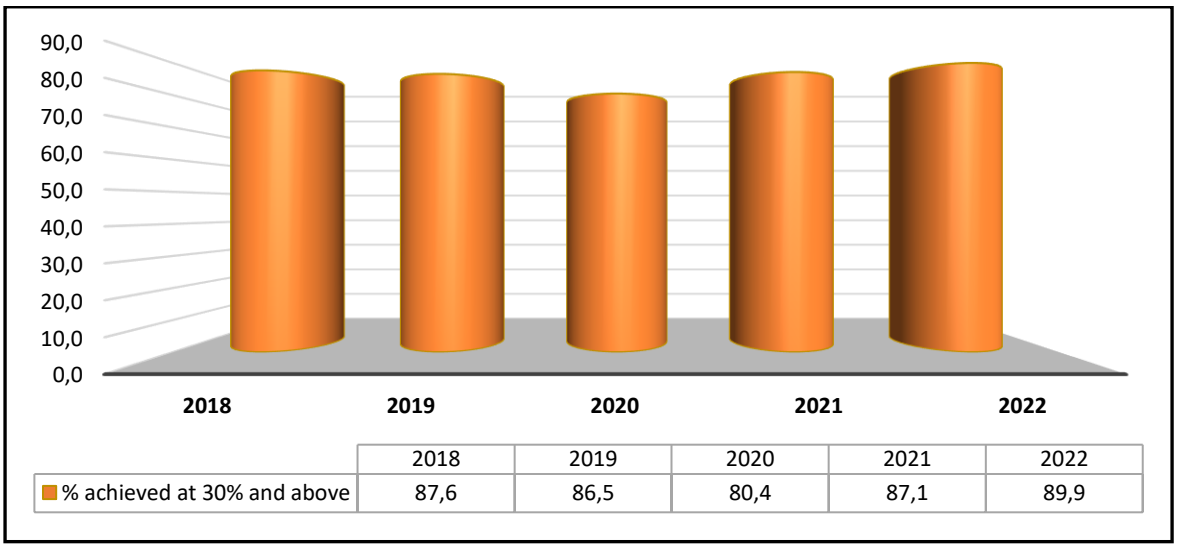
However, there is a decrease in the percentage of distinctions over 80% (Level 7) from 3,0% to 0,9%. This converts into a decrease of 298 in the total number of distinctions.

In view of disruption to academic programmes in 2020 and 2021, the results achieved by this cohort are commendable. Strategic intervention programmes at all levels (National, Provincial, Districts and Schools) ensured that learners were adequately prepared.

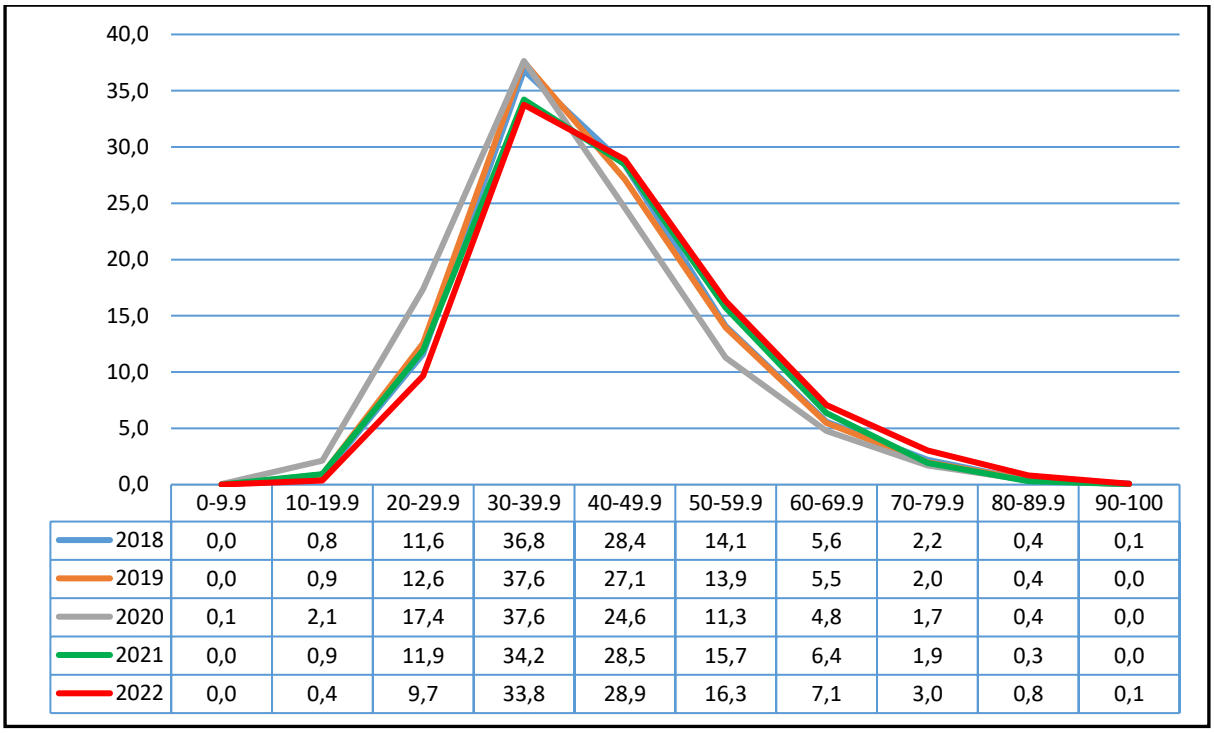
Table 3.1.1 Overall achievement rates in Technical Sciences

Year	No. wrote	No. achieved at 30% and above	% achieved at 30% and above
2018	10 503	9 204	87,6
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

Graph 3.1.1 Overall achievement rates in Technical Sciences (percentage)



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
2018	0,0	0,8	11,6	36,8	28,4	14,1	5,6	2,2	0,4	0,1
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

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 in Q1 and the questions on work, energy and power (Q4); hydraulics and elasticity (Q5); light (reflection and refraction) (Q6) and electromagnetic radiation (Q7) were generally well answered.

(b) In general, Q2, Q3, Q8 and Q10 were poorly answered. Q2 dealt with Newton's laws; Q3 examined momentum and impulse; Q8 focused on electrostatics and Q10 was based on electric circuits.

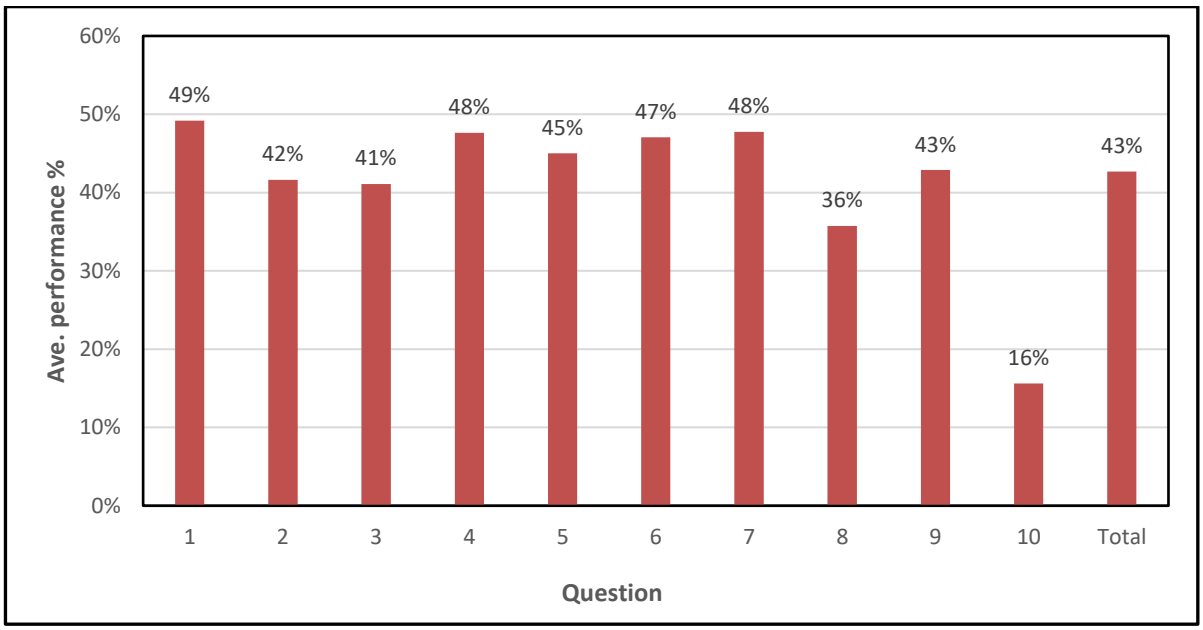
(c) Candidates are still having a challenge in answering recall questions, although there is a notable improvement in these types of questions.

(d) Most candidates showed poor mathematical skills, such as understanding and using formulae and scientific notation as well as interpreting and representing direction in terms of a positive and negative sign.

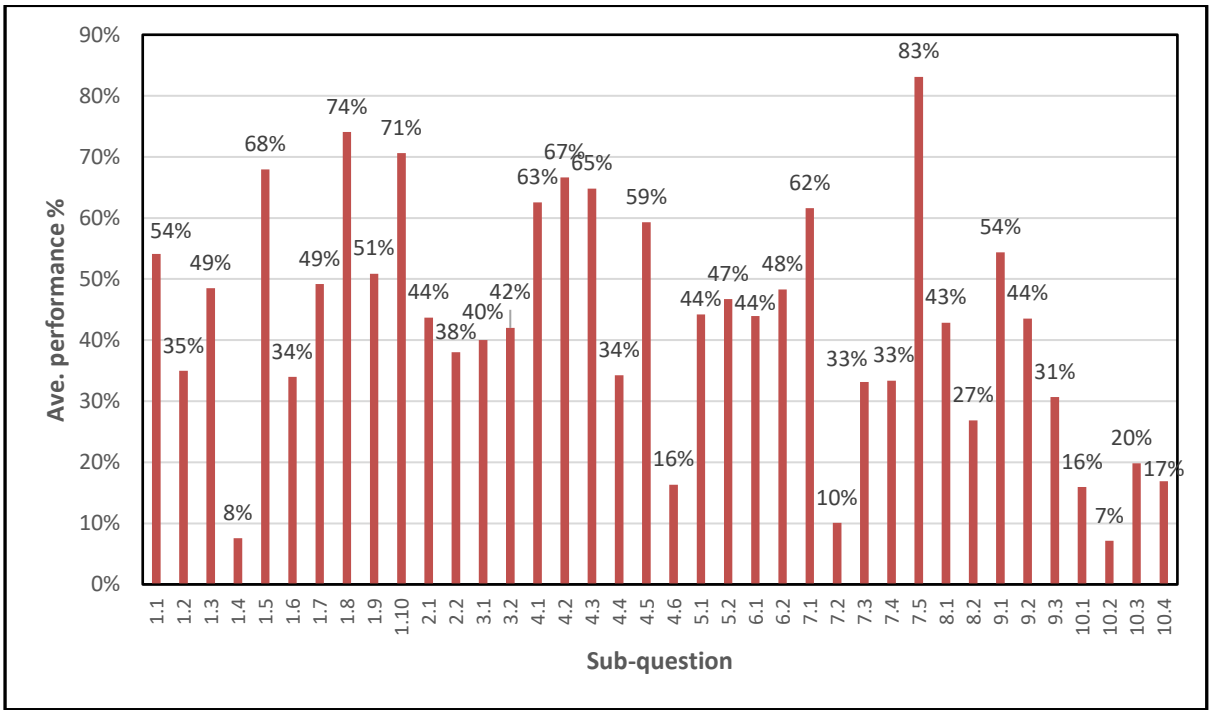
3.3 DIAGNOSTIC QUESTION ANALYSIS OF PAPER 1

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



Graph 3.3.2 Average performance per sub-question 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) In Q1.1 most candidates failed to realise that the frictional force is balanced by the horizontal component of the applied force (i.e. $F_{horizontal} = f$).

(b) The majority of the candidates showed a lack of understanding of action-reaction forces acting on an object in Q1.2.

(c) A notable number of candidates defined impulse as a rate of change in momentum in Q1.3.

(d) In Q1.4 most candidates struggled to use trigonometric functions, special angles and reciprocals when dealing with the force exerted at an angle.

(e) In Q1.6 a significant number of candidates could not manipulate the formula to determine the correct option.

(f) Some candidates were unable to use the formula to determine the relationship between capacitance and electric charge in Q1.9.

Suggestions for improvement

(a) Teachers should focus on developing learners' abilities to answer multiple-choice-questions (MCQ) by reinforcing skills in eliminating incorrect options.

(b) Subject advisors and teachers are strongly encouraged to use previous NSC and preliminary examination papers to compile a booklet of MCQ per topic and distribute it to schools.

(c) Learners must be encouraged to refer to the formula sheet to recall laws and principles as well as to determine the relationship between variables.

(d) The *CAPS* and *Examination Guidelines* must also be used to equip learners to recall definitions of concepts and to state laws and principles.

(e) Teachers are encouraged to assess learners using questions from different cognitive levels ranging from basic calculation to drawing and interpretation of graphs as well as reasoning/justification/evaluation/synthesis.

(f) The use of ICT must be integrated into daily teaching and learning. Software such as *Edukite* or *PhET*-simulations and YouTube videos must be downloaded and used to reinforce understanding of concepts and skills.

QUESTION 2: NEWTON'S LAW OF MOTION

Common errors and misconceptions

(a) In Q2.1.1 a significant number of candidates just wrote it will *move* without stating the direction, i.e. *move/slide forwards*. Other common incorrect responses were *it will fall down* or *move backwards*.

(b) A notable number of candidates did not read the question carefully as they just stated Newton's first law of motion without naming it, thereby forfeiting 1 mark for not naming the law in Q2.1.2.

(c) Most candidates omitted keywords like *net/resultant force*, *remains in rest* or *uniform velocity* when stating Newton's first law of motion.

(d) In Q2.1.3 majority of candidates could not obtain maximum marks in a free-body diagram. Some of the common errors were:
- Incorrect labelling of forces, including using a capital W instead of w for weight
- Incorrect direction for frictional force
- Omitting a dot, or force(s) not in contact with a dot
- Using a line without an arrow head
- Including additional force(s)
- Drawing a force diagram instead of a free-body diagram.

(e) Most candidates committed the following errors in Q2.1.4:
- Using the formulae F_{net} = ma; F = mg or F = ma instead of a = $\frac{\Delta v}{\Delta t}$
- Writing the formula for acceleration as A = $\frac{\Delta v}{\Delta T}$ instead of a = $\frac{\Delta v}{\Delta t}$
- Swapping the values for initial and final velocities
- Not converting velocity from $km \cdot h^{-1}$ to $m \cdot s^{-1}$
- Not writing using the incorrect SI unit for acceleration in the final answer while some wrote $m \cdot s^{-1}$ instead of $m \cdot s^{-2}$
- Omitting the direction in the final answer and forfeited a mark for the final answer.

(f) In Q2.2.1 a notable number of candidates omitted keywords like *net force*, *applied* when stating Newton's second law of motion.

(g) The majority of the candidates had difficulty understanding that *frictionless* means *absence of friction*, i.e. *no friction is involved* in Q2.2.2. Common errors included:
- Using the formula F_g = mg to calculate acceleration of horizontal motion
- Writing F_{net} = ma as F = mg or F = ma, i.e., omitting *net*
- Failing to identify the forces acting on mass 1 and 2; those who managed to do so had a challenge to interpret the direction correctly in terms of a negative or positive sign when substituting the values into the equations.
- Committing errors when dealing with simultaneous equations
- Writing or using the incorrect SI units in the final answer
- Omitting the direction in the final answer and thereby forfeiting a mark for the final answer.

(h) In Q2.2.3 most candidates used an inappropriate formula for the force exerted by m_1 on m_2, like F_g = mg or $\Delta p = m(v_f - v_i)$. A notable number of them substituted 9,8 $m \cdot s^{-2}$ for *a*. Others swapped the forces acting on m_1 for those on m_2 and vice versa.

Suggestions for improvement

(a) Reading the question with understanding is a critical skill. Learners must be taught to read the questions with meaning before attempting to answer.

(b) Teachers should focus on capacitating learners to answer recall questions like defining concepts, stating laws and principles by insisting on the inclusion of keywords.

(c) Learners must be exposed to problems involving the drawing of free-body diagrams. They must also be drilled to identify forces acting on an object as it is a useful skill for problem-solving. The required number of forces must be linked to the mark allocation.

(d) Expose learners to multi-step problems including those that involve two-body systems resulting in solving of simultaneous equations. Feedback must be given promptly.

(e) Learners must be made aware that they will be penalised for each of the following errors:
- Drawing a force diagram instead of a free-body diagram or vice versa
- Omitting the dot
- Using a line instead of an arrow
- Using dotted/broken lines
- Drawing a number of forces that exceed the mark allocation.

(f) Teachers must emphasise the following:
- Selection of a suitable/correct formula based on what the question requires
- Inclusion of units and direction for vector quantities in the final answer.

QUESTION 3: IMPULSE AND CONSERVATION OF MOMENTUM

Common errors and misconceptions

(a) A notable number of candidates omitted keywords like *product* and *net* in Q3.1.1. Some of them used the word *applied force* instead of *net force*.

(b) In Q3.1.2 most candidates used the equation $F_{net} \cdot \Delta t = \Delta p$ and calculated the net force instead of the impulse. A significant number of candidates had a difficulty converting g to kg.

(c) Candidates also substituted a positive value for both initial and final velocity, even though the two velocities were in opposite directions. Some omitted the SI units and/or direction in the final answer.

(d) In Q3.1.3 some candidates did not recognise that the impulse or Δp calculated in Q3.1.2 must be used in the formula $F_{net} \cdot \Delta t = \Delta p$ to calculate the net force.

(e) A significant number of candidates omitted keywords like *total linear* and *isolated* when stating the principle of conservation of linear momentum in Q3.2.1.

(f) In Q3.2.1 most candidates used the formula $F_{net} \cdot \Delta t = \Delta p$ instead of Newton's First Law or inertia to explain how the seatbelt reduces injuries during collision.

(g) Some common mistakes committed by candidates in Q3.2.2 included:
- Using $p_{before} = p_{after}$ or $\sum Ek_i = \sum Ek_f$ instead of $\sum p_{before} = \sum p_{after}$
- The $m_1v_{i1} - m_2v_{i2} = m_1v_{f1} - m_2v_{f2}$ was also used
- Inability to determine the subject of the formula correctly

(h) In Q3.2.3 most candidates started calculations by equating $\sum Ek_i$ to $\sum Ek_f$, i.e. writing $\sum Ek_i = \sum Ek_f$ instead of calculating $\sum Ek_i$ and $\sum Ek_f$ separately/individually.

(i) Some candidates wrote an incomplete formula, they omitted the sigma sign ($\sum$) or $\frac{1}{2}$ in the formula $\sum Ek_i = \frac{1}{2}mv^2$. They also omitted a square when writing or substituting v^2.

Suggestions for improvement

(a) Teachers must highlight keywords when teaching definitions of concepts/terms, stating of laws or principles.

(b) Learners must be taught how to use formulae in the data sheet. They must:
- Be able to identify the relevant equation applicable to a specific problem
- Use equations to explain relationships between different variables

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

(d) Momentum is a vector quantity. Teachers must emphasise the inclusion of the direction in the final answer.

(e) Learners must be drilled on how to differentiate between *elastic* and *inelastic collisions* using a word statement. They must also be in a position to determine whether a collision is elastic or inelastic by means of a calculation.

(f) In calculations to prove that collision is elastic or inelastic by means of a calculation, learners must be taught to refrain from starting by equating $\sum E_{ki}$ to $\sum E_{kf}$, as they automatically forfeit 2 marks for doing so.

QUESTION 4: WORK AND ENERGY

Common errors and misconceptions

(a) Most candidates omitted words like *total, isolated* or *conserved* when stating the principle of conservation of mechanical energy in Q4.1.

(b) Some stated the principle of conservation of linear momentum instead of the principle of conservation of mechanical energy.

(c) A significant number of candidates omitted the units in the final answer. Others wrote incorrect units like $kg.m.s^{-1}$; $m.s^{-1}$ or N instead of J.

(d) In Q4.3 some of the notable errors were:
- Using the formula $ME = E_p + E_k$ without the indication point of reference in the formula, i.e., not writing $(ME)_{at\ C} = (ME)_{at\ B}$ or $(E_p + E_k)_{at\ C} = (E_p + E_k)_{at\ B}$
- Swapping the value for height, h or velocity, v at **C** and **B**
- Omitting the squares when writing or substituting values for v^2

(e) Q4.3 was poorly answered. The common errors were:
- It seems as if candidates were not aware that **T** is a force.
- A significant number of candidates used the formula P = $\frac{W}{\Delta t}$
- Some candidates omitted a subscript ave in the formula $P_{ave} = F\,v_{ave}$.
- Incorrect conversion of kW to W
- Incorrect substitution
- Incorrect SI unit in the final answer

Suggestions for improvement

(a) Learners must be drilled on stating principles and laws as well as definitions of concepts and terms.

(b) Teachers are encouraged to expose learners to informal and formal activities that involve the use of formula/data sheets. Learners must also be drilled on deriving formulae that are not in the formula sheet, for instance $(ME)_{at\,C} = (ME)_{at\,B}$ or $(E_p + E_k)_{at\,C} = (E_p + E_k)_{at\,B}$.

(c) Learners must also be drilled on the difference between *mechanical energy*, *kinetic energy*, *gravitational potential energy* as well as the *principle of conservation of mechanical energy and principle of conservation of linear momentum*.

QUESTION 5: ELASTICITY, HYDRAULICS AND VISCOSITY

Common errors and misconceptions

(a) In Q5.1.1 glaring mistakes included:
- Candidates omitting the keyword *force*
- Using the word *body* instead of *force*
- Defining an elastic body or plastic body instead of a deforming force

(b) A notable number of candidates had difficulty in calculating the area in Q5.1.2. Some common errors were:
- Inability to convert cm to m
- Substituting the value of the diameter for the radius

(c) Most of the candidates were not aware that strain is a ratio in Q5.1.3. They wrote the unit in the final answer, when required to calculate strain.

(d) A notable number of candidates confused the change in length, Δl with strain, ε so they did not write units for change in Q5.1.4.

(e) In Q5.2.1 a significant number of candidates omitted keywords like *continuous*, *liquid* or *equally* when stating Pascal's law.

(f) Some of the notable mistakes in Q5.2.2 were:
- Omitting the subscripts in the formula
- Swapping values for F_1 and F_2 around in the formula, $\frac{F_1}{A_1} = \frac{F_2}{A_2}$
- Not realising that weight is a force
- Omitting the units in the final answer

Suggestions for improvement

(a) Teachers should focus on drilling learners on mathematical skills required in Technical Sciences. Emphasis must be placed on scientific notation, conversion of units and the meaning of prefixes like *nano, giga, mega, milli*, etc. in calculations.

(b) It would benefit learners if they are given more practical problems where they can:
- Use mathematical skills learned in (a)
- Show understanding of the relationship between a *diameter* and *radius*.

(c) Learners must be taught that strain is a ratio, therefore it does not have ratio.

(d) Learners must be trained to refrain from writing units in the final answer when calculating strain.

QUESTION 6: REFRACTION AND REFLECTION OF LIGHT

Common errors and misconceptions

(a) In Q6.1 a large percentage of candidates omitted keywords *bending* or from *one medium to another*. Others defined *reflection* instead of *refraction*. A significant number of candidates just wrote *the bending of light*.

(b) Some candidates wrote *reflected ray* or *emergent ray* instead of *refracted ray* in Q6.2.2.

(c) Candidates also wrote *emergent angle* instead of *angle of refraction* in Q6.2.4.

Suggestions for improvement

(a) Teachers should stick to and put more emphasis on the definitions in the *Examination Guidelines* and the *CAPS*.

(b) Learners must be drilled on the concepts *reflection, refraction* and *dispersion* thoroughly.

(c) Expose learners to class activities that involve the drawing of ray diagrams as light moves from an optically less dense medium to an optical more dense medium and vice versa.

(d) Teachers are encouraged to use live experiments and simulations to enhance learners' understanding of different phenomena and properties of light.

QUESTION 7: ELECTROMAGNETIC RADIATION (WAVES/SPECTRUM)

Common errors and misconceptions

(a) Some candidates wrote *micro-oven* or *macrowave* instead of *microwave* in Q7.1.

(b) A notable number of candidates identified the radiation as a heater in Q7.1.2.

(c) In Q7.1.3 a significant number of candidates wrote *danger* instead of *gamma rays.*

(d) In Q7.2 a notable number of candidates had difficulty stating the uses of UV radiation. Common errors include:
- Protect your eyes and skin
- To make you see better or used in sunglasses
- Protect you from sunrays or tanning

(e) Common errors made when defining a photon in Q7.3 include phrases like:
- Quantum of electromagnetic wave
- Packet of light

(f) Most candidates had difficulty converting from MHz to Hz in Q7.4. The use of scientific notation posed a serious challenge for most candidates as they substituted an incorrect value for the frequency in the formula E = hf.

(g) A significant number of candidates wrote colours that are not component colours of white light, like grey and black, in Q7.5.

Suggestions for improvement

(a) Teachers must emphasise the learning of definitions as they appear in the *CAPS* and *Examination Guidelines*.

(b) Use acronyms and rhymes like *ROYGBIV* and *RMIVUXG* to help learners to recall different colours of the spectrum and radiation of electromagnetic waves, respectively.

(c) Learners must be drilled on arranging the colours of white light in order of increase/decrease in energy, frequency and wavelength as well as from the least to the most refracted colour of light.

(d) They must also be drilled on arranging the radiations of electromagnetic waves in order of increase/decrease in energy, frequency and wavelength.

(e) Formulae, E = hf and E =h $\frac{c}{\lambda}$ must be used to explain the relationship between *energy* and *frequency* or *energy* and *wavelength* of a specific radiation.

(f) Revise the meaning of prefixes *micro, nano, mega, giga*, etc, and use them in calculations to reinforce understanding.

QUESTION 8: ELECTRIC CIRCUITS AND POWER

Common errors and misconceptions

(a) In Q8.1 most candidates had a difficulty calculating magnitude of charge as this was a multi-step problem. A notable number of candidates made the following mistakes:
- Converted mm to m incorrectly or did not attempt to do so.
- Calculated C instead of Q.

(b) In Q8.2.2 and Q8.2.3 candidates had difficulty stating and explaining a relationship between capacitance and the distance between plates of a capacitor.

Suggestions for improvement

(a) Teachers must infuse unit conversion, scientific notation and writing of an SI unit in the final answer in daily activities.

(b) Calculator skills must be an integral part of daily lessons.

(c) Learners must also be encouraged to use a formula sheet to establish a relationship between variables.

QUESTION 9: ELECTRIC CIRCUITS AND POWER

Common errors and misconceptions

(a) A notable number of candidates calculated $\frac{1}{R_P}$ instead of R_p, i.e. they left their answers as $\frac{1}{R_P} = \frac{3}{44}\Omega$ instead of $R_p = \frac{44}{3}\Omega$.

(b) In Q9.2 most candidates used the equation $P = \frac{W}{\Delta t}$ to calculate the power dissipated.
Other common errors include:
- Substituting the resistance of the microwave oven instead of the one for the kettle
- Some wrote *joule* instead of *watt* for the SI units of power in the final answer.

(c) Most of the candidates failed to convert from minutes to seconds, hence they lost two marks in Q9.3.

Suggestions for improvement

(a) Learners must be taught basic concepts of resistors, i.e. how to calculate the total resistance of resistors in series and in parallel.

(b) They must be given informal activities to reinforce the fact that parallel resistors are current dividers and resistors in series are voltage dividers. They must also be encouraged to show all the steps in their calculations and avoid short cuts.,e.g. $\frac{1}{R_P}$ is not the same as R_P.

(c) Learners must know the SI units for different variables and they must be drilled to write units in the final answers of calculations.

QUESTION 10: GENERATORS AND TRANSFORMERS

Common errors and misconceptions

(a) In Q10.1 most candidates had difficulty demonstrating that they know what a galvanometer is and how it functions.

(b) In Q10.2 the majority of the candidates stated Faraday's law instead of using it to state a relationship between the extent of the deflection of a needle, rate of change and induced emf.

(c) A significant number of candidates could not relate electromagnetic induction to Faraday's law in Q10.3. Some wrote Lenz's law.

(d) In Q10.4 a notable number of candidates had a difficulty stating how to increase the magnitude of an induced emf. Some of them listed the factors affecting the emf without explaining how each factor increases the induced emf.

Suggestions for improvement

(a) Teachers are advised to teach learners terminology as they appear in the *CAPS* and *Examination Guidelines*.

(b) *Edukite* or *PhET*-simulations must be used to enhance the understanding of the principle of electromagnetic induction as well as Faraday's law and Lenz's law.

(c) The difference between a *motor* and a *generator*, as well as the difference between an *AC* and a *DC* motor/generator must be explained thoroughly.

(d) Teachers must emphasise the writing of the correct formula, substitution and the need to have units in the final answer.

3.5 OVERVIEW OF CANDIDATES' PERFORMANCE IN PAPER 2

General comments

(a) Q2.1, Q3.1 and Q5.2 on definitions were poorly answered.

(b) Most candidates struggled with Q4: Reactions of organic molecules, Q5: Electrolytic cell and Q6: Galvanic cell.

(c) Q5.7 involving scientific explanation posed a challenge for the candidates.

(d) The interpretation and the use of the Table of Standard Reduction Potentials posed a challenge to most of the candidates.

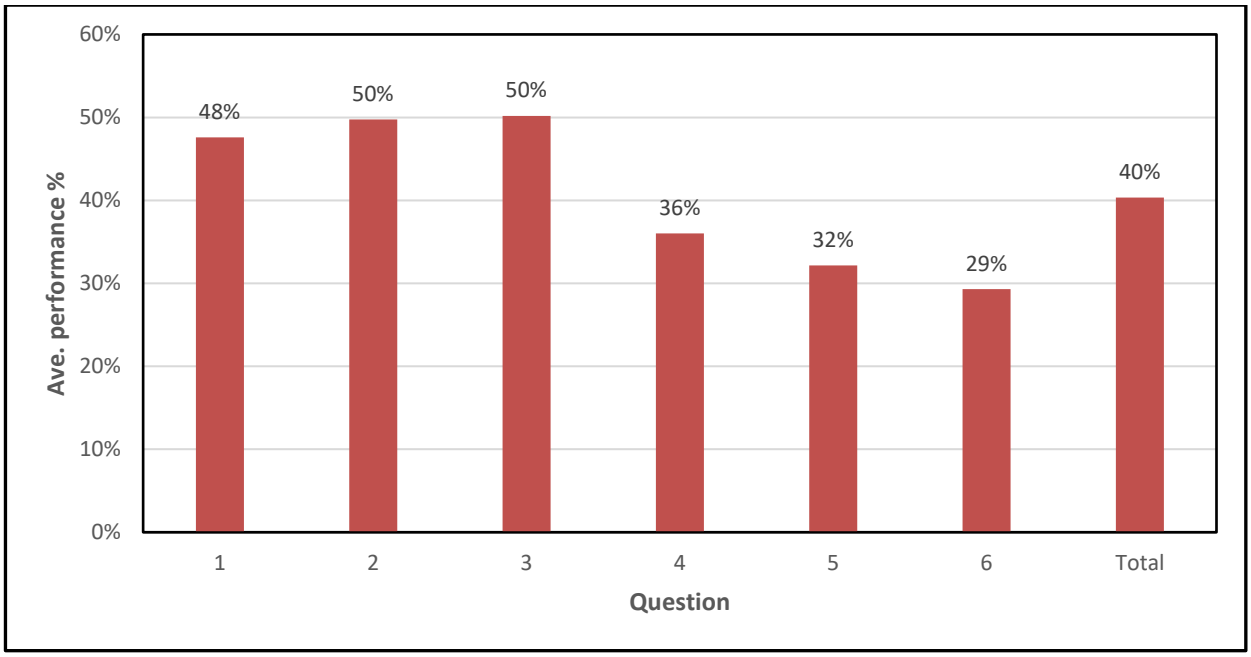
(e) It was disappointing to note that many candidates lack mathematical skills like writing the correct formula from the data sheet, substituting directly to the formula, mathematical manipulation and using incorrect SI units.

(f) Candidates' performances were poor in questions which required motivation using scientific reasoning.

3.6 DIAGNOSTIC QUESTION ANALYSIS OF PAPER 2

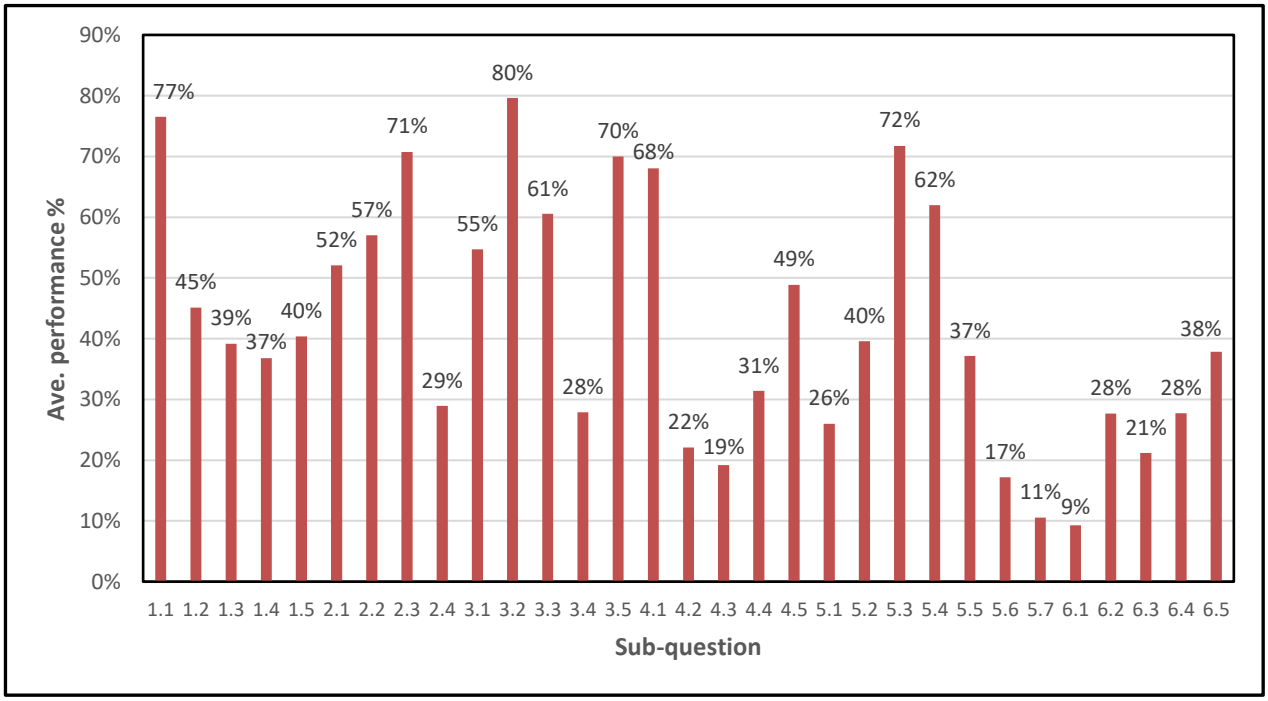
The following graph is based on data from a random sample of candidates. While this graph might not accurately reflect national averages, it is useful in assessing the relative degrees of challenge of each question as experienced by candidates.

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 identify a combination of compounds which are secondary alcohols from the given structural formulae. Most gave an answer for primary and tertiary alcohols.

(b) Candidates were unable to identify examples which are pure semiconductors in Q1.3.

(c) In Q1.4 a significant number of candidates could not select an option which is not an application of electroplating.

(d) The majority of the candidates did not know that the net cell reaction taking place in fuel cells is a galvanic cell and the reaction is exothermic in Q1.5.

Suggestions for improvement

(a) The difference between primary, secondary and tertiary alcohols should be explained using structural formulae.

(b) Teachers must ensure that learners can define and give examples of semiconductors

(c) Teachers are encouraged to emphasise the uses of electroplating.

(d) Fuel cells need to be taught in detail.

(e) Learners must be taught skills to answer the multiple-choice questions by using the elimination method and relating the principles of science to the question.

(f) Teachers should include multiple-choice questions as part of the daily activities to expose learners to how to approach these questions.

QUESTION 2: NAMING OF ORGANIC MOLECULES AND STRUCTURAL FORMULAE

Common errors and misconceptions

(a) When defining the term *homologous series* candidates:

- Left out the word *compound* and included *same molecular formula* instead of *same general formula* in Q2.1.
- Used incorrect words such as *atoms*, *ions* instead of *compounds*, e.g. A series of atoms with the general formula.
- Omitted key phrases such as *same general formula* or CH_2
- Omitted the second part of the definition: *where each member differs from the next by a CH_2 group*
- CH_2 was replaced with the general formula (C_nH_{2n+2}) or Ch.

(b) In Q2.2.2 most candidates could not identify a pair of functional isomers. They failed to understand the concept of functional isomers and only gave letters for isomers which are not functional isomers.

(c) Some candidates struggled to give the IUPAC name compound **E** which was butane in Q2.3 even when the structural formula was given. IUPAC naming rules were not followed, they wrote answers such as *But-1-ane*, *1-Butane* and *4-Butane*.

(d) Common errors committed by candidates when drawing structural formula for methyl ethanoate in Q2.4.1 are as follows:
- They drew the structural formula of ethyl methanoate instead of methyl ethanoate.
- They omitted some of the hydrogen atoms and bonds.
- They gave the incorrect structural formula of the functional group for a carboxylic acid and not an ester.

(e) Candidates drew the structural formula of compound **F** instead of drawing the structure of the functional group in Q2.4.2, and they also wrote *double bond* instead of drawing. Some candidates gave the general formula of the alkenes.

Suggestions for improvement

(a) Teachers must emphasise the inclusion of the key words when defining concepts. Greater emphasis should be placed on the learning of definitions listed in the *CAPS* and the *Examination Guidelines*.

(b) Positional, chain and functional structural isomers should be clearly defined and the difference be thoroughly explained using examples.

(c) Drawing of structural formula of the functional groups and compounds in different homologous series should be assessed. Learners should check whether each carbon atom has four bonds.

(d) Drawing structural formulae, condensed and molecular formulae of organic compounds should be assessed informally and formally.

(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 hydrogens must be included
- All bonds must be indicated.
- Hydrogen should have only ONE bond.

(f) More informal activities on naming and drawing of organic molecules should be given.

QUESTION 3: PHYSICAL PROPERTIES OF ORGANIC COMPOUNDS

Common errors and misconceptions

(a) When defining the term *boiling point* in Q3.1 candidates:
- Left out the words *temperature*, *pressure*
- Used words such as *equilibrium*, *remain the same* and *balanced* instead of *equals to*.
- Instead of writing *temperature* wrote *the point/the pressure*.
- Defined it as temperature at which vapour pressure is equal to *atmosphere* instead of *atmospheric pressure*.

(b) Candidates failed to name the compounds by interpreting the boiling point graphs in Q3.3.1 to Q3.3.3. They failed to link the given graph with the IUPAC name and the strength of intermolecular forces.

(c) Most candidates omitted the hyphen in propan-1-ol, even though the name was given in the question paper in Q3.3.2. They also wrote *pro-1-ol* instead of *propan-1-ol*.

(d) When explaining the difference in the vapour pressure of propanoic acid (carboxylic acid) and propan-1-ol (an alcohol) in Q3.4, candidates:
- Could not identify the correct type of intermolecular forces
- Struggled to compare the strength of the intermolecular forces, they referred to *higher intermolecular forces* instead of *stronger intermolecular forces*
- Failed to indicate how the energy affects the boiling points of alkanes and alcohols
- Used the abbreviation *IMF* instead of *intermolecular forces*
- Used terms such as *hydrogen force* or *hydrogen strength* instead of *hydrogen bonds*
- Mentioned breaking the bonds instead of overcoming the intermolecular forces

(e) The language ability of these candidates is poor, and they struggle to use the correct words to express themselves. They used words such as *larger* and *bigger* instead of *stronger* or *weaker*; and *higher* and *lower* instead of *increase* or *decrease*.

Suggestions for improvement

(a) Teachers must emphasise the importance of stating the key words when defining concepts and stating the laws.

(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
- Compare energy needed to overcome the intermolecular forces
- Explain the relationship between boiling point and vapour pressure.

(c) Teachers must expose learners to questions which will develop skills on how to interpret tables and graphs and assign science concepts to the information given. Mind maps can also be used to summarise content relating to physical properties of organic compounds.

(d) Teachers must emphasise the relationship of physical properties and the impact they have on one another.

(e) Teachers must train learners to pay attention to the mark allocation of a question, which will inform them regarding the extent to which the answer should be given.

(f) Intermolecular forces should be thoroughly taught to explain physical properties. Teachers should tabulate different types of intermolecular forces, identify their strengths and how it influences the boiling points of various molecules/homologous series.

(g) 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.

(h) 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) A significant number of candidates could not name the types of reactions in Q4.1.1; Q4.1.2; Q4.3.1 and Q4.4.1 from the flow diagram. They failed to interpret the flow diagram to identify the type of reaction**.**

(b) In Q4.1.1 the given responses were *adding*, *add and additional* instead of *addition*.

(c) Substitution reaction was referred to as *subtraction reaction* in Q 4.1.2 and in Q4.3.1 the incorrect responses were *addition* and *substitution* instead of *combustion/oxidation*.

(d) In Q4.2 most candidates:
- Used the structural formula instead of the molecular formula when writing the chemical equation for reaction of ethene and hydrogen gas
- Seem not to know the difference between *molecular formula* and *structural formula*
- Used an equal sign instead of an arrow
- Omitted H_2 as a reactant.

(e) In Q4.3.2 candidates failed to give the name or the formula of compound **X** as carbon dioxide (CO_2) when ethane reacted in excess oxygen.

(f) Candidates struggled to write down reaction conditions for the reaction of hydration of chloroethene in Q4.4.2. The responses included *sunlight or heat* instead of *mild heat* and *water* instead of *excess water*.

(g) Most candidates could not name compound **Y** which was formed in Q4.4.3 for the reaction of chloroethane and water. Some wrote *alcohol* or *ethan-1-ol* instead of *ethanol*.

(h) In Q4.5.1 candidates gave examples of semi-conductors instead of the collective name semiconductors/metalloids/semimetals.

(i) When defining the term *doping*, candidates left out the word *intrinsic* and *process* in Q4.5.2. They also replaced the word *semiconductor* with *conductor*.

Suggestions for improvement

(a) The different types of reactions should be thoroughly explained and identified from the flow diagram. The reaction conditions for the reactions should be emphasised.

(b) To help with the interpretation of the flow diagram to identify different types of reactions, different analogies can be used to mitigate the challenge.

Analogy	Reactant	Product	Type of reaction
USA	Unsaturated	Saturated	Addition
SSS	Saturated	Saturated	Substitution

(c) Learners must be drilled on using molecular formula, structural formula and condensed structural formulae to write chemical reactions.

(d) Define and state laws as stated in the *CAPS* and the *Examination Guidelines* and key words should be emphasised.

(e) A clear distinction should be made between the *forward biased* and *reverse biased diode*.

QUESTION 5: ELECTROLYTIC CELL

Common errors and misconceptions

(a) In Q5.1 most candidates struggled to write the magnitude of the copper charge in $CuC\ell_2$. They confused the magnitude of the charge of copper with E^θ values +0.16 V or +0,34 V of the half reactions of copper as found on the Standard Reduction Potentials Table. Some wrote the half reaction of Copper: $Cu^{2+} + 2e^- \rightarrow Cu$

(b) In Q5.2 most candidates:
- Defined *electrolysis* incorrectly as *electrical energy is converted to mechanical energy* instead of defining it as *a chemical process in which electrical energy is converted to chemical energy*
- Referred to this electrolysis as a substance or a cell and not as a process

(c) Some learners swapped the electrodes around between the anode and the cathode in Q5.4.

(d) Some candidates could not write the observations made at electrode **P** (anode) and electrode **Q** (cathode) in Q5.5.1 and Q5.5.2. They also swopped the observations made at the cathode and the anode.

(e) Most candidates struggled to write the chemical equation of the net cell reaction in Q5.6. Challenges included:
- Omitting ions in the reactants
- The reactants and products were swopped
- Use of the equal sign instead of the arrow to separate reactants and products
- Loss of marks for writing wrong phases.

(f) Candidates were unable to explain why $CuC\ell_2$ in Q5.7 was used in a molten state.

Suggestions for improvement

(a) The oxidation state of atoms in compounds should be thoroughly taught in Grade 11. Worksheets should be prepared for the topics done in Grade 10 and 11 but examinable in Grade 12.

(b) Ensure that the definitions are stated as they appear in the *Examination Guidelines* and the *CAPS*.

(c) Polarity of the electrodes should be used to determine which one is the cathode and which one is the anode in an electrolytic cell.

(d) The experiment on the decomposition of copper chloride and electroplating should be conducted and an explanation should be provided on the observation made.

(e) More activities on writing net cell reactions and half reactions should be given as informal activities. Learners should get more practice with the balancing of reactions.

(f) Teachers must explain and use simulations for the movement of ions in an electrolyte of an electrolytic cell.

QUESTION 6: GALVANIC CELL

Common errors and misconceptions

(a) Most candidates could not explain what the single vertical line in the cell notation represents in Q6.1. Most identified it as a salt bridge or liquid changes to a solid.

(b) In Q6.2 candidates used incorrect units and values when writing the standard conditions. They wrote:
- Concentration: 1 mol/dm^{-3} or 1 mol·d^{-3} or 1 mol·dm^3
- Candidates used these units for temperature: 25 °
- Pressure as one of the conditions.

(c) Most candidates could not write the name or the formula of the oxidising agent in Q6.3 and they also omitted ions. Most learners wrote *Copper/Cu* instead of *Cu^{2+}/Copper (II) ions*. Some wrote the *half reaction of Cu^{2+}* instead of identifying the oxidizing agent.

(d) Most candidates struggled to identify the polarity of the anode and the cathode of a galvanic cell in Q6.4.1 and Q6.4.2. They seemed not to understand what the term *polarity* means. Most learners wrote *Cu^{2+}* and *Cl^-*.

(e) In Q6.5 candidates struggled to use calculation to identify metal **Y**. They used unconventional formulae and swopped the value of the anode and the cathode. They also omitted the SI unit. Most candidates wrote the half-cell reaction of Zinc instead of identifying the metal.

Suggestions for improvement

(a) Teachers must explain how the cell notation is written and what the symbols represent. Use mnemonic device like, **ABC,** where **'A'** represents anode which is to be written on the left, **'B'** for the salt bridge represented by parallel vertical lines and **'C'** for the cathode to be written on the left and single line as a phase boundary/interphase.

(b) Teachers should ensure that learners write the correct values and units of standard conditions of a galvanic cell.

(c) Use the Table of Standard Reduction Potentials to identify the oxidising and reducing agents in electrochemical cells. Teach learners stock notation when naming copper (II) chloride and not just copper chloride.

(d) Teachers must encourage learners to use and write formulae that are on the formula sheet.

(e) Calculations relating to the emf of the cell should be assessed informally and formally.

(f) Perform experiments and teach learners how to observe and write down observations.

(g) Discuss the differences between environmental advantages and uses and/or sources of alternative energy.

CHAPTER 4

CIVIL TECHNOLOGY

Civil Technology encompasses three specialisation subjects, namely Civil Services, Construction and Woodworking. This was the fourth examination in which the specialisation subjects were examined. The following report should be read in conjunction with the respective question paper of the November 2022 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:

The following trends were identified in the 2021 NSC examinations, however, the challenges stated in the 2021 diagnostic report were still evident in the 2022 November NSC examinations.

(a) It was observed that many candidates did not start each question on a new page as indicated in the instructions.

(b) Many candidates were not able to correctly interpret and use subject-specific and academic terminology.

(c) Most candidates demonstrated poor drawing and interpretation skills. Many candidates could not differentiate between line diagrams, sketches, pictorial views and scale drawings. Many scale drawings were not done using drawing equipment.

(d) Responses from candidates showed that the candidates lacked practical exposure and experience.

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

(f) Describing and explaining posed a challenge for many candidates and they were not equipped to express themselves when responding to these types of questions.

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

(h) Due to the lack of practical experience, many candidates found it difficult to explain practical applications theoretically.

(i) A significant number of candidates provided only one response instead of two in a question that counts 2 marks.

(j) It was observed that the candidates performed poorest in the topics indicated last in the ATP. A possible reason for the poor performance may be that at the end of the year, teachers are under pressure to complete the ATP and do not spend enough time teaching these topics.

(k) The activities in the textbooks are not sufficient and, in many instances, do not address the expected outcomes of the *CAPS*. Teachers should therefore develop alternative

questions that address the expected outcomes, as listed in the *CAPS* for all the topics, to cover all cognitive levels.

(l) 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.

(m) 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 candidate responds incorrectly to the instructions, they may lose marks as a result.

(n) Teachers and learners 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	MARK	CM
Correctness of sectional view	2	
Members	10	
Projection lines	1	
TOTAL:	13	

NO	ASSESSMENT CRITERIA	MARK
1	Correctness of sectional view	2
2	Natural ground level	1
3	Brick pier	1
4	Outer wall	2
5	Plaster	1
6	Wall plate	1
7	Bearer	1
8	Joists	3
9	Projection lines	1
	TOTAL:	13

4.1 CIVIL SERVICES

The following report should be read in conjunction with the Civil Services question paper of the November 2022 examinations.

4.1.1 PERFORMANCE TRENDS (2018–2022)

The number of candidates who wrote the Civil Services examination in 2022 increased by 101 compared to that of 2021.

The table below indicates consistent performance over the past four years with pass rates in the 93% to 99% range. The performance of the candidates in 2022 remains consistent with 96,8% of candidates passing at 30% (Level 2).

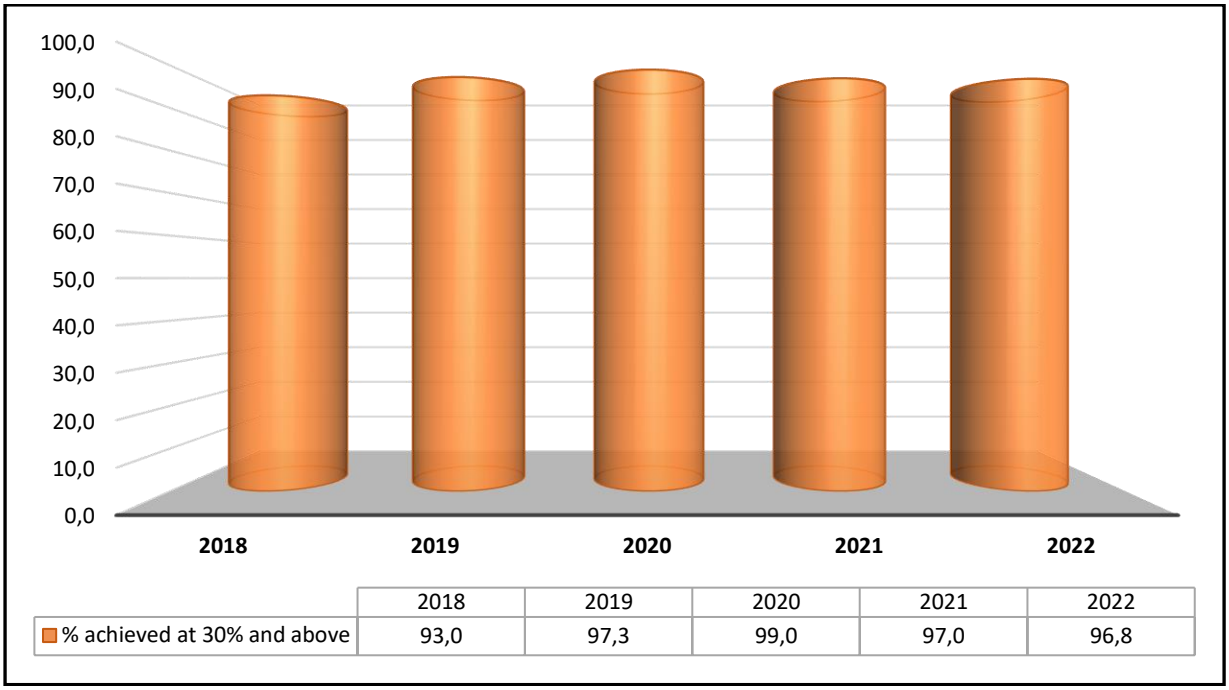
There was a decline in performance at 50% (Level 4) with 57,5% of candidates achieving this level in 2022 compared to 61,3% doing so in 2021. The percentage distinctions over 80% (Level 7) remains static at approximately 3%. This converts into a total of 20 candidates who achieved distinctions in 2022.

In view of disruption to academic programmes in 2020 and 2021, and despite some of the factors mentioned above, the results achieved by this cohort are commendable. Strategic intervention programmes at all levels (National, Provincial, Districts and Schools) ensured that learners were adequately prepared.

Table 4.1.1 Overall achievement rates in Civil Services

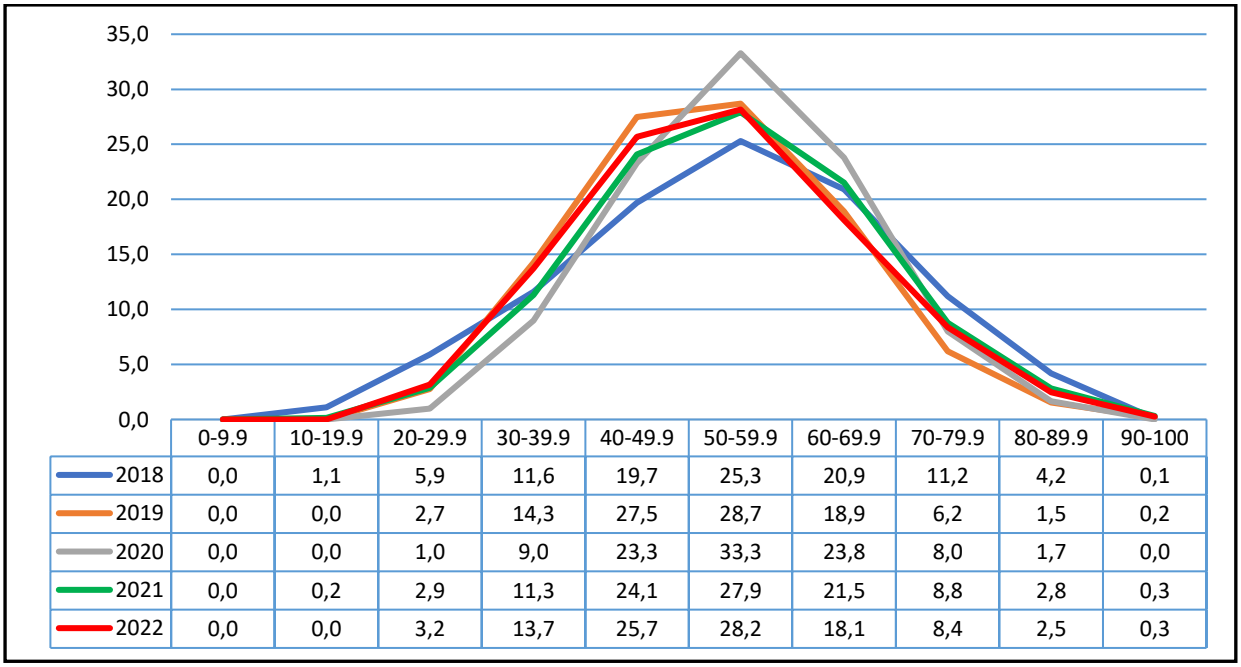
Year	No. wrote	No. achieved at 30% and above	% achieved at 30% and above
2018	795	739	93,0
2019	582	566	97,3
2020	601	595	99,0
2021	627	608	97,0
2022	728	705	96,8

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



	2018	2019	2020	2021	2022
% achieved at 30% and above	93,0	97,3	99,0	97,0	96,8

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
2018	0,0	1,1	5,9	11,6	19,7	25,3	20,9	11,2	4,2	0,1
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

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 (5 marks) candidates did not respond well to the question by writing the full statement in brackets, e.g. *oil or water-based paint* as required, but only wrote *oil based* or *water-based paint* and were not credited for the incomplete statements.

(b) In Q1.2.1 (1 mark) most candidates were not able to state the maximum angle of the staircase.

(c) In Q1.3 (2 marks) many candidates could not explain the safety precautions that need to be adhered to when transporting a ladder. Instead, the candidates wrote general safety precautions for the use of ladders.

(d) In Q1.4 (1 mark) most candidates could not state the safety component that can be positioned above workers to protect them from falling objects. Instead, the candidates stated personal protective equipment, e.g. hard hat to protect the head.

(e) In Q1.5 (1 mark) only a few candidates were able to name the component that will ensure the stability of a scaffold in all directions. Most candidates responded with general safety precautions that are relevant to a scaffold.

(f) Q1.6 (1 mark) was well answered by most candidates.

(g) In Q1.7 (1 mark) many candidates were not able to convert the ratio of a stack that may not be higher than three times the width to a figure of three metres if the width is one metre.

Suggestions for improvement

(a) It is recommended that teachers ensure that learners fully understand the importance of quoting the full statements provided in this type of questions.

(b) It would be beneficial to learners if they are taught to summarise and learn important detail regarding the specifications of different construction processes so that they can apply this knowledge where required.

(c) Learners should be taught the importance of reading the question carefully and to isolate the exact aspect within the topic that should form the basis of their response.

(d) More emphasis should be placed on the use of practical demonstrations of the application of safety features used on a building site. Learners should be given the opportunity to see these safety features in use practically.

(e) Practical demonstrations of the erecting of scaffolding can be used to familiarise learners with all the components and safety features of the different types of scaffolding.

(f) It would be to the advantage of learners if they are taught how to apply basic mathematical conversions and to apply logical thinking skills in various situations.

QUESTION 2: GRAPHICS AS METHOD OF COMMUNICATION

Common errors and misconceptions

(a) Many candidates experienced challenges reading and interpreting the floor plan and elevation. They were not able to identify, draw and interpret drawing symbols.

(b) The use of the correct subject terminology seems to be a challenge for many candidates. When candidates are asked to identify features or objects in the drawings, they used layman's terminologies or gave explanations.

(c) In Q2.4 (1 mark) many candidates were not able to correctly identify the *balcony*.

(d) In Q2.8 (1 mark) some candidates identified the ramp as paving or garage entrance.

(e) In Q2.12 (1 mark) some candidates used lowercase letters instead of capital letters to indicate the FFL and NGL and was not credited for the answer as a result.

(f) Poor performance by candidates was noted in Q2.22 (1 mark), Q2.23 (1 mark) and Q2.23 (1 mark) where the candidates failed to correctly draw the symbols for face brick, earth and the grease trap.

(g) In Q2.25 (7 marks) and Q2.26 (3 marks) there was a slight improvement in responses from candidates who could correctly deduce the dimensions from the floor plan and calculate the length of the sides of the building as well as the area of a room.

Suggestions for improvement

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

(b) A lot of attention should be given to the correct subject terminology when explaining content to learners. Learners should always be corrected when they respond using the wrong terminology when interacting in the classroom.

(c) More analytical questions and worksheets, similar to Q2, should be done in class focusing on the correct terminology for each part of the drawings.

(d) The correct use of subject terminology should be emphasised to ensure learners avoid unnecessary loss of marks using incorrect terms.

(e) It is recommended that teachers emphasise the importance of indicating abbreviations of information and symbols used on building plans in the correct format (uppercase or lowercase letters) to ensure that learners do not lose easy-to-score marks.

(f) It is recommended that teachers require learners to draw the symbols used on building plans and write the abbreviations of these symbols during class and homework activities and to give short informal assessments on this topic on a regular basis.

(g) Learners should be exposed to more calculations involving area, perimeter and lengths of walls to ensure that they have mastered the mathematical concepts.

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

Common errors and misconceptions

(a) Q3.1 (2 marks) was poorly answered by most candidates. They were not familiar with the correct positioning of manholes in a sewerage system.

(b) In Q3.2 (2 marks) most candidates were not able to explain the purpose of the slope of the benching in a manhole.

(c) Many candidates had difficulty drawing the sketch for the support of firm ground during excavations, as required in Q3.4 (6 marks). This seemed to be because candidates had not been exposed to the specific practical aspects of the supporting of excavations.

(d) In Q3.6 (2 marks) the majority of candidates were not able to explain why a competent person should be appointed to prepare a fall protection plan.

(e) In Q3.9 (6 marks) most of the candidates demonstrated a poor understanding of the basic concepts in the calculation of the volume of a cubical water storage tank and to convert the volume to litre.

(f) In Q3.10 (6 marks) many candidates were not familiar with the brick bond tested and were not able to correctly project and draw the front view of the two consecutive brick courses.

Suggestions for improvement

(a) It is recommended that teachers teach sewerage plans and the components of a sewerage installation by means of practical lessons where learners can see and understand the parts and principles of a sewerage system.

(b) It is advised that aspects pertaining to the support of excavations be coupled with a practical demonstration using scale models of trenches along with the members used to support the excavations in different soil types. Pictures and video clips can be used to enhance the understanding of the support of excavated trenches.

(c) It will be beneficial for learners if they can be taught to think critically and instead of rote learning and repetition, be able to understand concepts and apply their knowledge in other contexts.

(d) Subject advisors should conduct workshops on the calculation of quantities. It is recommended that teachers first explain the concept of the specific items that the quantities should be calculated for, before explaining the actual calculation. It will be beneficial for learners if they are given more exercises on the calculation of quantities of each item than the one example in the textbook. These additional exercises should form part of the teacher's lesson preparation.

(e) It will be beneficial for learners if they are exposed to the practical dry packing of the different brick bonds. Learners should also make freehand drawings of the different brick bonds as they see it after dry packing.

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

Common errors and misconceptions

(a) In Q4.1 (8 marks) many candidates had difficulty matching the description in the matching column question with the item. Candidates had to demonstrate deeper insight into the parts and working principles of valves and components than the mere identification and use and were not fully equipped to respond in the required manner.

(b) In Q4.2 the majority of candidates were not able to correctly identify the fitting, explain the function of the fitting and explaining the purpose of the rubber seal of the fitting.

(c) In Q4.3 (4 marks) most candidates were not familiar with the jetting machine and the working principles of the machine. Candidates experienced challenges explaining how the machine works to clean a blocked drain.

(d) Many candidates demonstrated a poor understanding of the use of a water pressure testing pump and a compressed air test apparatus in Q4.4.

(e) In Q4.5 most candidates had difficulty explaining what an *Airloc* is.

(f) In Q4.7 (3 marks) most candidates could not state the direction in which solar panels should face to obtain maximum exposure to the sun and very few candidates were able to draw the cross-sectional view of an evacuated tube correctly.

(g) In Q4.9 (5 marks) it was evident that most candidates were not familiar with the components and position of the different components including the cold-water inlet and hot-water outlet. Most candidates could not able to draw the required components in the correct position.

Suggestions for improvement

(a) More emphasis should be placed on the practical disassembly, reassembly and installation of valves to enable learners to see the different parts of the valves and the purpose of each part.

(b) It will be beneficial for learners if they can be shown the different waste-pipe and soil-pipe fittings of a sewerage system and to allow them to assemble these pipes using the different pipe fittings in the workshop to simulate a sewerage system.

(c) It is recommended that teachers use pictures and/or video clips that can be obtained from YouTube to explain the parts and working principles of machines that are not available at schools.

(d) A practical demonstration will help learners to develop a better understanding of the different faults that may occur in hot- and cold-water systems.

(e) Teachers are advised to explain the orientation and movement of the sun during the different seasons to learners so that they can understand why solar panels should face north in order to obtain maximum exposure to the sun for the longest period of the day.

(f) The challenge with the position of the different components of a geyser can best be addressed by using a practical demonstration of the complete installation of a high-pressure geyser and learners should then do the installation themselves under supervision of the teacher. Old geysers and components can be used for this exercise.

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

Common errors and misconceptions

(a) In Q5.1 (2 marks) most candidates struggled to name the places where flashings are commonly used.

(b) In 5.2 (4 marks) many candidates were not familiar with the components of a PVC gutter system and had difficulty explaining the function and purpose of the different components.

(c) Poor performance was evident in the drawing of the development of the square-based truncated pyramid in Q5.5 (20 marks). It was disappointing to note that a large percentage of candidates could not determine the true length of the sides of the pyramid and were not able to apply the basic drawing principles for developments or did not attempt the question at all.

Suggestions for improvement

(a) It will benefit learners if a PVC gutter with gutter clips, gutter outlet, stop ends and a down pipe can be erected in the workshop so that learners can be exposed to this topic in a real-life context. A possible reason for the poor performance in this topic can be that this is one of the last topics in the ATP and teachers do not plan for sufficient time to cover this topic in detail.

(b) It is recommended that teachers use pictures and/or video clips that can be obtained from YouTube to explain the position and purpose of flashings. A tour around the school can also assist learners to understand the position and use of flashings if the teacher points out the flashings on school buildings.

(c) Workshops on the development of cones and pipes and pyramids, conducted by subject specialists, will benefit teachers. Making paper or cardboard models of the developments listed in the *CAPS* will assist learners with their understanding of these concepts. The Grade 10 and 11 PATs can also be used to develop the skills of learners in this topic. A possible reason for the poor performance in this topic can be that Civil Technology teachers rely on the EGD teachers to teach this topic and do not teach and give enough examples to learners to draw in the Civil Technology class.

QUESTION 6: SEWERAGE, SANITARY FITTINGS AND JOINING

Common errors and misconceptions

(a) In Q6.2 most of the candidates were not familiar with the terms *sewerage* and *sewage* and could not explain the meaning of the terms as required.

(b) In Q6.3 the majority of candidates were not able to correctly identify the fitting, explain the function of the fitting and explain where this fitting is used.

(c) In Q6.5 (8 marks) many candidates had difficulty identifying the conservancy tank and were not equipped to explain the reason, function and different parts of the conservancy tank.

(d) Most candidates had difficulty explaining the final steps in the treatment process of water to make it safe for consumption in Q6.6.

(e) Poor performance was observed in the designing and drawing of the sewerage plan for a dwelling in Q6.8. A possible reason may be that candidates were not exposed to the practical application of the design and layout of a sewerage system according to drainage principles and regulations. The correct flow direction of branch pipes, the correct connection of two sewer lines and the positioning of the rodding eyes posed the biggest challenge for candidates in this question.

Suggestions for improvement

(a) Teachers are encouraged to develop a glossary with subject terminology and the explanation of the different terms in each topic taught.

(b) Teachers are advised to show learners different fittings of a sewerage system and to allow them to practically install the different pipe fittings in the workshop to understand the position and function of each type of fitting.

(c) It will benefit learners if teachers practically demonstrate the working principles and purpose of conservancy tanks.

(d) A possible reason for the poor performance in this question may be that candidates were not exposed to the treatment process of water as this is one of the last topics in the ATP. It is recommended that teachers ensure that they cover all the topics before the start of the preparatory examination.

(e) Subject advisors should conduct workshops on the design and installation of a sewerage system by taking teachers on a site excursion around a school to show them the different parts of a sewerage system. This will assist teachers in understanding the function and position of each component before going into a classroom to demonstrate to their learners how to design and draw the layout of a sewerage system. Teachers might find that replicating the strategy of a real-life tour of the school will enhance learners' understanding of the details of this topic.

4.2 CONSTRUCTION

The following report should be read in conjunction with the Construction question paper of the November 2022 Examinations.

4.2.1 PERFORMANCE TRENDS (2018–2022)

The number of candidates who sat for the Construction examination in 2022 increased by 299 compared to that of 2021.

The table below indicates consistent performance over the past four years with pass rates in the 98% to 99% range. The performance of the candidates in 2022 remains consistent with 97,3% of candidates passing at 30% (Level 2).

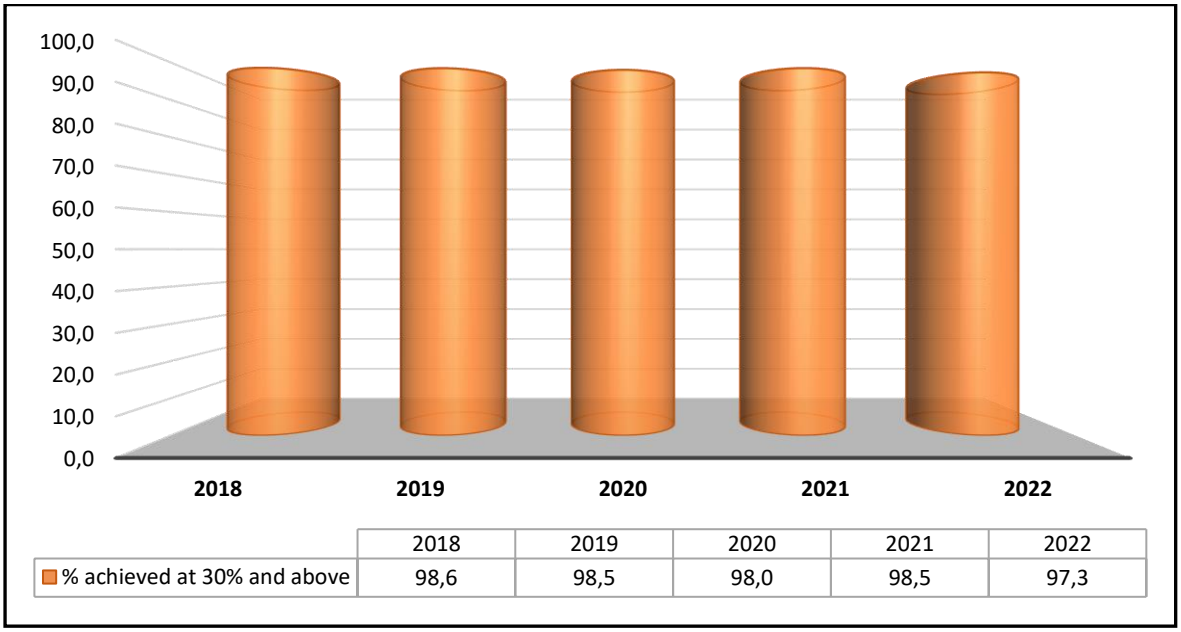
There was a decline in performance at 50% (Level 4) with 56,3% of candidates achieving this level in 2022 compared to 62,7% doing so in 2021. The percentage of distinctions over 80% (Level 7) declined slightly from 3,0% to 2,6%. This converts into a total of 124 candidates who achieved distinctions in 2022 compared to 134 in 2021.

In view of disruption to academic programmes in 2020 and 2021, and despite some of the factors mentioned above, the results achieved by this cohort are commendable. Strategic intervention programmes at all levels (National, Provincial, Districts and Schools) ensured that learners were adequately prepared.

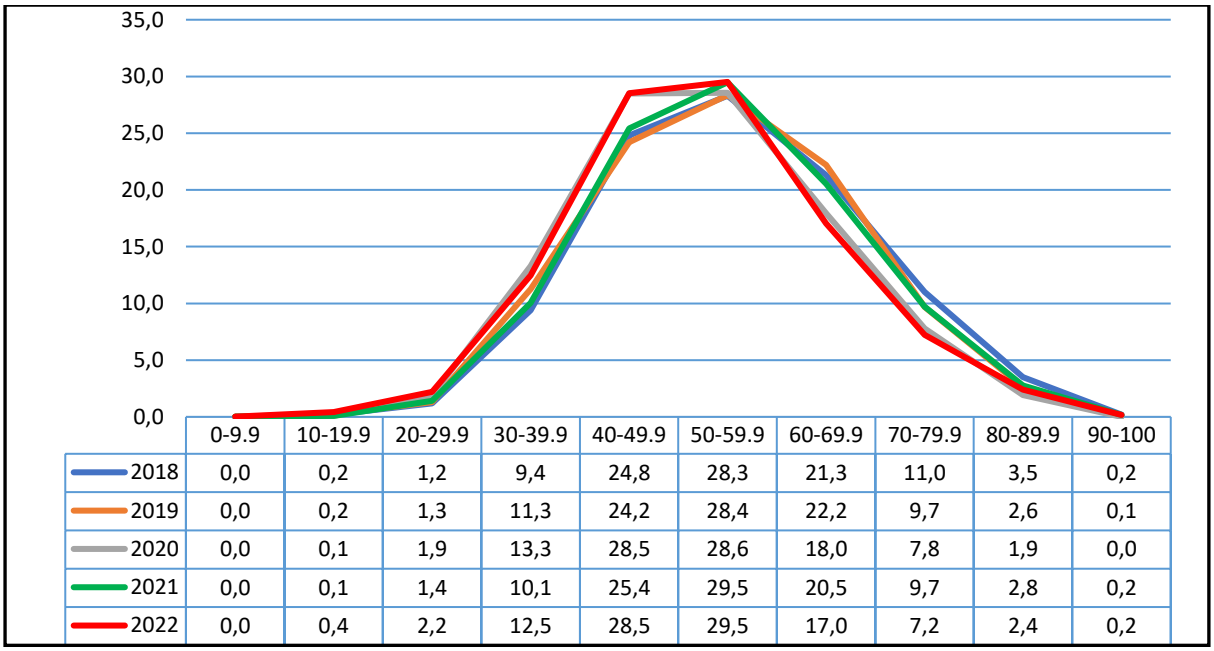
Table 4.2.1 Overall achievement rates in Construction

Year	No. wrote	No. achieved at 30% and above	% achieved at 30% and above
2018	4 350	4 288	98,6
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

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
2018	0,0	0,2	1,2	9,4	24,8	28,3	21,3	11,0	3,5	0,2
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

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 (5 marks) candidates did not respond well to the question by writing the full statement in brackets, e.g. *oil or water-based paint* as required, but only wrote *oil based* or *water-based paint* and were not credited for the incomplete statements.

(b) In Q1.2.1 (1 mark) most candidates were not able to state the maximum angle of the staircase.

(c) In Q1.3 (2 marks) many candidates could not explain the safety precautions that need to be adhered to when transporting a ladder. Instead, the candidates wrote general safety precautions for the use of ladders.

(d) In Q1.4 (1 mark) most candidates could not state the safety component that can be positioned above workers to protect them from falling objects. Instead, the candidates stated personal protective equipment, e.g. hard hat to protect the head.

(e) In Q1.5 (1 mark) only a few candidates were able to name the component that will ensure the stability of a scaffold in all directions. Most candidates responded with general safety precautions that are relevant to a scaffold.

(f) Q1.6 (1 mark) was well answered by most candidates.

(g) In Q1.7 (1 mark) many candidates were not able to convert the ratio of a stack that may not be higher than three times the width to a figure of three metres if the width is one metre.

Suggestions for improvement

(a) It is recommended that teachers ensure that learners fully understand the importance of quoting the full statements provided in this type of questions.

(b) It would be beneficial to learners if they are taught to summarise and learn important detail regarding the specifications of different construction processes so that they can apply this knowledge where required.

(c) Learners should be taught the importance of reading the question carefully and to isolate the exact aspect within the topic that should form the basis of their response.

(d) More emphasis should be placed on the use of practical demonstrations of the application of safety features used on a building site. Learners should be given the opportunity to see these safety features in use practically.

(e) Practical demonstrations of the erecting of scaffolding can be used to familiarise learners with all the components and safety features of the different types of scaffolding.

(f) It would be to the advantage of learners if they are taught how to apply basic mathematical conversions and to apply logical thinking skills in various situations.

QUESTION 2: GRAPHICS AS METHOD OF COMMUNICATION

Common errors and misconceptions

(a) Many candidates experienced challenges reading and interpreting the floor plan and elevation. They were not able to identify, draw and interpret drawing symbols.

(b) The use of the correct subject terminology seems to be a challenge for many candidates. When candidates are asked to identify features or objects in the drawings, they used layman's terminologies or gave explanations.

(c) In Q2.4 (1 mark) many candidates were not able to correctly identify the *balcony*.

(d) In Q2.8 (1 mark) some candidates identified the ramp as paving or garage entrance.

(e) In Q2.12 (1 mark) some candidates used lowercase letters instead of capital letters to indicate the FFL and NGL and was not credited for the answer as a result.

(f) Poor performance by candidates was noted in Q2.22 (1 mark), Q2.23 (1 mark) and Q2.23 (1 mark) where the candidates failed to correctly draw the symbols for face brick, earth and the grease trap.

(g) In Q2.25 (7 marks) and Q2.26 (3 marks) there was a slight improvement in responses from candidates who could correctly deduce the dimensions from the floor plan and calculate the length of the sides of the building as well as the area of a room.

Suggestions for improvement

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

(b) A lot of attention should be given to the correct subject terminology when explaining content to learners. Learners should always be corrected when they respond using the wrong terminology when interacting in the classroom.

(c) More analytical questions and worksheets, similar to Q2, should be done in class focusing on the correct terminology for each part of the drawings.

(d) The correct use of subject terminology should be emphasised to ensure learners avoid unnecessary loss of marks using incorrect terms.

(e) It is recommended that teachers emphasise the importance of indicating abbreviations of information and symbols used on building plans in the correct format (uppercase or lowercase letters) to ensure that learners do not lose easy-to-score marks.

(f) It is recommended that teachers require learners to draw the symbols used on building plans and write the abbreviations of these symbols during class and homework activities and to give short informal assessments on this topic on a regular basis.

(g) Learners should be exposed to more calculations involving area, perimeter and lengths of walls to ensure that they have mastered the mathematical concepts.

QUESTION 3: ROOFS, STAIRCASES AND JOINING

Common errors and misconceptions

(a) Q3.1 (1 mark) was answered very poorly. Candidates were not familiar with the roof covering with specific spacing dimensions.

(b) It was observed that most candidates did not answer Q3.2 (1 mark) and could not recall the maximum span of a closed-couple roof truss.

(c) Q3.3 (2 marks) was answered poorly. Candidate were not familiar with the methods to secure a wall plate to a wall.

(d) Q3.4 (2 marks) appeared to be challenging for most candidates. Candidates could not describe the TWO methods used to mount balusters to staircases.

(e) Candidates struggled to draw the components of a couple roof truss to scale in Q3.6 (16 marks). Candidates did not adhere to or apply the prescribed scale.

Suggestions for improvement

(a) Wall charts which indicate the type of roof as well as the spacing/span should be displayed in the classrooms to be visible to learners daily.

(b) Samples of the different methods to secure a wall plate to a wall could be displayed in the classroom so that learners could identify these different methods especially during revision. Learners remember content better if they see it physically and not just in the textbook.

(c) Simulation tasks work very well for learners to identify and know the different methods used to mount balusters to staircases. If time allows, it will benefit the learners if they could build (even according to a smaller scale) their own simulations on the mounting of balusters to staircases.

(d) It is recommended that teachers provide learners with more exercises on the drawing of roof trusses so that they develop their drawing skills and understanding of the different types of roof trusses.

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

Common errors and misconceptions

(a) In Q4.1 (8 marks) many of the candidates were not sufficiently equipped to select the correct description of the content on shuttering to match the items listed in column A.

(b) Q4.2 (6 marks) expected candidates to show, by means of pictorial views, the difference between a *wedge* and a *folding wedge*. Candidates were not able to differentiate between *wedges* and *folding wedges*. Many candidates understood the concept but experienced challenges drawing a pictorial view. It seems that the candidates did not understand what the different drawing methods are.

(c) Candidates could not state the number of days it will take for high-strength concrete to reach the minimum compression strength of 30 MPa in Q4.5. (1 mark).

(d) Candidates struggled to draw the components of a vertical section of the formwork for a concrete beam above the bearer/head tree in Q4.7 (14 marks).

Suggestions for Improvement

(a) All formal and informal tasks should be set according to the same standard as the NSC question papers and according to the examination guidelines. Learners should be exposed to these types of questions on a regular basis.

(b) The different drawing principles and methods should be explained to learners in the classroom, so that they are able to respond with the correct type of drawing during examinations. Marks should not be awarded for incorrect drawings to learners during formal or informal tasks.

(c) The correct terminology should be used during teaching and learning, so that learners can respond accurately to these types of questions.

(d) All the different verbs and instructions that are used in the question papers should be explained to learners so that they can understand what the questions expect from them and how to respond.

(e) Samples of the shuttering, wedges and different types of formwork can be used effectively to practically demonstrate this topic.

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

Common errors and misconceptions

(a) In Q5.1 (1 mark) many candidates were not familiar with the machine that is used to create a spatter-dash finish.

(b) Q5.2.1 to Q5.2.3 (3 marks) required the candidate to explain how to plaster the reveals at a door opening. Many candidates were not equipped to explain plaster processes accurately.

(c) Q5.3 (1 mark) seemed to be challenging for many candidates. It appeared that candidates did not understand how to draw half of a wooden turning piece/centre for a semi-circular arch with closed laggings.

(d) Only a limited number of candidates were able to draw the sectional view of a cavity wall above the lintel. (10 marks).

(e) Candidates struggled to complete the consecutive brick courses of a one-and-a-half brick pier built in stretcher bond in Q5.5 (10 marks).

Suggestions for improvement

(a) Real-life machines related to subject content processes should be part of the subject in order to illustrate the use hereof to learners (splatter-dash machine).

(b) Construction processes should be a high priority during teaching and learning. Learners need to know and be able to explain the processes and should be able to advance to the practical implementation of processes (plastering).

(c) It is recommended that teachers provide learners with more exercises on the drawing of a sectional view of the cavity wall as well as consecutive brick courses of a one-and-a-half-brick pier built in stretcher bond.

(d) More emphasis should be placed on the different orientations of sectional drawings for brick courses.

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

Common errors and misconceptions

(a) Many candidates lacked the necessary knowledge to select the correct answer from the given options in the multiple-choice questions regarding rib and block floors in Q6.1 (5 marks).

(b) Q6.2, Q6.3 and Q6.8 (5 marks) seemed to be challenging for most candidates. Candidates struggled to identify mistakes in the construction of rib and block floors.

(c) In Q6.3 (4 marks) candidates had difficulty drawing a tool used to drive a precast pile into the ground and the labelling thereof.

(d) Q6.5 required the candidates to answer questions on a reinforced concrete beam. Many candidates found it difficult to explain the construction processes of reinforced concrete columns accurately.

(e) Doing basic calculations posed a serious challenge for candidates. Many could not calculate the centre line of the external walls of a storeroom or use the dimension paper on the answer sheet for Q6.9 correctly.

Suggestions for improvement

(a) Learners should be encouraged to know the content topics in the subject in order to answer any type of question on it. (Multiple questions as well as identifying of mistakes).

(b) It is recommended that these types of drawings be drawn in class (piling, rib and block floors, reinforcement in concrete, etc.). Visits to construction sites would be an excellent way to demonstrate such installations since it would be difficult to demonstrate at school. If that is not possible then there are different videos available on the internet that can be used to demonstrate these installations.

(c) Teachers should encourage learners to answer all the questions and number them according to the numbering system used in the question paper.

(d) Reinforcing is covered in Grade 10, Grade 11 and Grade 12. Learners should be exposed to different methods of asking questions on the same content and not only examples from previous NSC question papers.

(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 of preparing for examinations. Arrangements could be made with the Mathematics teacher to also focus on the different formulae used in the Technology subjects to ensure a concrete understanding of these.

4.3 WOODWORKING

The following report should be read in conjunction with the Woodworking question paper of the November 2022 examinations.

4.3.1 PERFORMANCE TRENDS (2018–2022)

The number of candidates who wrote the Woodworking examinations in 2022 increased by 176 compared to that of 2021.

The table below indicates consistent performance over the past four years with pass rates in the 97% to 99% range. The pass rate in 2022 reflects a marginal decline with 95,6% of candidates passing at 30% (Level 2) compared to 97% in 2021.

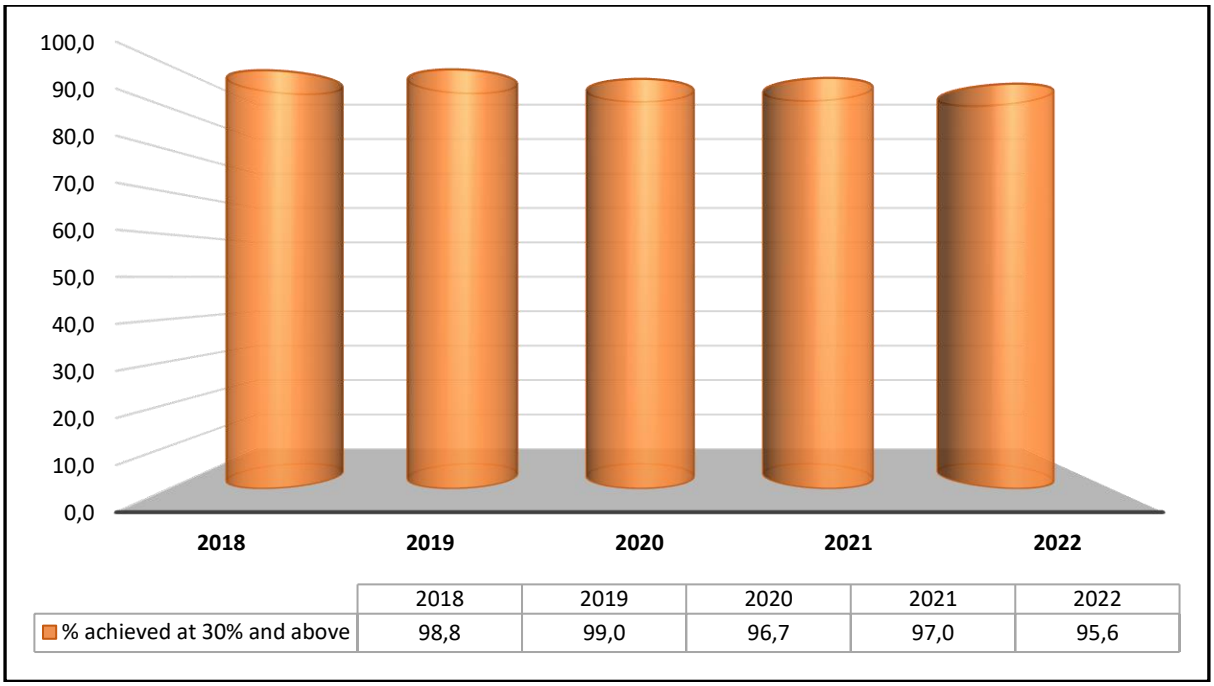
There was an improvement at 50% (Level 4) with 53,0% of candidates achieving over 50% this year compared to 50,4% of candidates doing so in 2021. The percentage of distinctions over 80% (Level 7) remained static at 1,7%. Given the increase in the total number of candidates this converts into a total of 43 candidates who achieved distinctions in 2022.

In view of disruption to academic programmes in 2020 and 2021, and despite some of the factors mentioned above, the results achieved by this cohort are commendable. Strategic intervention programmes at all levels (National, Provincial, Districts and Schools) ensured that learners were adequately prepared.

Table 4.3.1 Overall achievement rates in Woodworking

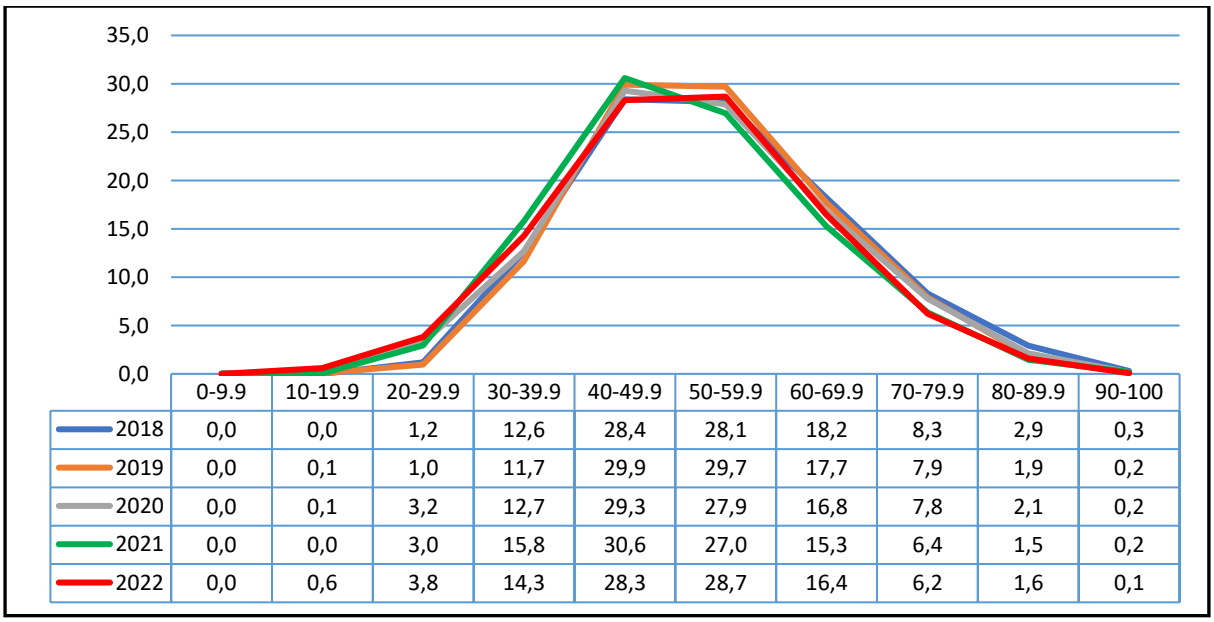
Year	No. wrote	No. achieved at 30% and above	% achieved at 30% and above
2018	2 606	2 574	98,8
2019	1 946	1 926	99,0
2020	1 837	1 777	96,7
2021	2 366	2 294	97,0
2022	2 542	2 430	95,6

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



	2018	2019	2020	2021	2022
% achieved at 30% and above	98,8	99,0	96,7	97,0	95,6

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
2018	0,0	0,0	1,2	12,6	28,4	28,1	18,2	8,3	2,9	0,3
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

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 (5 marks) candidates did not respond well to the question by writing the full statement in brackets, e.g. *oil or water-based paint* as required, but only wrote *oil based* or *water-based paint* and were not credited for the incomplete statements.

(b) In Q1.2.1 (1 mark) most candidates were not able to state the maximum angle of the staircase.

(c) In Q1.3 (2 marks) many candidates could not explain the safety precautions that need to be adhered to when transporting a ladder. Instead, the candidates wrote general safety precautions for the use of ladders.

(d) In Q1.4 (1 mark) most candidates could not state the safety component that can be positioned above workers to protect them from falling objects. Instead, the candidates stated personal protective equipment, e.g. hard hat to protect the head.

(e) In Q1.5 (1 mark) only a few candidates were able to name the component that will ensure the stability of a scaffold in all directions. Most candidates responded with general safety precautions that are relevant to a scaffold.

(f) Q1.6 (1 mark) was well answered by most candidates.

(g) In Q1.7 (1 mark) many candidates were not able to convert the ratio of a stack that may not be higher than three times the width to a figure of three metres if the width is one metre.

Suggestions for improvement

(a) It is recommended that teachers ensure that learners fully understand the importance of quoting the full statements provided in this type of questions.

(b) It would be beneficial for learners if they are taught to summarise and learn important detail regarding the specifications of different construction processes so that they can apply this knowledge where required.

(c) Learners should be taught the importance of reading the question carefully and to isolate the exact aspect within the topic that should form the basis of their response.

(d) More emphasis should be placed on the use of practical demonstrations of the application of safety features used on a building site. Learners should be given the opportunity to see these safety features in use practically.

(e) Practical demonstrations of the erecting of scaffolding can be used to familiarise learners with all the components and safety features of the different types of scaffolding.

(f) It would be to the advantage of learners if they are taught how to apply basic mathematical conversions and to apply logical thinking skills in various situations.

QUESTION 2: GRAPHICS AS METHOD OF COMMUNICATION

Common errors and misconceptions

(a) Many candidates experienced challenges reading and interpreting the floor plan and elevation. They were not able to identify, draw and interpret drawing symbols.

(b) The use of the correct subject terminology seems to be a challenge for many candidates. When candidates are asked to identify features or objects in the drawings, they used layman's terminologies or gave explanations.

(c) In Q2.4 (1 mark) many candidates were not able to correctly identify the *balcony*.

(d) In Q2.8 (1 mark) some candidates identified the ramp as paving or garage entrance.

(e) In Q2.12 (1 mark) some candidates used lowercase letters instead of capital letters to indicate the FFL and NGL and was not credited for the answer as a result.

(f) Poor performance by candidates was noted in Q2.22 (1 mark), Q2.23 (1 mark) and Q2.23 (1 mark) where the candidates failed to correctly draw the symbols for face brick, earth and the grease trap.

(g) In Q2.25 (7 marks) and Q2.26 (3 marks) there was a slight improvement in responses from candidates who could correctly deduce the dimensions from the floor plan and calculate the length of the sides of the building as well as the area of a room.

Suggestions for improvement

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

(b) A lot of attention should be given to the correct subject terminology when explaining content to learners. Learners should always be corrected when they respond using the wrong terminology when interacting in the classroom.

(c) More analytical questions and worksheets, similar to Q2, should be done in class focusing on the correct terminology for each part of the drawings.

(d) The correct use of subject terminology should be emphasised to ensure learners avoid unnecessary loss of marks using incorrect terms.

(e) It is recommended that teachers emphasise the importance of indicating abbreviations of information and symbols used on building plans in the correct format (uppercase or lowercase letters) to ensure that learners do not lose easy-to-score marks.

(f) It is recommended that teachers require learners to draw the symbols used on building plans and write the abbreviations of these symbols during class and homework activities and to give short informal assessments on this topic on a regular basis.

(g) Learners should be exposed to more calculations involving area, perimeter and lengths of walls to ensure that they have mastered the mathematical concepts.

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

Common errors and misconceptions

(a) In Q3.1 (4 marks) many candidates had difficulty drawing the sectional view of a transom. 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 isolation, but only as a unit.

(b) In Q3.2 (10 marks) most candidates were not equipped to correctly calculate the number of roof trusses and the length of barge board needed. It was also evident in this question that a larger percentage of candidates were not able to use the dimension paper correctly.

(c) In Q3.3 (12 marks) it was evident from the responses of many candidates that they were unable to draw the front view of the free-standing cupboard correctly according to the given specifications.

(d) In Q3.3 (6 marks) the majority of candidates were unable to project and draw to the given scale the sectional view of the top part of the wall panelling with a capping between the wall panel and the cornice.

Suggestions for improvement

(a) It is recommended that drawings of the whole casement and of each different member of the casement be combined into an activity. Learners should be able to identify each drawing or part of the drawing. They should then draw each member of the casement in their workbooks.

(b) Subject advisors should conduct workshops on the calculation of quantities. More exercises on the calculation of quantities of materials should be given to learners. It is advisable that learners be taught to read and interpret drawings and to use the dimension paper for the calculation of quantities correctly.

(c) It will be beneficial for learners if they are exposed to more practical examples of cupboards with doors, shelves and drawers from which learners can draw the cupboards so that they can see and understand the composition of the structure of the cupboard. Learners should also be taught to draw drawings exactly according to the given specifications.

(d) Teachers should focus on in-depth revision and remediation required for learners to be able to draw the front, top and sectional views of the wall panelling. Revision and remediation classes will equip learners with the necessary skills needed to respond to this type of question.

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

Common errors and misconceptions

(a) In Q4.1 (8 marks) many of the candidates were not sufficiently equipped to select the correct description of the roof members to match the items listed in column A.

(b) In Q4.2 (6 marks), Q4.3 (1 mark) and Q4.4 (2 marks) most candidates had difficulty identifying the machines and explaining the safe handling of the machines in terms of the specified criteria. Instead, candidates listed general aspects regarding the safe handling of the machines and were not credited as a result.

(c) Many candidates were not able state the requirements or properties of timber when it must be selected for a specific purpose in Q4.5 (1 mark).

(d) In Q4.6 (3 marks) a fair percentage of candidates were not able to differentiate between the different markings on timber that are visually and mechanically graded. They could not explain the meaning of the letters and numbers on the timber.

(e) In Q4.7 (5 marks) the majority of candidates were not equipped to draw pictorial views of the cover strip and T strip. They drew two-dimensional drawings for which they were not credited with all the marks.

(f) It was evident in Q4.9 (11 marks) that most of the candidates had difficulty drawing the collar-tie roof truss. Candidates drew the wrong truss or drew the correct truss incorrectly. A possible reason for the poor performance in this question may be that the activities in the textbooks do not require the drawing of all the different roof trusses as is required in *CAPS*.

Suggestions for improvement

(a) It will be beneficial if teachers can expose learners to more drawings of roofs and the members that each type of roof consists of.

(b) A practical application of this content will assist learners in understanding all the listed machines and equipment prescribed in the *CAPS.* Practical exposure of this content will ensure that learners familiarise themselves with the parts, proper use, care and safety of machines.

(c) Learners should be taught the technique to look critically at the properties of materials and to be able to determine the properties of materials that would be required to complete specific tasks.

(d) Teachers are strongly advised to expose learners to more freehand drawings of pictorial views of different components to prepare them for proper communication and assessment.

(e) A challenge could be that learners were not exposed to the drawing of scale drawings of the different roof trusses. It is advised that teachers develop additional questions to cover the scale drawings of all drawings as listed in the *CAPS* document.

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

Common errors and misconceptions

(a) Many candidates were not able to select the correct answer from the given options in the multiple-choice questions regarding staircases in Q5.1 (5 marks).

(b) In Q5.2 (5 marks) many candidates were not able to respond correctly to questions on shoring.

(c) In Q5.3 (2 marks) most candidates were not able to describe the purpose of the components of a dead shore.

(d) In Q5.5 (11 marks) most of the candidates were unable to complete the drawing of the centering for a semi-circular arch correctly.

Suggestions for improvement

(a) A challenge could be that candidates were not practically exposed to shoring and do not understand the concept of this topic.

(b) Learners should be exposed to more drawings of the different arches and be taught how to draw the arches correctly.

(c) It will benefit candidates if they read the instructions in the question carefully and follow the instructions to the letter to ensure that they can obtain maximum marks.

(d) Models of all concrete structures requiring formwork that are listed in the *CAPS* should be made in the workshop. It must be explained to learners why each component of the formwork is placed at a particular position, its correct name and the purpose that the component serves.

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

Common errors and misconceptions

(a) In Q6.1 (2 marks) many candidates had difficulty identifying and stating the use of the required locks.

(b) In Q6.2 (13 marks) most candidates' responses reflected that they were not equipped to draw, to the given scale, the front elevation of a three-panel door with raised and fielded panels and a high-lock rail.

(c) In Q6.3 (6 marks) most candidates were unable to complete the side elevation of a straight flight of stairs with a landing on answer sheet 6.3.

(d) Very few candidates were able to correctly draw the adjoining stile of a haunched mortice and tenon joint in Q6.4.

(e) Most candidates did not answer Q6.5 (10 marks) or were not able to correctly project and draw a vertical section of the supporting structure of a suspended timber floor. It appeared that they might not have been taught how to do a practical construction of a suspended timber floor or how to do scale drawings of this floor.

Suggestions for improvement

(a) It is recommended that examples of all the prescribed locks be available in the classroom, so that learners can practically see where and how these locks are used.

(b) A model of a three-panel entrance door with raised and fielded panels and a high-lock rail can be made in the workshop. Learners should draw front elevations, horizontal and vertical sectional drawings of this door with raised panels as well as raised and fielded panels.

(c) Practical demonstrations can be used to enhance learners' understanding of the different parts and views of a staircase.

(d) Learners should be exposed to more scale drawings of the different woodworking joints as prescribed in the *CAPS*.

(e) The use of a model of a suspended timber floor showing all components, including the supporting piers, will assist learners in gaining a better understanding of this item.

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 2022 examinations.

5.1.1 PERFORMANCE TRENDS (2018–2022)

The number of candidates who sat for the Digital Electronics examinations in 2022 increased by 20 compared to that of 2021.

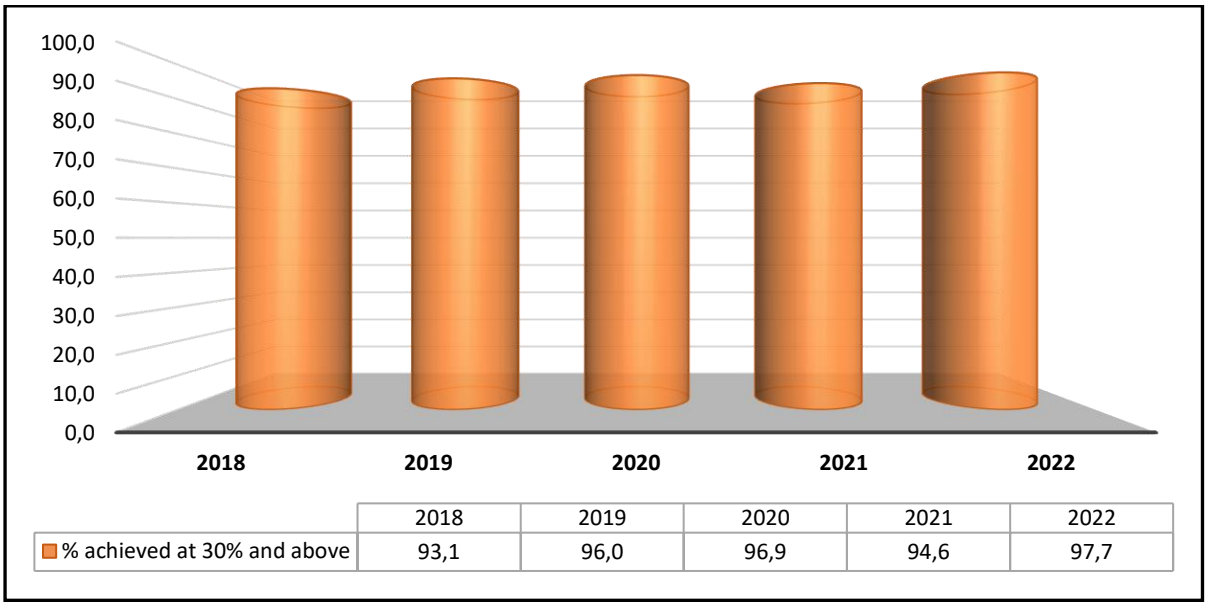
The table below indicates pass rates at 30% (Level 2) for the past three years in the 93% to 97% range. The pass rate of candidates in 2022 improved marginally from 94,6% in 2021 to 97,7% in 2022. There was a decline in performance at 50% (Level 4) with 36,6% of candidates achieving this in 2022 compared to 41,1% of candidates doing so in 2021. Although there were 6 distinctions in 2021 over 80% (Level 7), no candidates achieved distinctions in 2022.

In view of disruption to academic programmes in 2020 and 2021, and despite some of the factors mentioned above, the results achieved by this cohort are commendable. Strategic intervention programmes at all levels (National, Provincial, Districts and Schools) ensured that learners were adequately prepared.

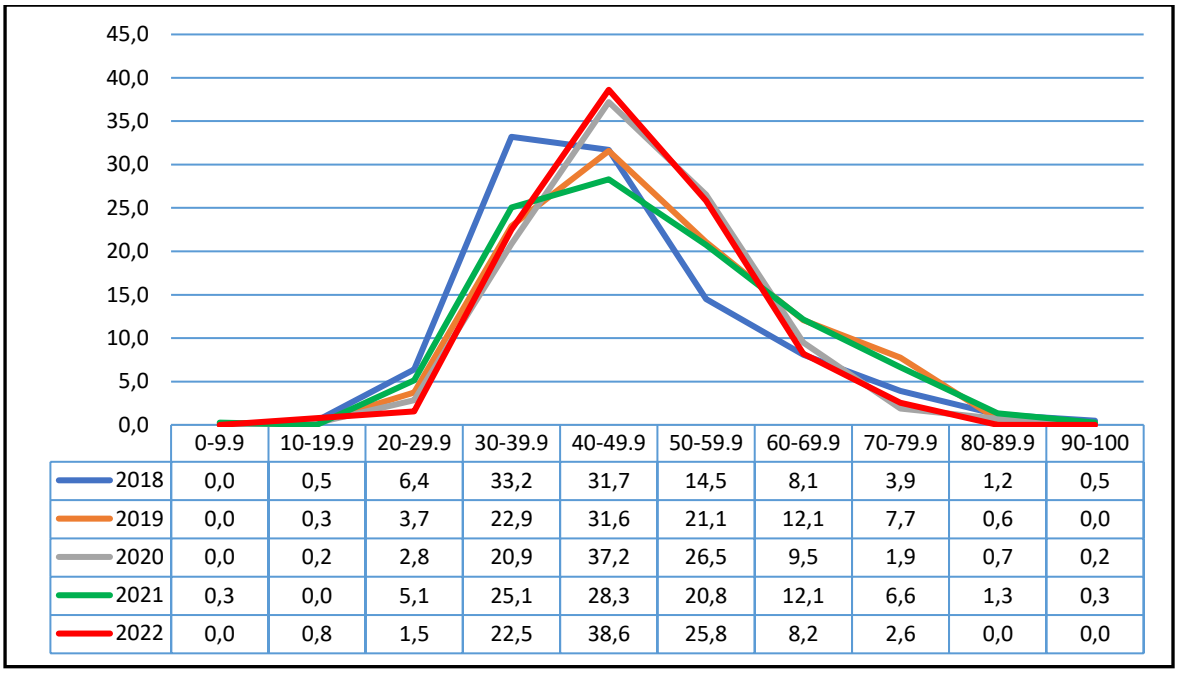
Table 5.1.1 Overall achievement rates in Digital Electronics

Year	No. wrote	No. achieved at 30% and above	% achieved at 30% and above
2018	407	379	93,1
2019	323	310	96,0
2020	422	409	96,9
2021	371	351	94,6
2022	391	382	97,7

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



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
2018	0,0	0,5	6,4	33,2	31,7	14,5	8,1	3,9	1,2	0,5
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

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, including the 2022 NSC examination, that most candidates continue to struggle in these areas. Curriculum specialists and teachers are urged to attend to these areas of concern as a matter of urgency.

Furthermore, learners should:

- Complete well-planned practical activities for these areas.
- Be assessed on complex questions that use verbs, such as *explain*, *describe*, *discuss*, *state*, *determine* and *motivate,* which can be taken from previous examination papers.
- Be exposed to problem-solving activities in all topics in the curriculum from lower grades, particularly from Grade 10.

5.1.2 OVERVIEW OF CANDIDATES' PERFORMANCE IN DIGITAL ELECTONICS

General comments

Most comments mentioned in 2021 diagnostic reports are still relevant to this report.

(a) An overall poor performance was recorded, even in questions that were set at the lower cognitive levels.

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

(c) Many candidates experienced difficulty answering questions of a narrative nature on application of theory, and mathematical operations learned from Grade 10, e.g.:
- Principle operations of circuits
- Manipulation of formulae
- Analysis of circuit diagrams

General suggestions for improvement

These suggestions, as mentioned in the *2021 Diagnostic Report* are still relevant with certain amendments.

(a) The use of past NSC papers: 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 2022 as these are based on the current *CAPS* content.

(b) Revision of relevant Grade 10 and 11 content: Although the NSC examinations only assess Grade 12 content, 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) Time management: According to the provincial internal moderators' reports, candidates were able to finish on time; however, some questions were not attended to. Teachers are encouraged to self-diagnose and request help from subject advisors or do further reading from other sources. Teachers are requested to identify their shortcomings by answering previous question papers. Their performance will inform them of the questions/sections with which they have challenges and those that they are good at. Based on their performance, they could seek assistance to develop themselves.

(d) For the narrative nature of questions, the responses in the marking guidelines are broken down into key areas of specific content and marks are then awarded accordingly. A general response will only be awarded one mark. Learners must respond in the required fashion which will hone their comprehension skills and eliminate vague one-word responses. Refer to Q3.6 and Q6.5.2 where the responses are broken down in bullet form and ticks/marks are placed at key areas of specific content.

(e) Practical experiments and past papers: At the end of each topic in the *CAPS*, there are practical experiments which 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).

(f) For graphical or diagrammatical nature of questions, the responses in the marking guidelines are broken down as in Q6.1 and Q6.8.

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

QUESTION 1: MULTIPLE-CHOICE QUESTION

Common errors and misconceptions

(a) A large number of candidates had difficulty answering Q1.8, Q1.9, Q1.10, and Q1.11. Their lack of knowledge of *digital and sequential devices* in these subquestions consequently also had a corresponding negative effect on performance in Q5.

(b) The majority of candidates could not answer Q1.12, Q1.13, Q1.14, and Q1.15. Their lack of knowledge of *microcontrollers* in these subquestions consequently also had a corresponding negative effect on performance in Q6.

Suggestions for improvement

(a) As these problems affect the answering of multiple choice in Q1, as well as the topics in Q5 and Q6, provincial subject heads should provide intensive training on the topics of *digital and sequential devices* and *microcontrollers*.

(b) Teachers should also use questions from past papers in an attempt to improve the confidence of learners in answering questions on these topics.

QUESTION 2: OCCUPATIONAL HEALTH AND SAFETY

Common errors and misconceptions

(a) In Q2.1 most candidates provided answers referring to the employees and not to the employer.

(b) In Q2.4 the majority of candidates confused human rights responses with those of victimisation and even with discrimination. Answers to Q2.1 were also found in Q2.4.

Suggestions for improvement

(a) Teachers are advised and encouraged to:
- Develop activities that require definitions according to the OHS Act, as well as explanations of concepts and terminologies.
- Use OHS videos to enhance their teaching. This will focus learner responses in the proper direction and eliminate one-word, vague responses.

(b) The following suggestions are as relevant, particularly as they were covered in the 2021 Diagnostic Report:
- Learners must realise that the understanding of concepts, terminology and jargon of the subject is important.
- To overcome language barriers, 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.

(c) OHS should be emphasised from Grades 10 and 11 and should be incorporated in practical tasks and infused in teaching rather than being taught in isolation.

QUESTION 3: SWITCHING CIRCUITS

Common errors and misconceptions

In 2021, the majority of candidates did not answer this question. This was also the case in 2022 with the errors made and with similar misunderstanding in answering these questions. Curriculum specialists and teachers are therefore advised to attend to this concern.

(a) In Q3.1 most candidates could not differentiate between the two multivibrators with reference to their output states; instead, they referred to one having two switches while the other had no switch.

(b) In Q3.2, Q3.3, Q3.4, Q3.5, Q3.6 and Q3.8.2 a large number of candidates had difficulty answering these questions of narrative nature including their subquestions. Interpretation, analysis and understanding of the circuit was still a challenge.

(c) In Q3.4.1 a few candidates lost marks for not labelling the circuit correctly and they left out the ground connector in the circuit.

(d) In Q3.7.4 most candidates provided the correct answer but could not state that the gain would also increase, thereby losing the second mark.

Suggestions for improvement

The following suggestions, as mentioned in the *2021 Diagnostic Report* are still relevant with a number of additions.

(a) It is important for teachers to understand that components in a circuit may perform different functions; therefore, they are advised to study and understand the following:
- Internal construction of the *555 IC*, including the function of each pin.
- How the circuit responds when S_1 and S_2 are activated in Q3.2, including the drawing of an output *waveform*.

(b) In Q3.3 the concepts of *input voltage* (V_{in}) and *reference voltage* (V_{ref}) for the operation of the circuit should be explored when the trigger pulse is applied, particularly in Q3.3.3. Learners must understand what will happen during the following conditions:
- If $V_{in} < V_{ref}$, what will the polarity of the output voltage be?
- If $V_{in} > V_{ref}$, what will the polarity of the output voltage be?

(c) Learners should understand the following concepts:
- *Closed-loop* and *open-loop gain*
- An *op-amp circuit with feedback* and the purpose of such feedback
- The difference between *RC integrated circuit* and *op-amp integrated circuit*.

(d) The functions of each component in the above circuits should be studied, e.g. a capacitor and three resistors.

(e) Electrical Technology is an applied subject, therefore explanation of a circuit must be coupled with calculations and input and the correlating output waveforms e.g. in Q3.7.

(f) The changing of components affects the characteristics and the operation of the circuit. Learners should be taught these concepts and how to apply their knowledge in a dynamic circuit and to predict the *output waveforms*. This should also direct the teacher's approach and style when teaching this subject. Reference is made to Q3.2.3.

(g) Teachers must ensure that:
- Learners' calculations include the correct steps as per instruction 7 on the question paper so that they do not lose marks unnecessarily.
- Learners draw a fully labelled circuit. Teachers must do the same, as learners use the teacher's work as the model and copy it.
- ICT showing simulations and circuits is integrated into lessons to enhance teaching and learning. This will strengthen learners' theoretical knowledge in the process.

(h) The difference between the verbs *calculate* and *determine*, which was raised in the provincial report, must be taught:

- Calculate: In this context, it 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 Q3.7.
- Determine: 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 demonstrate operational understanding of the circuit, particularly when the capacitor is fully charged. The same considerations applied to Q3.4.1, Q3.5.1 and Q3.7.2.

QUESTION 4: SEMICONDUCTOR DEVICES

Common errors and misconceptions

In 2021 the majority of candidates did not answer this question and, despite suggestions for improvement having been made in the *2021 Diagnostic Report,* this question remained problematic.

(a) In Q4.1.2 some candidates still found it difficult to substitute the value with prefix k, e.g. instead of writing 1,4 kΩ, they wrote 1,4 and omitted the 'k', which affected the answer.

(b) In Q4.2.3 the majority of candidates could not draw the *output waveform* correctly on the provided answer sheet. Some drew the full *waveform* without showing the *saturation*, while others drew the *square wave* and waves that could not be defined.

Suggestions for improvement

While some new suggestions have been added, there are some suggestions from the *2021 Diagnostic* Report that have been retained because they are still applicable.

(a) Teachers are advised and encouraged to use this format when delivering content:
- Always provide background when introducing topics
- Definition of concepts and terminologies
- Basic construction of *op amps*
- Functional operation; their operating voltages
- *op-amp* as:
  - *Inverting* and calculations
  - *Non-inverting* and calculations
- Advantages and disadvantages
- *Open loop* and *closed loop gain* of amplifiers

(b) It is important to use practically built circuits with voltage measurements in conjunction with the theoretical concepts being addressed.

(c) Teachers are further advised and encouraged to emphasise the following:
- The identification of formulae and linking of the formulae with the correct circuits during class lessons.
- The importance of using the correct prefixes in all calculations and showing them in the substitutions. This must be applied strictly during the year in informal tasks and during the marking of all assessment tasks. Candidates lose marks if these are not in place, even if all the steps are correct.

(d) The internal operation of the *555 IC* is of utmost importance, not only in this section, but also for switching circuits. Teachers can show educational videos on the operation

of the *555 IC* to learners. Learners must be motivated to build practical circuits to embed theoretical knowledge. Teachers can also use educational software to enhance the learning experience of difficult abstract circuits and concepts.

QUESTION 5: DIGITAL AND SEQUENTIAL DEVICES

Common errors and misconceptions

(a) In Q5.1.1 and Q5.3.1 most candidates did not label block A and B, and were not able to name the gates represented by X and Y respectively as place holders.

(b) In Q5.3.2 and Q5.5.2 the majority of candidates were unable to complete the truth tables of a *half-adder* and an *RS flip flop* respectively.

(c) In Q5.2 and Q5.8 many candidates could not complete the equivalent *logic circuit* of a decoder and a *4-bit parallel-in serial-out shift register* respectively for information given on the answer sheet.

(d) In Q5.4 and Q5.7.1 a large number of candidates could not complete the timing diagrams for the given clocked *J-K flip-flop* and *synchronous down counter* respectively.

(e) In Q5.6 most candidates could not explain these counters; they confused them and gave vague explanations that had the words *counting upwards, downwards or up and down.*

Suggestions for improvement

Most suggestions mentioned in the *2021 Diagnostic Report* are still relevant with a few additions.

(a) Classrooms or workshops should display charts showing drawings of the following:
- *7-segment LED display* and *display drivers*
- *2-to-4 binary decoders* with their truth tables and symbols, including encoders
- Different types of counters and registers, their operations, truth tables and symbols

(b) Teachers are advised to:
- Incorporate logic gates (e.g. *AND, NAND, OR* or *NOR gates*) as prior knowledge in their lesson plans/preparations. This will assist with the understanding of the operations, drawing of *circuit diagrams, truth tables, timing diagrams* and symbols of the:
  - *Adders* (*half and full adders* including *binary parallel adder*)
  - *Flip-flop (SR, JK*, and *D flip-flop*)
- Implement instruction number 5 from the question paper when marking learners' work, which states, *Sketches and diagrams must be large, neat and fully labelled for learners to earn full marks* and provide feedback.
- Perform simulations on *seven-segment displays, decoders, flip-flops* and *counters*. Draw the relevant diagrams and display them on the wall.

(c) Note that IEC symbols and American symbols cannot be used in the same diagram.

QUESTION 6: MICROCONTROLLERS

Common errors and misconceptions

(a) Correct responses were noted in Q6.1, however, many candidates omitted the connection lines, mixed up the blocks or included blocks that were incorrect.

(b) In Q6.2 the majority of candidates did not answer the question correctly; some explained the *CPU* operation while others explained the *microcontrollers* operation.

(c) Most candidates had difficulty answering Q6.3.2. Their responses suggested that they had no idea of this register and how it functions.

(d) In Q6.5.2 and Q6.6.3 many candidates could not describe how data is transferred from the sender to the receiver and the operation of the *SPI*.

(e) In Q6.7 definitions of concepts/terminologies were still a challenge for most candidates, hence this question was poorly answered.

(f) In Q6.8 many candidates only completed parts of this flow chart correctly, while very few candidates achieved full marks. Responses varied from full marks to zero marks. Many candidates included sensors where the increase and decrease of the variable process blocks were placed. Some candidates mixed up when the red and green light goes on, while others did not include the *depart decision* element and the *decrease process function*. Many candidates labelled the flow chart incorrectly.

Suggestions for improvement

(a) Teaching and learning may be enhanced through the use of ICT/videos for simulations of circuits as most schools do not have *microcontrollers*. Teachers are advised to start focusing and channelling their effort towards using ICT.

(b) Teachers are further advised to:

- Use the *Examination Guidelines* and the *CAPS* closely when planning their teaching of this topic.
- Assist learners to use the correct subject terminology when answering questions, and to avoid statements like *voltage flow* or *the current runs through the circuit* or *the output of the circuit travels from high to low*.
- Use PICAXE Editor 6 program software to help the learners compile flowcharts and simulate them on the computer. This will help learners to complete the complex scenarios given in the exams.

5.2 ELECTRONICS

The following report should be read in conjunction with the Electronics question paper of the November 2022 examinations.

5.2.1 PERFORMANCE TRENDS (2018–2022)

The number of candidates who sat for the Electronics examinations in 2022 increased by 56 compared to that of 2021.

The table below indicates pass rates at 30% (Level 2) for the past four years in the 91% to 97% range. The performance of the candidates in 2022 improved marginally from 91% in 2021 to 92,2% in 2022.

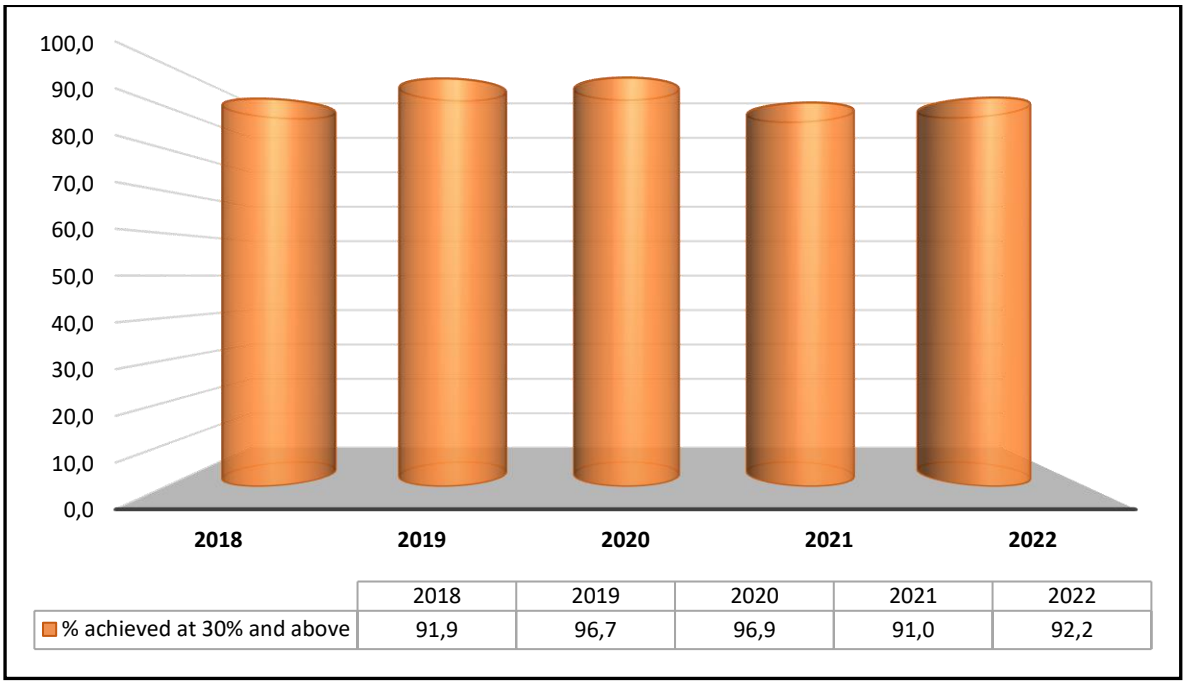
There was a slight decline in performance at 50% (Level 4) with 26,8% of candidates achieving this in 2022 compared to 28,2% of candidates doing so in 2021. The total number of distinctions at 80% (Level 7) remained consistent, with 5 in 2022.

In view of disruption to academic programmes in 2020 and 2021, and despite some of the factors mentioned above, the results achieved by this cohort are commendable. Strategic intervention programmes at all levels (National, Provincial, Districts and Schools) ensured that learners were adequately prepared.

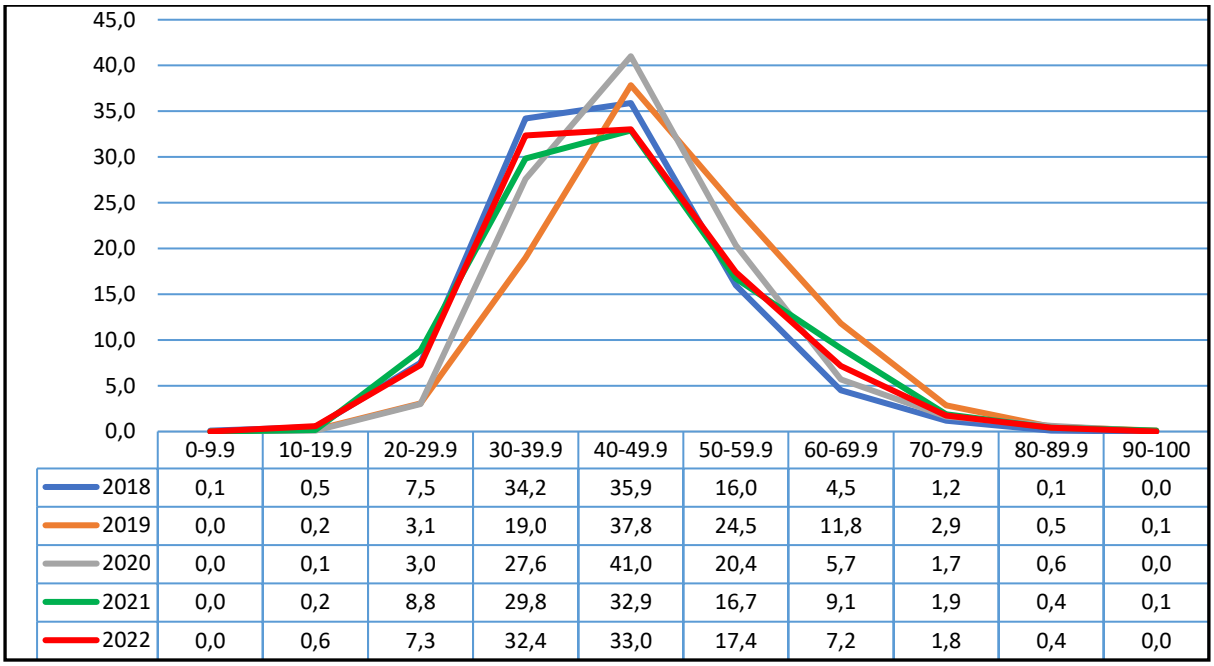
Table 5.2.1 Overall achievement rates in Electronics

Year	No. wrote	No. achieved at 30% and above	% achieved at 30% and above
2018	1 077	990	91,9
2019	938	907	96,7
2020	968	938	96,9
2021	1 143	1 040	91,0
2022	1 199	1 105	92,2

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
2018	0,1	0,5	7,5	34,2	35,9	16,0	4,5	1,2	0,1	0,0
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

5.2.2 OVERVIEW OF CANDIDATES' PERFORMANCE IN ELECTRONICS

General comments

Some comments mentioned in the *2021 Diagnostic Report* are still relevant to this report and therefore they have been retained.

(a) To improve performance, the following areas, namely: *switching circuits*, *semiconductors* and *amplifiers* need to be covered as it was evident that most candidates continued to struggle with them in the 2022 examination, Curriculum specialists and teachers are urged to attend to these areas of concern as large number of candidates recorded zero marks in this question.

(b) A random sample of scripts reflected that Q1 (multiple-choice questions) and Q2 were well answered; averages of 40% and 50% were observed respectively. However, these questions comprised only 12,5% of the entire paper. Q3 was also well answered with an average of 47%. 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) It was evident from some candidates' responses that they lacked relevant content knowledge and the necessary skills to answer the questions.

(f) Many candidates experienced difficulty particularly in answering questions on:
- Application of theory learned, and application of mathematical principles
- Principle operations of circuits
- Manipulation of formulae
- Analysis of circuit diagrams

(g) Marks were lost due to the omission of units in the calculations and/or for incorrect substitutions and for the omission of labels in the drawings.

(h) Candidates could not use the answer sheets provided, correctly.

General suggestions for improvement

Most suggestions as mentioned in the *2021 Diagnostic Reports* are still relevant and have therefore been retained.

(a) Use of past NSC papers: It must be noted that 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 2022 as these are based on the current *CAPS* content.

(b) Revision of relevant Grade 10 and 11 content: Although the NSC examinations only assess Grade 12 content, 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 imperative that this prior knowledge be incorporated into teachers' lesson preparations/plan.

(c) Time management: Based on feedback from the provincial internal moderators' reports, candidates were able to finish on time, however, some questions were not answered. Teachers are advised and encouraged to self-diagnose and request assistance from subject advisors or do further reading from other sources and to identify shortcomings by answering previous question papers. Their performance will inform them of the questions/sections with which they have challenges and those that they are good at. Based on their performance, they could seek assistance to develop themselves.

(d) 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 Q5.6 where the responses are broken down in bullet form and note the ticks/marks that are placed at key areas of specific content.

(e) Practical experiments and past papers: At the end of each topic in the *CAPS*, there are practical experiments to 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).

(f) A deeper understanding of presenting *waveforms* from circuits using an EGD (Engineering Graphics and Design) approach needs much attention. Drawing *waveforms* on answer sheets, taking into account the correlation between *input* and *output waveforms* must be practised.

(g) It is of utmost importance to teach the function of components. It forms part of circuit analysis and is crucial in understanding the operation of an electronic circuit.

(h) It was evident that candidates did not know the effect of altered component values and *input voltages* on the operation and output of circuits. Teachers must demonstrate the effect of different component values and/or input voltages on the operation and output

of electronic circuits. These are higher-order concepts that must be demonstrated through practical circuits and displayed on an *oscilloscope*.

5.2.3 ANALYSIS OF CANDIDATES' PERFORMANCE IN EACH QUESTION IN ELECTRONICS

QUESTION 1: MULTIPLE-CHOICE QUESTION

Common errors and misconceptions

(a) In Q1.3 most candidates had difficulty understanding the relationship between *impedance* and *frequency* in a *resonance series RLC circuit*.

(b) In Q1.6 the majority of the candidates did not define *reactive power*; they confused it with *apparent power* and *real/active/true power*.

Suggestions for improvement

(a) Learners should:
- Not rush when choosing the answer. They should rather read carefully, eliminate incorrect answers until they have identified the most relevant and accurately correct answer.
- Be encouraged to read the textbook and other relevant sources as guided by the teacher to gain insight and content knowledge to answer all the questions.

(b) Teachers are advised to include this type of question in formal and even informal assessment tasks, and furthermore to develop in learners the skills of analysing and interpreting the questions for an answer that is possibly correct. This should eliminate wrong answers and distractors in their responses.

QUESTION 2: OCCUPATIONAL HEALTH AND SAFETY

Common errors and misconceptions

(a) In Q2.1 most candidates provided answers referring to the employees and not to the employer.

(b) In Q2.4 the majority of candidates confused human rights responses with those of victimisation and even with discrimination. Answers to Q2.1 were also found in Q2.4.

Suggestions for improvement

(a) Teachers are advised and encouraged to:
- Develop activities that require definitions according to the OHS Act, as well as explanations of concepts and terminologies.
- Use OHS videos to enhance their teaching. This will focus learner responses in the proper direction and eliminate one-word, vague responses.

(b) The following suggestions are as relevant as they were in the *2021 Diagnostic Report*:
- Learners must realise that the 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.

(c) OHS should be emphasised from Grades 10 and 11 and be incorporated into practical tasks and infused in teaching rather than being taught in isolation.

QUESTION 3: RLC CIRCUITS

Common errors and misconceptions

(a) In Q3.1 most candidates were unable to explain the term *inductance*, and the few who did explain the term, did not refer to AC in their attempt to answer the question. Furthermore, some explained *inductive reactance* with reference to the RLC circuits.

(b) In Q3.2.1 and Q3.2.2 when drawing the phasor diagram, most candidates did not know the phase relationship between current and voltage in a *resistive* and *capacitive* circuit respectively. A few candidates drew the correct phasor diagram but omitted arrows.

(c) In Q3.3.1 and Q3.4.1 a few candidates wrote the incorrect formula:
$Z = \sqrt{R^2 +}\ (X_L - X_C)^2$ and $I_T = \sqrt{{I_R}^2 +}\ (I_L - I_C)^2$ instead of the correct formula
$Z = \sqrt{R^2 - (X_L - X_C)^2}$ and $I_T = \sqrt{{I_R}^2 - (I_L - I_C)^2}$. They lost 1 mark.

(d) In Q3.3.2 and Q.3.3.3 the majority of the candidates could not make θ and L respectively, the subject of the formula in the formulae taken from the formula sheet. This affected the substitution and the answer.

(e) In Q3.3.4 candidates were unable to explain the meaning of *lagging power factor;* some said, *A lagging power factor is when the circuit is predominately inductive*.

(f) In Q3.3.5 most candidates did not know why the current and the voltage *waveforms* were in phase. Some stated, *the phase angle is zero (0)* while others included the concept of *lagging* and *leading power factor* in their responses.

(g) In Q3.4.3 a few candidates used *three-phase AC system* formula $P = \sqrt{3} \times V \times L \times Cos\,\theta$ instead of $P = V \times L \times Cos\,\theta$ to calculate the total power.

(h) In Q3.5.3 most candidates read from the graph instead of interpreting and analysing it, i.e. the *impedance* is going up or down, the *impedance* will increase or decrease without considering the effect that frequency has on the *impedance*, either below or above *resonance frequency*.

Suggestions for improvement

(a) Teachers are advised to illustrate/demonstrate the phase relationship between current and voltage in a/an:
- Resistive circuit
- Inductive circuit
- Capacitive circuit

(b) The definitions of the terms, explanations and descriptions of concepts that are likely to be asked in the examination should be summarised in a booklet and handed to

learners at the beginning of the year. This should include, among others, the following: *inductance*, *lagging* and *leading power factor*. A formula sheet should also be given to learners at the beginning of the year, and learners should be assisted on how to identify the correct formulae to be used in calculations. This suggestion is also applicable to all other affected questions.

(c) Teachers are encouraged to emphasise the effect of varying the frequency of the supply in an RLC circuit, the characteristics of *curve* and *phasor* diagrams of *resonance circuits* and the conditions of *series/parallel resonant circuits*.

QUESTION 4: SEMICONDUCTOR DEVICES

Common errors and misconceptions

The majority of the candidates did not answer this question despite suggestions for improvement having been made in the *2021 Diagnostic Report.* This question remains problematic.

(a) In Q4.1.1 and Q4.4.1 most candidates had difficulty identifying the circuits and this affected the subsequent questions where candidates were expected to explain the operation of the circuit.

(b) The majority of the candidates did not attempt Q4.1.2, Q4.3.2, Q4.3.3 and Q4.4.4. Those who attempted to answer them lacked knowledge of the operation of the circuit.

(c) In Q4.2.2 candidates could not draw the *output waveform* on the provided answer sheet, instead, some incorrectly redrew the characteristic curve in the answer book, which affected the accuracy of the *output waveform*.

(d) In Q4.6.2 some candidates found it difficult to substitute the value with prefix k, e.g. instead of writing 1,4 kΩ, they wrote 1,4 and omitted the 'k' which affected the answer.

(e) In Q4.7.3 the majority of the candidates could not draw the *output waveform* correctly on the provided answer sheet. Some drew the full *waveform* without showing the *saturation*, while others drew the *square wave* and waves that cannot be defined.

Suggestions for improvement

While some new suggestions have been added, there are suggestions from the *2021 Diagnostic* Report that have been retained because they are still applicable.

(a) Teachers are advised and encouraged to use this format when delivering content:
- Always provide background when introducing topics, e.g. knowledge of the *diode*
- 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 and disadvantages
- *Open loop* and *closed loop gain* of amplifiers

(b) When teaching the operation of components, reference must be made to the *characteristic curve* and the *construction* of the components.

(c) It is important to use practically built circuits with voltage measurements in conjunction with the theoretical concepts being addressed.

(d) Teachers are further advised and encouraged to emphasise/use the:
- Identification of formulae while linking the formulae to the correct circuits during lessons.
- Importance of using the correct prefixes in all calculations and showing them in the substitutions. This must be applied strictly during the year in informal tasks and during the marking of all assessment tasks. Candidates lose marks if these are not in place, even if all the steps are correct.
- Educational software/YouTube to enhance the learning experience of difficult abstract circuits and concepts, e.g. *block diagram* of *internal construction operation* of the *555 IC/timer.*

QUESTION 5: SWITCHING CIRCUITS

Common errors and misconceptions

In 2021, the majority of the candidates did not answer this question. This was also the case in 2022 with the errors made and with similar misunderstanding in answering these questions. Curriculum specialists and teachers are therefore advised to attend to this concern.

(a) In Q5.1 most candidates could not differentiate between the two *multivibrators* with reference to their output states, instead they referred to one having two switches while the other had no switch.

(b) In Q5.2, Q5.3, Q5.4, Q5.5, Q5.6 and Q5.8.2 many candidates had difficulty answering these questions of a narrative nature including their subquestions. Interpretation, analysis and understanding of the circuit were still a challenge.

(c) In Q5.4.1 a few candidates lost marks for not labelling the circuit correctly and they left out the *ground connector* in the circuit.

(d) In Q5.7.4 most candidates provided the correct answer but could not state that the gain would also increase, thereby losing the second mark.

Suggestions for improvement

The following suggestions, as mentioned in the *2021 Diagnostic Report*, are still relevant with a number of additions:

(a) It is important for teachers to understand that components in a circuit may perform different functions; therefore, they are advised to study and understand the following:
- Internal construction of the *555 IC*, including the function of each pin
- How the circuit responds when S_1 and S_2 are activated in Q5.2, including the drawing of an *output waveform*

(b) In Q5.3 the concepts of *input voltage* (V_{in}) and *reference voltage* (V_{ref}) for the operation of the circuit should be explored when the trigger pulse is applied, particularly in Q5.3.3. Learners must understand what will happen during the following conditions:

- If $V_{in} < V_{ref}$, what will the polarity of the output voltage be?
- If $V_{in} > V_{ref}$, what will the polarity of the output voltage be?

(c) Learners should understand the following concepts:
- *Closed-loop* and *open-loop gain*
- An *op-amp circuit* with feedback and the purpose of such feedback
- The difference between *RC integrated circuit* and *op-amp integrated circuit*.

(d) The functions of each component in the above circuits should be studied, e.g. a *capacitor* and three *resistors*.

(e) Electrical Technology is an applied subject; therefore, the explanation of a circuit must be coupled with calculations and input and the correlating *output waveforms*, e.g. in Q5.7.

(f) The changing of components affects the characteristics and the operation of the circuit. Learners should be taught these concepts and how to apply their knowledge in a dynamic circuit and to predict the *output waveforms*. This should also direct the teacher's approach and style when teaching this subject. Reference is made to Q5.2.3.

(g) Teachers must ensure that:
- Learners' calculations include the correct steps as per instruction 7 on the question paper so that they do not lose marks unnecessarily.
- Learners draw a fully labelled circuit. Teachers must do the same, as learners use the teacher's work as the model and copy it.
- ICT showing simulations and circuits is integrated into lessons to enhance teaching and learning. This will strengthen learners' theoretical knowledge in the process.

(h) The difference between the verbs *calculate* and *determine* which was raised in provincial report must be explained:
- Calculate: In this context, it 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 Q5.7.
- Determine: 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 demonstrate operational understanding of the circuit, particularly when the capacitor is fully charged. The same considerations applied to Q5.4.1, Q5.5.1 and Q5.7.2.

QUESTION 6: AMPLIFIERS

Common errors and misconceptions

In 2021 there were many candidates who did not answer this question. This trend continued with the 2022 candidates. It was the most poorly answered question, with the majority of candidates registering zero marks or not attempting it at all. This could suggest that most candidates might be lacking content knowledge and the skills to answer the question. These areas were also mentioned in previous diagnostic reports. Curriculum specialists and teachers are requested to attend to these area as a matter of urgency.

(a) In Q6.1 most of the candidates did not know the categories of amplifiers.

(b) In Q6.2.3 many candidates did not know how to draw the *load line*.

(c) In Q6.2.4 most candidates could not indicate the *bias point* on the *load line*.

(d) In Q6.2.5 candidates were not familiar with the determination of the value of the *collector current* at the *class A bias point*.

(e) In Q6.3.2 most candidates could not explain why the values of the *coupling capacitors* were purposely selected to be as large as possible.

(f) In Q6.3.3 most of the candidates did not know the purpose of R_E.

(g) In Q6.3.4 most candidates did not know the function of the *RC coupling* due to a lack of content knowledge.

(h) In Q6.4.1 the application of a *transformer coupled amplifier* was unknown.

(i) In Q6.4.2 many candidates could not state the TWO advantages of a *two-stage transformer coupled amplifier.*

(j) In Q6.4.3 most of the candidates struggled to differentiate between *ac* and *dc operated loads*.

(k) In Q6.5 the majority of the candidates did not know the operation and the function of the radio-frequency amplifier because of a lack of content knowledge.

(l) In Q6.6 many candidates did not know the operation of the *LC tank circuit* because of a lack of content knowledge.

(m) In Q6.6.2 most candidates could not draw the *output wave form* from a *damped oscillation waveform*. The majority drew a *waveform* without a decreasing amplitude.

(n) In Q6.7 the operation of the *Hartley oscillator* was not known by many candidates.

(o) In Q6.81 and Q6.8.2 the operation of the circuit was not known. Many candidates wrote vague responses.

(p) In Q6.8.3 candidates could not compare feedback in *transistor amplifiers* to *oscillator circuits*, since they did not know the type of feedback with reference to *transistor amplifiers* (negative feedback) and *oscillator circuits* (positive feedback).

(q) In Q6.9 most of the candidates did not know the difference between *LC* and *RC oscillators* with reference to the frequency.

Suggestions for improvement

Some of the suggestions ~~as~~ mentioned in the *2021 Diagnostic Report* are still relevant and are repeated here.

(a) The building of the circuits needs to be reinforced with more revision. The learners need to draw the various circuits multiple times to consolidate their knowledge.

(b) The definitions and categories of amplifiers must be reinforced until learners master them.

(c) Teachers are advised and encouraged to:

- Focus on the skill of circuit analysis so that learners can correctly identify circuits and the function of each component in the circuit diagrams.
- Emphasise the correct and accurate substitution of values in calculations throughout formal and informal activities.
- give attention to the function of different components in the circuits as well as the effect of changing their component values during the lesson.
- Build amplifier circuits during practical lessons and display the input and output signals on an *oscilloscope*. Teachers must also change the value of the input signal and value of components to show their effect on the output of the circuit.
- Emphasise the characteristic curves of amplifiers with the circuit analysis and function of different components as a whole and not separately.
- Make 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.
- Build *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.
- Demonstrate the function of the components by either disconnecting them or replacing them with other components to show the importance of such specific components.
- Emphasise the calculation and demonstration of *oscillation frequency* using different component values.

(d) With regard to Q6.8.3, emphasis should be on positive feedback and the reasons to maintain oscillations.

(e) Teachers must explain the use of *FET* and *BJT transistors* in *oscillator circuits* as well as their advantages.

(f) 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 theory.

5.3 POWER SYSTEMS

This report should be read in conjunction with the Power Systems question paper and marking guidelines of the November 2022 examinations.

5.3.1 PERFORMANCE TRENDS (2018–2022)

The number of candidates who sat for the Power Systems examinations in 2022 increased by 232 compared to that of 2021.

The table below indicates pass rates at 30% (Level 2) for the past five years in the 92% to 96% range. The pass rate of candidates at 30% (Level 2) of 94,1% in 2022 was consistent with that of 2021.

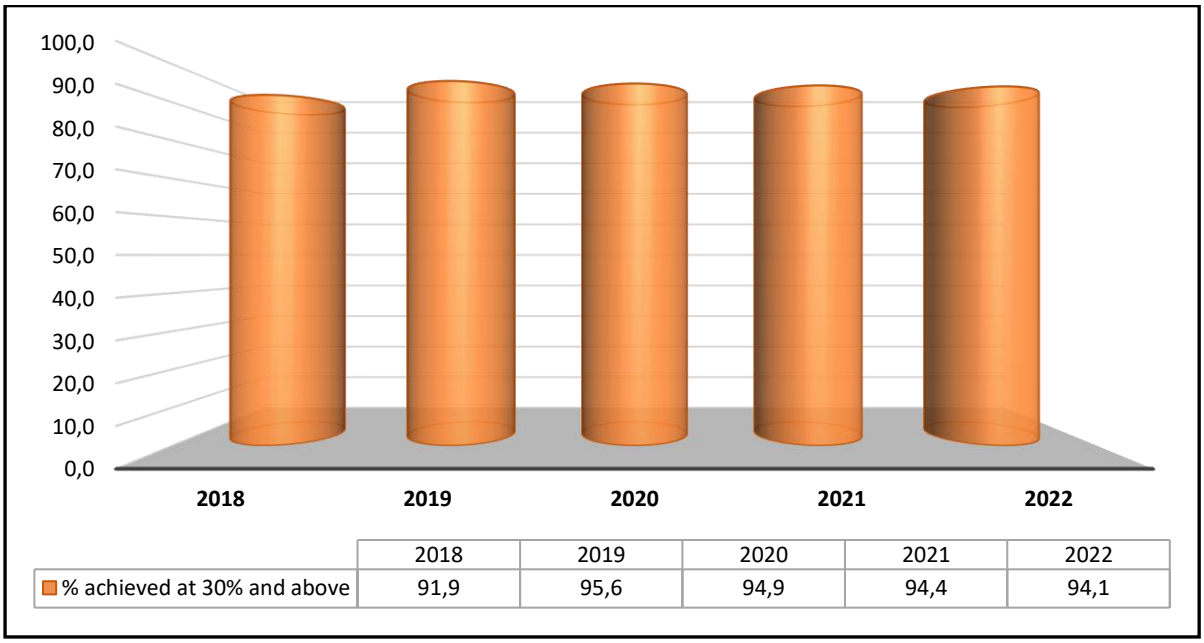
There was a decline in the pass rate at 50% (Level 4) with 26,8% of candidates achieving this in 2022 compared to 44% in 2021. There was a disappointing decline in the percentage of distinctions at 80% (Level 7) from 1,5% in 2022 to 0,6% in 2021. This converts into a decrease in total distinctions from 85 to 35.

However, in view of disruption to academic programmes in 2020 and 2021, and despite some of the factors mentioned above, the results achieved by this cohort are generally acceptable. Strategic intervention programmes at all levels (National, Provincial, Districts and Schools) ensured that learners were adequately prepared.

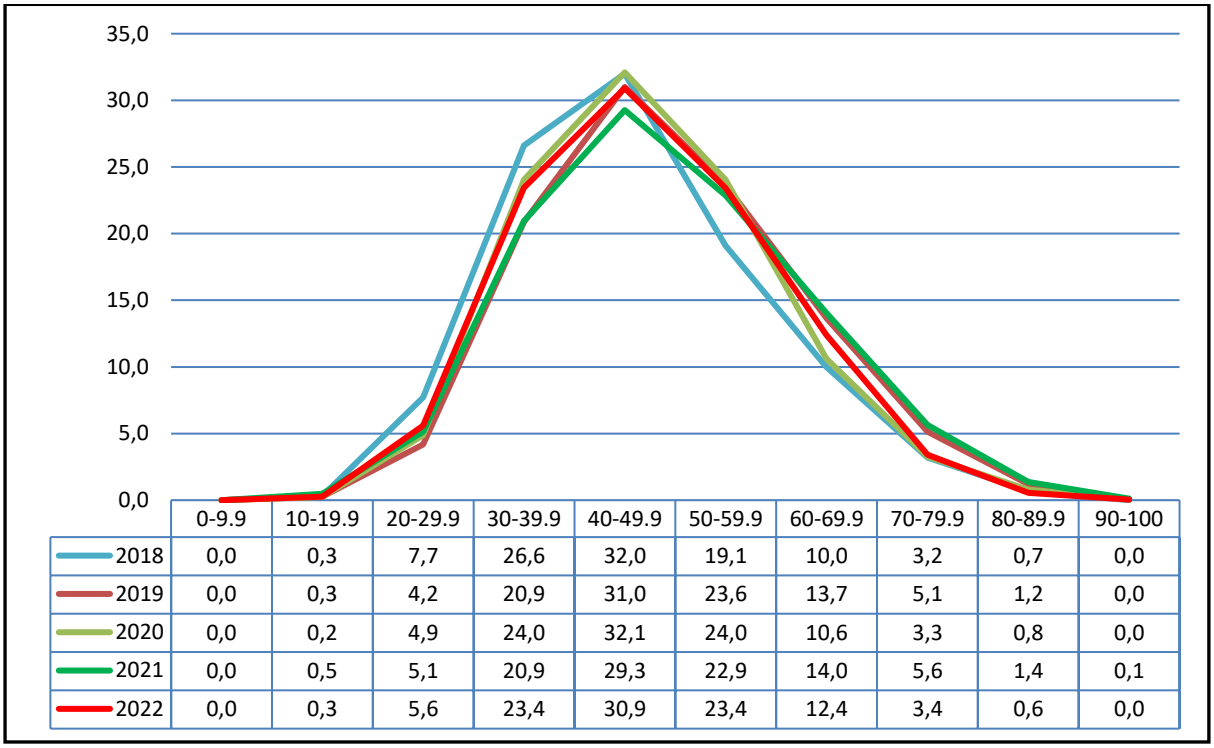
Table 5.3.1 Overall achievement rates in Power Systems

Year	No. wrote	No. achieved at 30% and above	% achieved at 30% and above
2018	5 228	4 806	91,9
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

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
2018	0,0	0,3	7,7	26,6	32,0	19,1	10,0	3,2	0,7	0,0
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

5.3.2 OVERVIEW OF CANDIDATES' PERFORMANCE IN POWER SYSTEMS

General comments

Some of the comments mentioned in the *2021 Diagnostic Report* must be revisited as they are still applicable in 2022.

(a) Based on a sample of the candidates' responses, it is evident that most candidates still experienced challenges with interpreting the requirements of the question and had difficulty answering questions of a narrative nature.

(b) Questions that required candidates to explain basic operations of circuits were still a challenge because of a lack of content knowledge and insight into the concepts.

(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

These suggestions, as mentioned in the *2021 Diagnostic Report* are still relevant with certain amendments.

(a) Use of past NSC papers: 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 2022 as these are based on the current *CAPS* content.

(b) Revision of relevant Grade 10 and 11 content: Although the NSC examinations only assess Grade 12 content, 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/plan.

(c) Time management: According to the provincial internal moderators' reports, candidates were able to finish on time, however, some questions were not attended to. Teachers are encouraged to self-diagnose and request help from subject advisors or do further reading from other sources. Teachers are requested to identify their shortcomings by answering previous question papers. Their performance will inform them of the questions/sections with which they have challenges and those that they are good at. Based on their performance, they could seek assistance to develop themselves.

(d) For the narrative nature of questions, the responses in the marking guidelines are broken down into key areas of specific content and marks are then awarded accordingly. A general response is only awarded one mark. Learners must respond in the required fashion, which will hone their comprehension skills and eliminate vague one-word responses. Refer to Q4.5, Q6.6.4, and Q7.6.3 where the responses are broken down in bullet form and ticks/marks are placed at key areas of specific content.

(e) Practical experiments and past papers**:** 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).

(f) For graphical or diagrammatical nature of questions, the responses in the marking guideline are broken down as in Q4.4.

5.3.3 ANALYSIS OF CANDIDATES' PERFORMANCE IN EACH QUESTION IN POWER SYSTEMS

QUESTION 1: MULTIPLE-CHOICE QUESTION

Common errors and misconceptions

(a) In Q1.3 most candidates had difficulty understanding the relationship between *impedance* and *frequency* in a *resonance series RLC circuit*.

(b) In Q1.6 the majority of candidates did not define *reactive power*. They confused it with *apparent power* and *real/active/true power*.

(c) In Q1.11 a large number of candidates were not familiar with this type of a question.

(d) Most candidates did not answer Q1.14 correctly.

Suggestions for improvement

(a) Learners should:
- Not rush when choosing the answer. They should rather read carefully, eliminate incorrect answers until they have identified the most relevant and accurate correct answer.
- Be encouraged to read the textbook and other relevant sources as guided by the teacher to gain insight and content knowledge, in order to answer all the questions.

(b) Teachers are advised to include this type of question in formal and even informal assessment tasks, and furthermore to develop in learners the skill of analysing and interpreting the questions for a correct possible answer. This should eliminate wrong answers and distractors in their approach.

QUESTION 2: OCCUPATIONAL HEALTH AND SAFETY

Common errors and misconceptions

(a) In Q2.1 most candidates provided answers referring to the employees and not to the employer.

(b) In Q2.4 the majority of the candidates confused human rights responses with those of victimisation and even with discrimination. Answers to Q2.1 were also found in Q2.4.

Suggestions for improvement

(a) Teachers are advised and encouraged to:
- Develop activities that require definitions according to the OHS Act as well as explanations of concepts and terminologies.
- Use OHS videos to enhance their teaching. This will focus learner responses in the proper direction and eliminate one-word, vague responses.

(b) The following suggestions are as relevant as they were in the *2021 Diagnostic Report.*
- Learners must realise that the understanding of concepts, terminology and jargon of the subject are 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.

(c) OHS should be emphasised from Grades 10 and 11 and be incorporated in practical tasks and infused in teaching rather than being taught in isolation.

QUESTION 3: RLC CIRCUITS

Common errors and misconceptions

(a) In Q3.1 most candidates were unable to explain the term *inductance,* and the few who did explain the term, did not refer to *AC* in their attempt to answer the question. Furthermore, some explained *inductive reactance* with reference to the *RLC circuits*.

(b) In Q3.2.1 and Q3.2.2, when drawing the *phasor* diagram, most candidates did not know the phase relationship between current and voltage in a *resistive* and *capacitive circuit* respectively. A few candidates drew the correct phasor diagram, but omitted arrows.

(c) In Q3.3.1 and Q3.4.1 a few candidates wrote the incorrect formula:
$Z = \sqrt{R^2 +}\ (X_L - X_C)^2$ and $I_T = \sqrt{{I_R}^2 +}\ (I_L - I_C)^2$ instead of the correct formula
$Z = \sqrt{R^2 - (X_L - X_C)^2}$ and $I_T = \sqrt{{I_R}^2 - (I_L - I_C)^2}$. They lost 1 mark.

(d) In Q3.3.2 and Q3.3.3 the majority of the candidates could not make θ and L respectively, the subject of the formula from the formulae taken from the formula sheet. This affected the substitution and the answer.

(e) In Q3.3.4 candidates were unable to explain the meaning of *lagging power factor,* some stated: *A lagging power factor is when the circuit is predominately inductive.*

(f) In Q3.3.5 most candidates did not know why the current and the voltage waveforms were in phase. Some said *the phase angle is zero (0)* while others included the concept of *lagging* and *leading power factor* in their responses.

(g) In Q3.4.3 a few candidates used *three-phase AC system* formula $P = \sqrt{3} \times V \times L \times Cos\,\theta$ instead of $P = V \times L \times Cos\,\theta$ to calculate the total power.

(h) In Q3.5.3 most candidates read from the graph instead of interpreting and analysing it, i.e. the *impedance* is going up or down, the *impedance* will increase or decrease without considering the effect that frequency has on the impedance, either below or above resonance frequency.

Suggestions for improvement

(a) Teachers are advised to illustrate/demonstrate the phase relationship between current and voltage in a/an:
- *Resistive* circuit
- *Inductive* circuit
- *Capacitive* circuit

(b) The definitions of the terms, explanations and descriptions of concepts that are likely to be asked in the examination should be summarised in a booklet and handed to learners at the beginning of the year. This should include, among others, the following: *inductance*, *lagging* and *leading power factor*. A formula sheet should also be given to learners at the beginning of the year, and learners should be assisted with how to identify the correct formulae to be used in calculations. This suggestion is also applicable to all other affected questions/areas.

(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 circuit*s and the conditions of *series/parallel resonant circuits*.

QUESTION 4: THREE-PHASE AC GENERATION (SPECIFIC)

Common errors and misconceptions

(a) Candidates were unable to answer Q4.1.1 and Q4.1.2, and most of them could not motivate their answers.

(b) Many candidates did not answer Q4.3 correctly; they referred to increasing current creating heat or voltage increasingly damaging equipment.

(c) In Q4.4 most candidates drew a schematic representation, instead of the diagrammatic representation of the circuit. A few candidates drew the correct diagram but did not label it correctly and they lost six marks.

(d) In Q4.5 the majority of candidates did not refer to *voltage* that was key to this question. Instead they mentioned the generation of electricity from power stations and stepped down to either 380/230 V or to industrial and domestic areas without mentioning the intermediate/substation and the value of voltages stepped down before reaching consumers.

(e) In Q4.6.3 a few candidates calculated apparent power and active power. From the values obtained in apparent power and active power, they then calculated Cos θ, manipulated and found the *phase angle*, even when Cos θ was given in Q4.6. Some made mistakes in their long method and were penalised.

(f) Most candidates did not answer Q4.6.5.

(g) In Q4.7.1 and Q4.7.2 most candidates provided the advantages and disadvantages of the *two-wattmeter method* instead of the *three-wattmeter method*.

Suggestions for improvement

(a) Teachers are advised to develop a chart as part of their teaching aids, where the three powers, namely *active power*, *reactive power*, *apparent power* and the *power factor* are explained or defined. These terms should be displayed on the wall so that learners become familiar with them. This technique can also be used for other sections where similar misconceptions exist.

(b) Teachers should emphasise the concept of losses in transmission lines, and interpretation of the formulae, '$P = I \times V$ *and* $P = I^2 \times R$*'* as applied.

(c) Teachers must ensure that learners understand the three main stages of the national power grid in a block diagram. They should also understand the distribution networks from generation to consumers. A video may also be used to enhance understanding of the network system.

(d) Teachers are advised to refer to the *CAPS* document, *Examination Guidelines*, and the prescribed textbook and other resources every time they prepare/plan their lessons. This will assist them to cover the work as prescribed and not as per previous question papers. This cannot be emphasised strongly enough as it would appear that the majority of candidates did not answer Q4.6.5 because it did not appear anywhere in the previous question papers.

QUESTION 5: THREE-PHASE TRANSFORMER (SPECIFIC)

Common errors and misconceptions

(a) In Q5.1 most candidates explained the principle operation of transformers and not the principle of *mutual induction* with reference to transformers.

(b) In Q5.3.1 and Q5.3.2 the majority of candidates mentioned resistance and current, *hysteresis* and *eddy current losses* respectively instead of discussing how they contribute to losses.

(c) In Q5.4 some candidates mentioned the cooling method for *oil-immersed transformers* instead of describing how insulation failure is controlled in *dry-type transformers*.

(d) Candidates had difficult answering Q5.6.

(e) In Q5.7 the inclusion of the *delta-connected* load in the secondary side of the transformer confused most of the candidates and this had an impact on their ability to answer Q5.7.2. They did not know whether to use the $I_{L2}= \sqrt{3} \times I_{p2}$ or the $I_{L2} = I_{p2}$ formula.

Suggestions for improvement

Teachers are advised to refer to the *CAPS* document, *Examination Guidelines*, and the prescribed textbook and other resources every time they prepare/plan their lessons. This will assist them to cover the work as prescribed and not as per previous question papers. This would appear to be the reason why the majority of candidates did not answer Q5.3.1, Q5.3.2, Q5.4, Q5.6 and Q5.7.2 satisfactorily.

QUESTION 6: THREE-PHASE MOTORS AND STARTERS (SPECIFIC)

Common errors and misconceptions

(a) In Q6.1 most candidates only mentioned one type of *rotor construction* in *induction* motors.

(b) In Q6.2.1 most candidates could not differentiate between *rated speed* and *full load* speed.

(c) In Q6.2.2 some candidates confused the number of magnetic pole pairs per phase with the total number of magnetic poles in a three-phase motor.

(d) In Q6.2.3 some candidates wrote *slip* instead of *% slip* in the formula, and others wrote *per unit slip*, while there were others who did not multiply the equation by 100. Furthermore, some did not write the unit and lost more than 1 mark.

(e) In Q6.3 most candidates mentioned mechanical inspections of motors instead of inspection of a rotor and bearings.

(f) In Q6.4.1 and Q6.4.2 the majority of the candidates confused the formulae for *input power* and *reactive power.* They incorrectly substituted the phase angle in the formula:

$P = \sqrt{3} \times 380 \times 5 \times 20^0$ and $Q = \sqrt{3} \times 5 \times 20^0$ instead of $P = \sqrt{3} \times 380 \times 5 \times Cos\ 20^0$ and $Q = \sqrt{3} \times 5 \times Sin\ 20^0$ respectively. Furthermore, some omitted the unit or wrote the incorrect unit.

(g) In Q6.4.3 some candidates did not multiply $P = \sqrt{3} \times 380 \times 5 \times Cos\ 20^0$ by the given 90% efficiency, i.e. $P = \sqrt{3} \times 380 \times 5 \times Cos\ 20^0 \times \frac{90}{100}$; this might be as a result of incorrect identification of formulae.

(h) In Q6.5 a few candidates did not redraw the terminal box, and those who did used coils for *delta connection* instead of plates/wires.

(i) In Q6.6 the interpretation, analysis and operation of the control circuit is still a challenge with candidates being unable to explain the purpose and importance of MC_1N/O_2 in Q6.6.2 and interlocking MC_3N/C MC_2N/C in Q6.6.3 respectively.

Suggestions for improvement

(a) When teachers introduce any chapter, their preparation/plan should include an introductory part, linking the known to the unknown which is a basic methodology, i.e. introduction to three-phase motors, types of induction motors as defined by their rotor construction, etc.

(b) A formula sheet should be photocopied and placed in learners' workbooks, and a chart should be displayed on the classroom wall. This should serve to eliminate wrong identification of formulae by learners.

(c) Teachers are advised to explain/describe/discuss the:
- Operation of the 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.

(d) Teachers are advised to perform practicals at the end of every chapter to enhance the understanding of how motors can be connected in either *star* or *delta*. For the benefit of learners, teachers should open the terminal box of a motor and show them how plates are connected in the motor.

QUESTION 7: PROGRAMMABLE LOGIC CONTROLLERS (PLCs) (SPECIFIC)

Common errors and misconceptions

(a) In Q7.3 a few candidates were still confused about whether the two inputs, OL/NC and STOP should be open or not, despite the given information on the question paper. Candidates continue to draw a mirror image of the programme/diagram. This poses a problem because the programme only works in a left to right and top to bottom sequence. This programme will not operate the programming software for PLCs. Note that *interlocking contacts* MC_2 N/C and MC_1 N/C must be closed to indicate interlocking contacts.

Incorrect labelling and incorrect symbols was still a challenge. Several candidates connected the second rung directly to the rail, bypassing the *stop* and *overload inputs* which meant that the second rung could not be stopped or de-energised by the overload.

(b) Most candidates could not answer Q7.2.1, Q7.2.2 and Q7.2.3 and Q7.3.2 and Q7.5. These questions examined basic knowledge and content that should be studied directly from the textbook.

(c) In Q7.4 candidates struggled to interpret the scenario and used *closed inputs* instead of *open inputs*. Some candidates still used the wrong output symbols as shown in the prescribed textbook.

(d) In Q7.6.1 many candidates gave the function of the converter and did not explain how it achieves its function.

(e) In Q7.6.3 most candidates confused the *inverter* with a *converter*.

(f) In Q7.6.4 candidates mentioned the advantages of three-phase motors instead of the advantages of VSD.

Suggestions for improvement

(a) *Variable speed drives* and *regenerative braking* need far more attention in terms of block diagrams, basic purpose of blocks, applications and advantages.

(b) Learners must be taught to explain what sensors are. The definitions and uses of sensors should be given in full.

(c) *Latching* is a very important concept as it is used in starters as well. Teachers should focus on insight information as the questions are not posed in a straightforward way. Use keywords such as *why*, *how*, *describe* and *explain*, when teaching the theoretical part of the subject.

(d) In Q.7.7 teachers should emphasise the purpose or function of regenerative braking and the energies involved in this process. Note that learners learn differently and at different paces, therefore teachers must consider all learners when preparing lessons. Some learners learn more effectively by means of sight and touch, while others learn more effectively though verbal or visual means.

(e) Teachers need to explain and demonstrate to learners how the conversion of *hard wiring* to a ladder logic diagram is done, and show correct labelling of inputs and outputs. 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 two power rails

The ladder logic diagram drawn should use the Engineering Graphics and Design (EGD) approach and not crude freehand drawings.

(f) Teachers should assist learners to:
- Understand the purpose of *interlocking*.
- Use the correct symbols for *interlocking.*
- Explain the concept of *series connection* as used in *interlocking circuit*.
- Perform the practical experiment.

CHAPTER 6

MECHANICAL TECHNOLOGY

Mechanical Technology encompasses three specialisation subjects, namely Automotive, Fitting and Machining and Welding and Metalwork. This was the fourth examination in which the specialisation subjects were examined. The following report should be read in conjunction with the respective question paper of the November 2022 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 pertaining to pure recall of content were very poorly answered by the majority of the candidates. Short 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) Many of the candidates experienced difficulty manipulating formulae correctly. 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 application of mathematical principles is still a challenge for many candidates

(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) It was disappointing to note that 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 impact of learning losses due to disruptions over the last two years.

(g) A lack of content and skills knowledge was also noticeable especially by novice teachers. This could have contributed to poor or inadequate preparation for learning and assessment.

(h) The negative impact of load shedding also affected continuity in the teaching and learning environment. 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 2022 NSC examinations.

6.1.1 PERFORMANCE TRENDS (2018–2022)

The number of candidates who sat for the Automotive examination in 2022 increased by 271 compared to that of 2021.

The table below indicates consistent pass rates over the past five years in the 94% to 95% range. The pass rate of the candidates at 30% (Level 2) shows a marginal decrease from 95,2% in 2021 to 94,1% in 2022. Performance at 50% (Level 4) reflects a decline from 35,5% in 2021 to 32,9% in 2022.

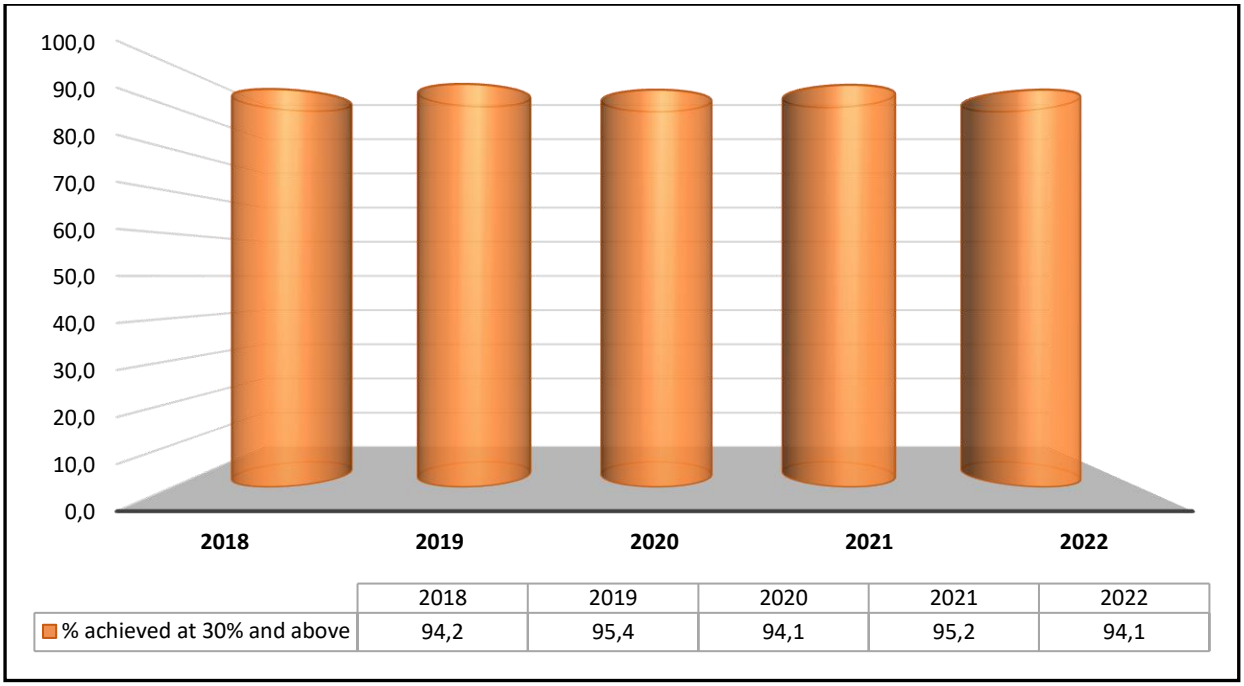
The percentage of distinctions over 80% (Level 7) in 2022 is 0,7% compared to 0,9% in 2021. This converts into a total of 25 distinctions achieved in 2022 compared to 30 in 2021.

In view of disruption to academic programmes in 2020 and 2021, and despite the factors mentioned above, the results achieved generally by this cohort are acceptable. Strategic intervention programmes at all levels (National, Provincial, Districts and Schools) ensured that learners were adequately prepared.

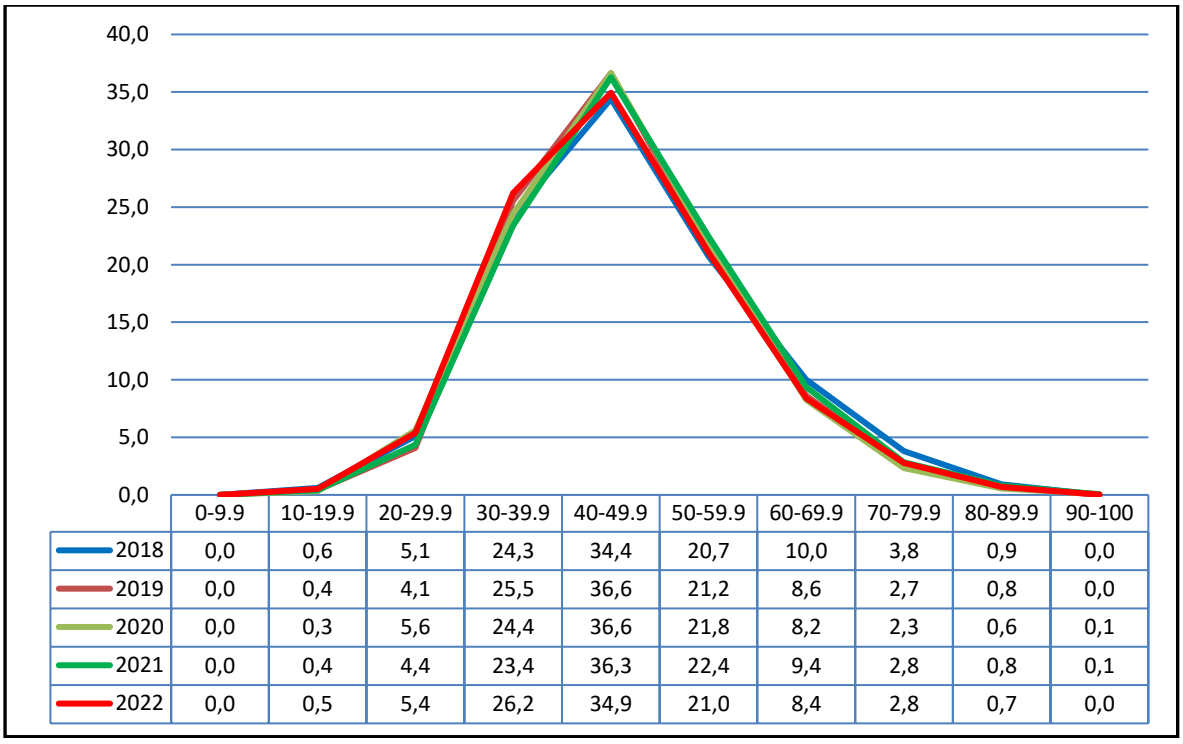
Table 6.1.1 Overall achievement rates in Automotive

Year	No. wrote	No. achieved at 30% and above	% achieved at 30% and above
2018	2 986	2 814	94,2
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

Graph 6.1.1(a) Overall achievement rates 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
2018	0,0	0,6	5,1	24,3	34,4	20,7	10,0	3,8	0,9	0,0
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

6.1.2 ANALYSIS OF CANDIDATES' PERFORMANCE IN EACH QUESTION IN AUTOMOTIVE

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Common errors and misconceptions

The majority of the candidates were not clear about the different sounds to be observed during a sound test in Q1.6.

Suggestions for improvement

(a) Teachers are advised to use practical demonstrations to explain and illustrate the different sounds to be observed during a sound test.

(b) In-depth revision and remediation measures must be taken on the topics of safety and materials. In order to prepare learners to respond with reasons to multiple-choice questions, the use of past question papers is encouraged. They must then apply their practical knowledge to the theory questions.

(c) 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 2: SAFETY

Common errors and misconceptions

(a) In Q2.1 most of the candidates struggled to provide the vital functions that must be checked when first aid is applied.

(b) In Q2.3 a large percentage of the candidates could not identify the type of safety guards to be used at the opening of the guillotine shears.

Suggestions for improvement

(a) Using video presentations and demonstrations will give learners an added advantage when answering the types of questions on first aid.

(b) Learners should be constantly exposed to workshop practice relating to the safety of tools, the equipment in the workshop and the workshop environment.

QUESTION 3: MATERIALS

Common errors and misconceptions

(a) In Q3.1 many candidates' responses exposed a lack of theoretical knowledge as well as practical application with regard to heat-treatment processes.

(b) In Q3.2 the majority of the candidates neglected to describe the temperature to which the steel needs to be heated as well as the quenching method or media.

(c) In Q 3.4 most of the candidates were not able to give the reason why steel is cooled in still air, away from draughts, during the normalising process.

Suggestions for improvement

(a) Teachers must ensure that learners are exposed to the different processes to enhance the properties of steel.

(b) The revision programme must include exercises 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 incorrectly answered by a fair percentage of candidates.

(b) Q4.4 was poorly answered as most candidates were not able to state the term of turbo lag.

(c) Q4.10 and Q4.11 were incorrectly answered by a large number of candidates. They showed a lack of practical knowledge of the automatic transmission system.

Suggestions for improvement

(a) Teachers must ensure that every learner possesses a worksheet containing the different terms. Short quick-fire questioning at regular intervals will ensure that the terms are understood.

(b) It is important that learners are able to distinguish between the different components of an automatic transmission and to provide the function of each component. This could be achieved by providing learners with a diagram of an automatic gearbox. Learners must then be requested to label the different components on the diagram and provide a short description of the functions of each component.

QUESTION 5: TOOLS AND EQUIPMENT

Common errors and misconceptions

(a) In Q5.1.1 to Q5.1.3 the majority of the candidates found it difficult to provide the correct safety precautions when conducting a compression test.

(b) In Q5.4 most of the candidates were unable to state the different ways to connect the on-board diagnostic scanner to a vehicle.

Suggestions for improvement

(a) It is imperative that learners should be exposed to all tools as prescribed in the *CAPS* for Automotive. Teachers must ensure that the purpose of each tool is emphasised in their lesson plans. They must also incorporate the correct training on how to use these tools. In this process, learners will be better equipped to correctly identify the different tools.

(b) Practical skills in performing compression 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 some candidates could not identify the different types of vibration dampers shown in the drawings.

(b) In Q6.7.3 most candidates could not give the reasons why the engine fitted with a turbo charger should idle for a while before turning the engine off.

(c) In Q6.8 some candidates could not identify the various superchargers in the sketches provided in the question paper.

Suggestions for improvement

(a) Teachers are encouraged to use drawings of various components in their lessons. Activities must require learners to identify the components and offer reasons.

(b) The theory must be covered first before demonstrations on supercharger and turbo-charged operations are done practically. This will ensure that learners are able to link theory with practical when identifying the types and operation.

QUESTION 7: FORCES

Common errors and misconceptions

(a) Most candidates struggled to provide a definition of *swept volume* in Q7.1.

(b) In Q7.3.1 most candidates could not identify the cylinder bore and diameter from the sketch given.

(c) In Q7.3.3 the majority of the candidates experienced difficulty calculating the compression ratio.

(d) In Q7.4 some candidates were not able to calculate the indicated power using the information given in the instructions. They could not convert standard units to the required units. Many candidates were challenged by the mathematical concepts which are essential for such calculations.

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*, *brake power* and *mechanical efficiency*.

(b) Using a line sketch to define *swept* and *clearance volume* is useful to enhance understanding of these concepts.

(c) 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.

(d) 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) In Q.8.1 most candidates were unable to state the gas reading for a faulty catalytic converter.

(b) Many candidates were challenged by Q8.3.1 to Q8.3.4. They were required to respond to the compression test.

Suggestions for improvement

(a) When conducting an exhaust gas analysing test, teachers are advised to design a worksheet requiring learners to indicate causes and corrective measures.

(b) A practical demonstration of how to do a compression test and stating the purpose of testing is a useful teaching technique in this regard.

(c) 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) In Q9.1.1 and Q9.1.2 the majority of the candidates could not label and explain the operation of the double epicyclic gear train in low gear.

(b) Many candidates were unable to label and state the function of the torque converter in Q9.2.1 and Q9.2.4.

Suggestions for improvement

(a) Teachers are advised to design a worksheet that will assist learners with identifying various parts and understanding their functions, purposes and advantages and disadvantages of the automatic transmission including the epicyclic gear train.

(b) 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) In Q10.2.1 many candidates were unable to state the purpose of *toe-in.*

(b) In Q10.2.2 the majority of the candidates could not state the purpose of *negative caster.*

(c) Most candidates did not label the rotor of an alternator in Q10.7.

(d) In Q10.10 most candidates did not know the function of the check valve in the fuel system.

Suggestions for improvement

(a) Teachers must do the practical application of a steering mechanism so that learners can have a better understanding of the topic.

(b) Teachers should assign more drawing exercises to allow learners to master all wheel alignment angles, definitions and labels. Take learners to a wheel alignment workshop for learners to understand the alignment and setting of wheel alignment angles. Alternatively, videos can be used to achieve this objective.

(c) The use of an actual alternator to show the components and to explain their stator wiring, functions, operations and methods to increase their frequency as well as safety measures, is advised.

(d) Design a worksheet for learners to complete regarding the difference between an *electrical* and a *mechanical* fuel pump as well as the types, advantages and disadvantages of each. Alternatively, they can use video clips to demonstrate how electrical and mechanical fuel pumps operate, to achieve the same goal.

(e) Teachers must demonstrate the parts of the fuel pump and discuss their functions to enhance the understanding of the functioning of this item.

(f) Frequent weekly short informal assessment tasks to enhance candidates' 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 2022 examinations.

6.2.1 PERFORMANCE TRENDS (2018–2022)

The number of candidates who sat for the Fitting and Machining examination in 2022 decreased by 54 compared to that of 2021.

The table below indicates consistent pass rates over the past five years in the 95% to 98% range. The pass rate of the candidates at 30% (Level 2) shows a marginal decrease from 97,1% in 2021 to 96,5% in 2022. Performance at 50% (Level 4) reflects a slight decline from 48,5% in 2021 to 47,6% in 2022.

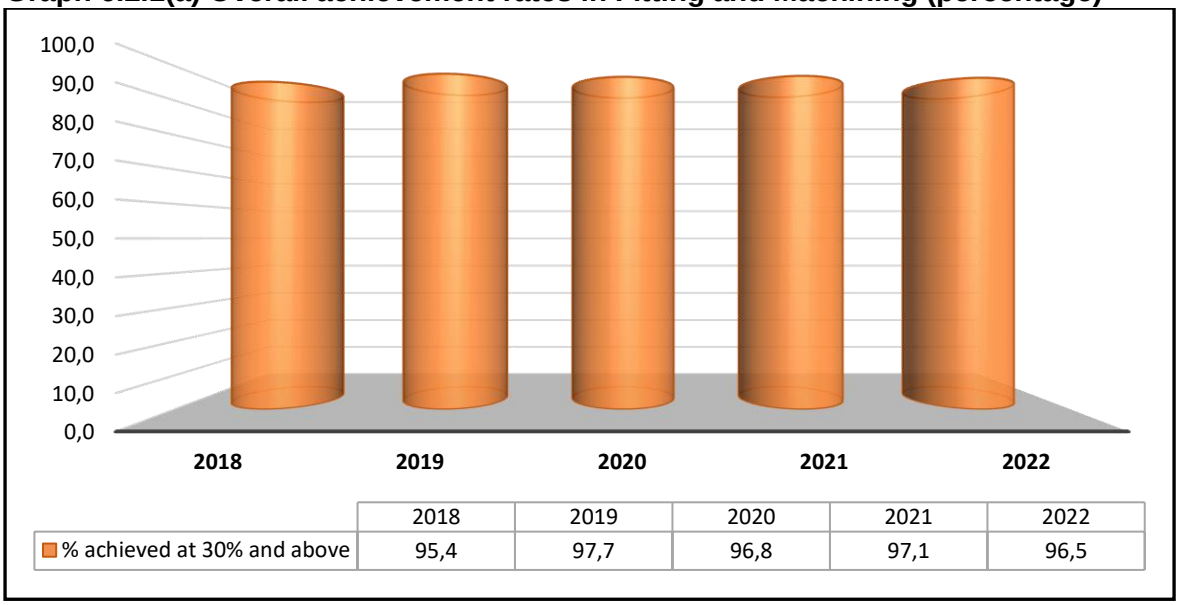
The percentage of distinctions over 80% (Level 7) remains stable at 3,1%. This converts into a total of 60 distinctions which is consistent with that of 2021.

In view of disruption to academic programmes in 2020 and 2021, the results achieved generally by this cohort are commendable. Strategic intervention programmes at all levels (National, Provincial, Districts and Schools) ensured that learners were adequately prepared.

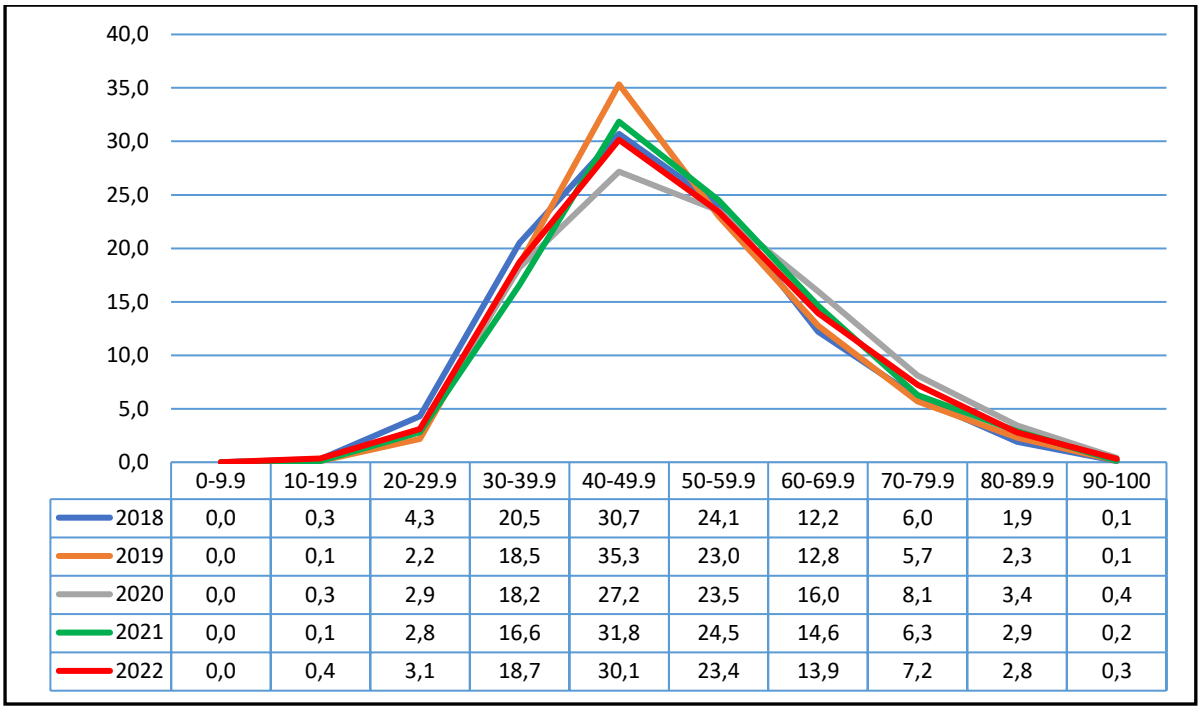
Table 6.2.1 Overall achievement rates in Fitting and Machining

Year	No. wrote	No. achieved at 30% and above	% achieved at 30% and above
2018	2 088	1 992	95,4
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

Graph 6.2.1(a) Overall achievement rates 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
2018	0,0	0,3	4,3	20,5	30,7	24,1	12,2	6,0	1,9	0,1
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

6.2.2 ANALYSIS OF LEARNER PERFORMANCE IN EACH QUESTION IN FITTING AND MACHINING

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Common errors and misconceptions

The majority of the candidates were not clear about the different sounds to be observed during a sound test in Q1.6.

Suggestions for improvement

(a) Teachers are advised to use practical demonstrations to explain and illustrate the different sounds to be observed during a sound test.

(b) In-depth revision and remediation measures must be put in place on the topics of safety and materials. In order to prepare learners to respond with reasons to multiple-choice questions, the use of past question papers is encouraged. They must then apply their practical knowledge to the theory questions.

(c) 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 2: SAFETY

Common errors and misconceptions

(a) In Q2.1 most of the candidates were unable to provide the vital functions that must be checked when first aid is applied.

(b) In Q2.3 most candidates could not identify the type of safety guards to be used at the opening of the guillotine shears.

Suggestions for improvement

(a) Making use of video presentations and demonstrations will give learners an added advantage when answering the types of questions on first aid.

(b) Learners should be exposed to workshop practice relating to the safety of tools, the equipment in the workshop and the workshop environment.

QUESTION 3: MATERIALS

Common errors and misconceptions

(a) In Q3.1 many candidates' responses exposed a lack of theoretical knowledge as well as practical application with regard to heat-treatment processes.

(b) In Q3.2 the majority of the candidates neglected to describe the temperature to which the steel needs to be heated as well as the quenching method or media.

(c) In Q 3.4 many candidates were not able to give the reason why steel is cooled in still air, away from draughts, during the normalising process.

Suggestions for improvement

(a) Teachers must ensure that learners are exposed to the different processes to enhance the properties of steel.

(b) The revision programme must include exercises 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) Some candidates did not read the questions carefully and provided inappropriate responses.

(b) The majority of the candidates appear to lack the necessary skills to answer multiple-choice type questions.

(c) Most candidates did not know the absolute measuring principle during CNC milling.

Suggestions for improvement

(a) Learners must be given direction on the technique of arriving at the correct answer through the process of elimination in instances where they are unable to identify the correct alternative immediately.

(b) Teachers should ensure that the main difference between *absolute* and *incremental programming* on a three-axis digital read-out system are clearly explained. A practical demonstration will enhance learners' understanding of this term.

QUESTION 5: TERMINOLOGY – LATHE AND MILLING MACHINE

Common errors and misconceptions

(a) Inappropriate answers to Q5.2 revealed that a few of candidates lacked the mathematical skills required to answer the question.

(b) Q5.4 and Q5.5 were based on the theory of the practical application of skills regarding the milling processes. Candidates who did not perform well could not relate this content to the process in practice.

(c) In Q5.6 the majority of the candidates seemed to lack the ability to formulate the calculation of the distance 'X' in order to centre the milling cutter.

Suggestions for improvement

(a) The subject teachers need to integrate relevant sections with Mathematics (Trigonometric equations) and Technical Mathematics.

(b) Teachers should provide learners with more weekly activities containing different questioning techniques such as substitution, manipulation of formulae and calculations. This will contribute to sharpening their answering skills in tests and examinations.

(c) Learners must be encouraged to practise using the diagram from question papers to assist them in formulating the calculations.

(d) Performing practical tasks can assist learners with understanding the concepts, processes, advantages and disadvantages. This should result in an improvement in the quality of answers they offer 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. The majority of the candidates struggled to answer these questions correctly.

(b) In Q6.3.1 the majority of the candidates did not give the final answers for indexing. They were expected to indicate that there were no full turns and 6 holes on the 24-hole circle or no full turns and 7 holes on the 28-hole circle.

(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 from previous grades over time.

Suggestions for improvement

(a) Relevant subject content needs to be integrated with Mathematics and Technical Mathematics. Teachers are advised to provide learners with more activities with different questioning techniques such as substitution, manipulation of formulae and calculations to enhance 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 must factor in more weekly calculation activities to their planning. This will enhance learners' mathematical skills and improve formula manipulation through practice.

QUESTION 7: TOOLS AND EQUIPMENT

Common errors and misconceptions

(a) In Q7.1 a few candidates were not familiar with the screw thread micrometer, hence presented poor or irrelevant responses.

(b) Many candidates were not able to present a proper labelled drawing of the Brinell hardness tester in Q7.2.

(c) In Q7.4.2 many candidates could not distinguish between the formula required for V-screw thread and square screw thread.

Suggestions for improvement

(a) It is important that learners become familiar with the names and uses of the measuring instruments that they are using. Teachers can create practical tasks to improve measuring skills using Vernier callipers, micrometres and accessories.

(b) Teachers should make 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 given instructions on how to improve their drawing skills so that they are better able to provide proper answers to these types of questions.

(d) Learners must be made aware of the formula required for V-screw thread and square screw thread and how this can be used. Short class tests 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 (south of west).

(b) Q8.2.2 and Q8.2.3 required reactions at supports A and B. Some candidates calculated reaction B at Q8.2.2 and reaction A at Q8.2.3.

(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) Calculations with exponents in Q8.3 were a great challenge for many candidates. They were unable to state the required units of measure. Furthermore, many were not able to work with formulae on 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 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 purpose.

(c) Learners should be encouraged to perform calculations systematically. The following steps are considered to be effective by the few that actually makes 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 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 unit in the answer.

(e) Different methods of calculation should be explored and explained to the learners. Manipulation of formulae should be practised and the meaning of every entity in the formula should be explained in a broader sense.

(f) Different areas must be practised. These can easily be incorporated in homework and assessment activities.

QUESTION 9: MAINTENANCE

Common errors and misconceptions

(a) Q9.1, Q9.3 and Q9.5, 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 section on maintenance consists mostly of factual information. It was surprising that most of candidates' responses showed a lack of knowledge and understanding in this topic.

(c) The inappropriate answers of the majority of the candidates was also a clear indication that they lacked practical experience in respect to maintenance.

(d) A large percentage of candidates also had difficulty providing valid reasons or explanations or stating a procedure correctly when required to do so.

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 must be accepted that maintenance procedures cannot be fully grasped from a textbook or notes. It has to be observed or performed in practice. Teachers must design more practical tasks that involve maintenance procedures. It is advisable that the procedures be listed in point form. It is also important that the correct terminology related to maintenance is emphasised.

(c) The integration of theory and practice in the workshop is imperative.

QUESTION 10: JOINING METHODS

Common errors and misconceptions

(a) It was evident that many candidates lacked relevant knowledge with regard to screw thread terminology.

(b) The majority of the candidates generally displayed a weakness in mathematical skills that were necessary to answer the questions.

(c) Candidates lost marks because of the scaffolding nature of some subquestions. Essentially, when the first calculation is incorrect, subsequent calculations will also be incorrect, e.g. 10.2.1–10.2.5.

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 be engaged in more practice involving calculations to gain confidence to answer this type of question. Regular activities must be used at strategic points during 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) This question was answered poorly by the majority. This was possibly due to the topic being placed towards the end of the year on the ATP and teachers had to cope with the time constraints.

(b) This section constitutes the higher-order component of the paper, hence most candidates struggled with systems and control calculations.

(c) Q11.1.1 and Q11.1.2 were very poorly answered by a large percentage of candidates due to an apparent lack of mathematical skills. Candidates lost marks because when the first calculation is incorrect, subsequent calculations will also be incorrect. The marking guidelines did not make provision for such circumstances, although the marking principle for calculations was followed.

(d) It was evident in Q11.2 and Q11.3 that a fair percentage of candidates lacked the necessary theoretical knowledge relevant to systems.

(e) In Q 11.4.1 and Q11.4.2 many candidates were not able to apply the formulae correctly and also expressed the answer in the incorrect unit of measure in their attempts.

(f) In Q11.5 many candidates did not calculate the *product* of the number of gear teeth, instead they calculated the *sum* of the number of gear teeth, which was not a requirement of the question.

Suggestions for improvement

(a) Mathematical skills can only improve with practice. Teachers must create many opportunities to ensure material is always available.

(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 with 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 regard 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 2022 examinations.

6.3.1 PERFORMANCE TRENDS (2018–2022)

The number of candidates who sat for the Welding and Metalwork examination in 2022 increased by 54 compared to that of 2021.

The table below indicates variable pass rates over the past five years in the 89% to 95% range. The pass rate of the candidates at 30% (Level 2) shows a pleasing increase from 90,6% in 2021 to 92,9% in 2022. Performance at 50% (Level 4) also reflects an marginal improvement from 31,0% in 2021 to 32,1% in 2022.

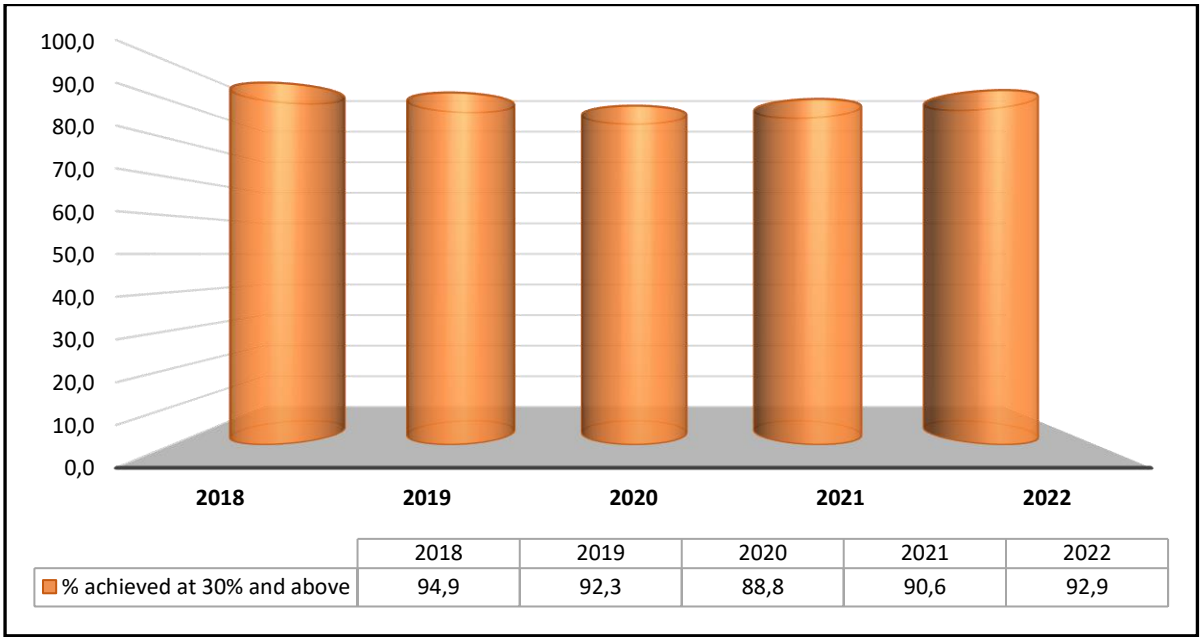
The percentage of distinctions over 80% (Level 7) remains stable at approximately 0,7%. This converts into a total of 17 distinctions which is consistent with that of 2021.

In view of disruption to academic programmes in 2020 and 2021, the results achieved generally by this cohort are commendable. Strategic intervention programmes at all levels (National, Provincial, Districts and Schools) ensured that learners were adequately prepared.

Table 6.3.1 Overall achievement rates in Welding and Metalwork

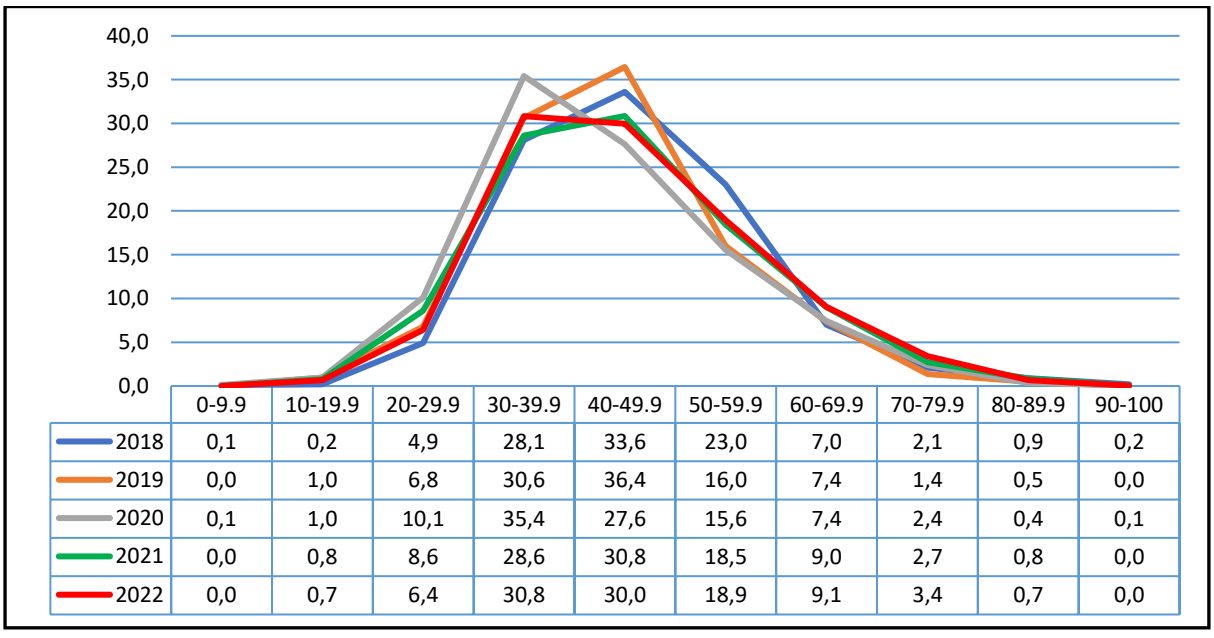
Year	No. wrote	No. achieved at 30% and above	% achieved at 30% and above
2018	1 934	1 835	94,9
2019	1 682	1 552	92,3
2020	1 683	1 495	88,8
2021	2 308	2 091	90,6
2022	2 397	2 227	92,9

Graph 6.3.1(a) Overall achievement rates in Welding and Metalwork (percentage)



	2018	2019	2020	2021	2022
% achieved at 30% and above	94,9	92,3	88,8	90,6	92,9

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
2018	0,1	0,2	4,9	28,1	33,6	23,0	7,0	2,1	0,9	0,2
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

6.3.2 ANALYSIS OF LEARNER PERFORMANCE IN EACH QUESTION IN WELDING AND METALWORK

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Common errors and misconceptions

The majority of the candidates were not able to differentiate the sounds to be observed during a sound test in Q1.6.

Suggestions for improvement

(a) Teachers are advised to use practical demonstrations to explain and illustrate the different sounds to be observed during a sound test.

(b) In-depth revision and remediation measures must be put in place on the topics of safety and materials. In order to prepare learners to respond with reasons to multiple-choice questions, the use of past question papers is encouraged. They must then apply their practical knowledge to the theory questions.

(c) 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 2: SAFETY

Common errors and misconceptions

(a) In Q2.1 most of the candidates were not able to provide the vital functions that must be checked when first aid is applied.

(b) In Q2.3 the majority of the candidates could not identify the type of safety guards to be used at the opening of the guillotine shears.

Suggestions for improvement

(a) Making use of video presentations and demonstrations will give learners an added advantage when answering the types of questions on first aid.

(b) Learners should be exposed to workshop practice relating to the safety of tools, the equipment in the workshop and the workshop environment.

QUESTION 3: MATERIALS

Common errors and misconceptions

(a) In Q3.1 many candidates' responses exposed a lack of theoretical knowledge as well as practical application with regard to heat-treatment processes.

(b) In Q3.2 the majority of the candidates neglected to describe the temperature to which the steel needs to be heated as well as the quenching method or media.

(c) In Q 3.4 many candidates were not able to give the reason why steel is cooled in still air, away from draughts, during the normalising process.

Suggestions for improvement

(a) Teachers must ensure that learners are exposed to the different processes to enhance their understanding of the properties of steel.

(b) The revision programme must include exercises 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

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

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 Q5.1.3 many candidates could not draw the correctly labelled sketch as per the information labels requested.

(b) In Q5.4 many/candidates lacked the necessary knowledge to correctly draw the welding symbol with the requested labelling insert on the correct position on the welding symbol.

Suggestions for improvement

(a) Learners should be trained to read and interpret questions carefully to ensure that they respond appropriately to the requirements of the questions posed.

(b) More revision using past year examination papers must be included in preparation for the assessment tasks given to learners. Learners need to be exposed to more practical application of theory as this will help understanding and remembering of the content.

QUESTION 6: TOOLS AND EQUIPMENT

Common errors and misconceptions

(a) In Q6.1 many candidates did not know what a punch and shear machine was meant to do.

(b) In Q6.6 some candidates found it difficult to label the machine parts correctly.

Suggestions for improvement

(a) Teachers must use practical demonstrations to explain the functions of the punch and shearing machine in the workshop.

(b) Teachers should show learners the practical components of the workshop equipment and ensure that learners use machines frequently in the workshop.

QUESTION 7: FORCES

Common errors and misconceptions

(a) In Q7.2 most of the candidates were unable to convert the UDL into a point load and calculated reactions incorrectly by swapping the reactions RL and RR.

(b) In Q7.3 most candidates could not manipulate the given formulae to calculate the safe working stress and diameter of the bar from the given formula.

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. A collaborative approach to teaching can be established to achieve this.

(b) Learners should be exposed to more practical exercises related to the formula manipulations when doing calculations.

QUESTION 8: JOINING METHODS – WELD INSPECTION

Common errors and misconceptions

(a) In Q8.1 the majority of candidates had difficulty to differentiate between the procedures in setting-up an arc welder with the arc welding process.

(b) In Q8.4 some candidates had difficulty interpreting the question. They provided responses on the *causes* instead of *prevention*.

(c) In Q8.6 some candidates did not know how to conduct a liquid dye penetration test.

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 videos and other electronic media during class lessons. Field trips should be arranged where welding inspections are conducted.

QUESTION 9: JOINING METHODS – STRESSES AND DISTORTION

Common errors and misconceptions

(a) In Q9.2 most candidates were unable to state the methods used to reduce distortion. Instead, they stated the causes of distortion.

(b) Many candidates had difficulty in labelling the iron-carbon diagram correctly in Q9.6.

Suggestions for improvement

(a) Learners should be exposed to videos during lessons as well as simulations on the factors of cooling rate compared to methods of cooling.

(b) This section consists of factual information and teachers should conduct thorough revision to ensure that learners become familiar with the content.

QUESTION 10: MAINTENANCE

Common errors and misconceptions

(a) In Q10.2 the majority of the candidates provided safety relate to the drill press rather than general maintenance. This was not a requirement of the question.

(b) In Q10.4 many candidates were unable to differentiate between major and minor service during machine maintenance.

Suggestions for improvement

(a) Learners should be given more informal assessment tasks and they should be exposed to industrial site visits where they could observe maintenance being done on machines.

(b) Teachers must involve learners in the maintenance of the equipment in your workshop and make learners responsible for specific maintenance tasks in the workshop. Schools must be sufficiently equipped with the relevant equipment and tools to ensure that practical lesson can take place to develop skills and reinforce the theory.

QUESTION 11: DEVELOPMENT BY CALCULATIONS

Common errors and misconceptions

(a) In Q11.3 most candidates used the formula of area of a circle instead of the circumference formula, as requested by the question.

(b) Generally, these questions need candidates to be proficient on how to perform calculations. Candidates struggled with this question because of the specific mathematical knowledge required.

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 papers for revision and remedial work in preparation for the assessment tasks planned. Also, integration with Mathematics could assist in improving long-term performance.

CHAPTER 7

ENGINEERING GRAPHICS AND DESIGN

The following report should be read in conjunction with the Engineering Graphics and Design question papers of the NSC November 2022 examinations.

7.1 PERFORMANCE TRENDS

There are no available statistical data or Rasch scores for Engineering Graphics and Design candidates. This Diagnostic Report has therefore been compiled based on the empirical data collected during the marking process of the NSC November 2022 examinations and the reports received from the nine provincial education departments. No qualitative comment can be made regarding performance trends of candidates.

7.2 OVERVIEW OF CANDIDATES' PERFORMANCE IN PAPER 1 AND PAPER 2

(a) **Quality of candidates' performance**

It does appear that the 2022 candidates may have performed slightly better in both Paper 1 and Paper 2 than the candidates of 2021. Consensus among the provinces was 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 are designed to be accessible to every candidate. 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, learners have been adequately prepared to cope with the complexities and the content of the examination. These candidates have demonstrated the ability to address the requirements of the questions, to extract and use information appropriately and to manage their time effectively. The inability of the weaker candidates to effectively deal with even the less challenging parts of questions is a clear indication of the deficiencies within the teaching and learning processes.

It is evident that the lack of understanding displayed by many candidates in all the provinces of the basic concepts and techniques covered in the Grade 10 *Curriculum Assessment Policy Statements (CAPS)*, indicates that the topics were not thoroughly covered and consequently this has had a knock-on effect, impacting negatively on 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:** It is imperative that candidates understand that the focus in Engineering Graphics and Design is on graphic content and graphic understanding and that the instructions

are kept as simple as possible. In Paper 1 Q4, candidates were expected to sift through and extract information as and when required. Even in this question, the standard structure of the question remains relatively constant. Many weaker candidates appeared to simply look at the graphics and then assumed what the expected response to the question was. Many candidates also displayed poor comprehension skills by providing incomplete responses or responses that did not address the requirements of the question.

- **Language barriers linked to poor comprehension skills:** Some candidates found it difficult to understand the requirements of questions. Learners need to be taught to *read with understanding*. Learners must also be taught the correct terminology so that they understand what they are expected to do.
- **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. Candidates often rush into answering a question and only later discover that they have not left sufficient space on the drawing sheet to place the required views.
- **The continued use of prepared drawing sheets:** It appears that many teachers are still making use of prepared drawing sheets in school-based tasks. As convenient as it may be for the teacher, the use of prepared drawing sheets removes the necessary practice in the fundamental aspects of the curriculum from the learner and often restricts access to answering a question in an examination. The prepared drawing sheets disadvantage the weaker learners particularly. 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 being reinforced continually. 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 promptly identify errors or valid alternative responses.
- **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.

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 should 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 the instructions carefully and in so doing, understanding what needs to be drawn. Learners should be encouraged to:
  - Read each word of the instruction;
  - Underline or highlight key words in the instructions;
  - Identify where the relevant source information can be found;
  - Plan the layout of the requirements of a drawing;
  - 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 is a widespread habit currently.
- Teachers are advised to, at appropriate times during the Grade 10–12 years, demonstrate the skill of interpreting and analysing past examination questions to their classes. 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 controlled 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. Every learner 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 have a choice of selecting 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 CANDIDATES' PERFORMANCE IN EACH QUESTION IN PAPER 1

QUESTION 1: CIVIL ANALYTICAL

The first few questions were answered very well by a large percentage of candidates. These questions were intended to be less challenging and were set at a low cognitive level. Candidates simply had to read correctly and then find the answer on the site plan or title panel. The middle set of subquestions were less predictable and therefore slightly more challenging as they required the recall of knowledge of the *SANS 10143 code of practice for building drawing and* are set at a middle cognitive level.

The last few questions were intended to be the most challenging as they examined application of the *SANS 10143* content and mathematical concepts in a civil context and are set at a

higher cognitive level. Although these questions were reasonably predictable, it was disappointing to note that many of the more able candidates still performed below average.

All questions covered a variety of civil concepts, in particular, the *site plan* and *title panel*. Weaker candidates continued to be challenged by these topics. However, many stronger candidates were able to show insight and understanding and they achieved good marks.

Common errors and misconceptions

(a) Attention to detail is an important skill in Engineering Graphics and Design. This skill was not displayed by many candidates when attempting to answer a number of the subquestions. Regrettably, many candidates displayed this in the poor answers given for Q1.7 and Q1.11.

(b) A large number of candidates displayed poor reading, comprehension and problem-solving skills and this was disconcerting. This was clearly demonstrated in the answers given for Q1.8 where the question asked the candidates to identify the number of *new* inspection eyes which were found along the new sewerage line. Many candidates incorrectly gave the total number of inspection eyes. Reading with meaning and the ability to understand what is being asked is a contributing factor to why learners do not achieve the marks that they expect to achieve.

(c) Many candidates were unable to use the correct terminology when identifying features. Q1.13 required candidates to state the name of the feature at *1,* which is the *North Point.* The correct terminology can be found in the *SANS 10143 Code of Practice for Building Drawings* and all *DBE* approved textbooks.

(d) The content of the *SANS 10143 Code of Practice for Building Drawings* is fundamental to the content of Paper 1. It was disappointing to note that many candidates had a problem recalling the colour of new steel (blue) and the graphical symbols for Q1.18.1 *face brick (hatching)* and Q18.2 a *staircase.*

(e) In calculating the total length of the *1 800 high palisade fence* in Q1.19, candidates had to refer to the *Symbol Legend* identifying and differentiating the palisade fence from the security fence. They then had to apply a basic mathematical calculation of adding the given lengths shown in the table on the drawing. There was a 3,6 m driveway that then had to be subtracted from the total length. Many candidates could not answer this question correctly. This is a difficult, higher cognitive level question which extended top candidates, and it is therefore understandable that not all the candidates would have been able to calculate the length correctly.

(f) Determining the total area of the *house* in Q1.20 was not an unfamiliar question as it has appeared regularly in past *NSC* examination papers. It was therefore disappointing that many candidates still experienced difficulty in dividing the shape of a simple structure into workable portions and applying the basic mathematical formula of *area = length x breadth*.

(g) All work in EGD must be presented neatly. This includes both printing and freehand line work. The *SANS 10143 Code of Practice for Building Drawings* stipulates the font that must be used in EGD. This should be adhered to in all aspects of drawing. 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.

Suggestions for improvement

(a) Attention to detail is an important skill in Engineering Graphics and Design and can be developed over time. Learners develop this skill through practice and the teacher making them aware of the finer detail in drawings.

(b) If learners are taught to read with understanding, it will help them to comprehend the requirements of the question. Learners must be taught to provide relevant and detailed responses to questions.

(c) Learners acquire knowledge according to the way they were 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 will learn the correct technical terms and terminology is if the teacher uses them continually and correctly.

(d) Teachers must be in possession of the *SANS 10143 Code of Practice for Building Drawings* and regularly refer to the contents. The content can be reinforced by giving learners short formative tests which will also serve as useful revision of work.

(e) Learners must practise applying the mathematical formulae for determining area and perimeter of shapes. Regularly including these calculations in short formative tests can serve as reinforcement and revision.

(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 civil content, and in particular, past *NSC* examination papers with marking guidelines.

(g) The quality of a learner's line work is assessed in the 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.

(h) Subject advisors or subject coordinators should convene regular content workshops to help teachers who are experiencing challenges with content and they should offer support where it is required.

QUESTION 2: SOLID GEOMETRY

There were centres in all provinces where a fair percentage of candidates performed well above average. However, there were also far too many centres where candidates experienced a number of challenges.

It is important to note that the question was designed to allow the weaker candidates to project three views of the right regular pentagonal prism. Then, the slightly more able candidate to place the tilted right square pyramid in the designated position relative to the pentagonal prism. The stronger candidate should have been able to cut the solids projecting and hatching the cut surfaces. The top candidates should then have been able to project the true shape of the cut surfaces.

Even though, when doing revision, it may be considered good practice to provide learners with a partially prepared answer sheet, learners should first master the techniques, skills and methodology needed to project these given views.

Common errors and misconceptions

(a) Orthographic projection is a fundamental Grade 10 concept. Many candidates were unable to differentiate between first-angle and third-angle orthographic projection. 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 that; *ALL drawings are in first-angle orthographic projection.*

(b) The first bullet in the *Instructions* on the question states clearly: *Planning is essential.* Due to a lack of or inability to plan, learners found it challenging to start the drawing in the correct place. Some learners struggled to correctly position the views. This question needed very precise planning to fit the required views onto the drawing sheet.

(c) Candidates continue to have difficulty answering questions relating to the projection of geometrical solids. It was most unfortunate to find out that the majority of the candidates in all nine provinces were unable to correctly construct a pentagon. Constructing polygons is a Grade 10 topic, yet many of the weaker candidates could not start the drawing because they were unable to construct a simple regular pentagon. It must be mentioned that by simply copying the given views correctly, a candidate could have achieved 40% of the marks. However, most candidates could not even complete Grade 10 content.

(d) From those candidates who managed to draw the required three views of the solids, a very poor attempt was made at projecting the true shape of the cut surfaces. Very little knowledge was shown as to where measurements were supposed to be taken from to complete the true shape. They also displayed little knowledge of the technique of hatching adjacent surfaces.

(e) Before candidates sit for an examination, they should have all the necessary skills to complete the examination and not use the examination as a time to learn what they should already know.

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 should regularly emphasise the difference between them.

(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 continue to be discouraged, as it diminishes the learners' ability to attempt an answer because they have been deprived of the regular practice of drawing the basic elements.

(c) Understanding the abstract concepts of drawing and projecting geometric solids starts in Grade 10 with the constructing of regular geometric shapes. These are the fundamental building blocks for all technical drawing and require continuous practice in understanding, perception and graphic problem-solving skills. The inability of candidates to construct a Grade 10 pentagon 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 in preparing drawings of relevant complexity. Learners who are then still unable to visualise the drawing may use other methods of determining, for example, a cut surface. Adding numbers or letters to the edges of a solid is one method that teachers can encourage their learners to use. This will assist learners either in speeding up their drawings 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 who are *spotting* which of the topics are most likely to appear in the examination must stop this practice immediately. While they may have been successful once or twice before, more often than not they will get it wrong, and this will be to the detriment of learners.

(f) Subject advisors must identify the underperforming schools, as informed by the analysis of results and support teachers by providing relevant material on an on-going basis, rather than engaging in damage control prior to the examinations.

QUESTION 3: PERSPECTIVE DRAWING

Although many candidates attempted the two-point perspective question, the general tendency was that candidates started the drawing off well, then rapidly regressed, producing poor quality line work that was inaccurate. The receding portion of the club house was poorly attempted with the semi-circular window not being attempted by most of the candidates. However, having said that it appears that the question was better answered than in the past.

Generally, it was found that correct perspective drawings were produced by candidates from the same centres and that incorrect perspective drawings tended to be produced by candidates from the same centres.

Common errors and misconceptions

(a) Many candidates were unable to accurately determine the position of the two vanishing points with the result that whatever was drawn from that point on was incorrect.

(b) There were still some candidates who moved the position of the given *Horizon Line (HL), Picture Plane (PP)* and/or *Ground Line (GL)*. Moving these lines could possibly alter both the cognitive and difficulty levels of the question.

(c) Many candidates were unable to correctly determine height lines and were therefore unable to determine the height of the receding lines of objects.

(d) Most candidates did not even attempt to draw the semicircle in perspective. Many of those who did, used an inaccurate method to determine the perspective curve and the quality of their perspective curves were poor.

Suggestions for improvement

(a) Determining the vanishing points correctly is fundamental to preparing the drawing and is considered to be at the easy lower cognitive level. They are projected off the *Station Point (SP)*, parallel to the inclined edges of the top view of the object to the *Picture Plane (PP).* At the point of intersection, they project perpendicularly downwards to

meet the *Horizon Line (HL).* There must be neatly labelled *VPL* on the left and *VLR* on the right. The teacher must ensure that all learners are able to perform these basics.

(b) It must be made clear to learners that the position of the given *Horizon Line (HL), Picture Plane (PP)* and *Ground Line (GL)* must NOT be moved. Projection lines are B-type or construction lines that must be visible. Learners must be taught not to erase them but to draw them feintly so that the method used to determine the answer can be seen during marking.

(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 the correct perspective position by joining the heights to the correct vanishing point. When this is done correctly, new height lines may then be constructed.

(d) Projecting a semicircle 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 experiences challenges in drawing, should demonstrate some basic knowledge by dividing up the views of the semicircle into 30˚ segments.

(e) 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 systematically through the drawing so that they do not waste time determining the same points multiple times.

(f) The teaching of the fundamentals of perspective drawing along with methodology and terminology pertaining to that topic is essential. On-going and regular practice is necessary in developing and maintaining a high level of skill and the ability to draw accurate and neat perspective drawings.

(g) It is imperative that teachers provide learners with a number of relevant course drawings which are at the level of complexity that is expected of the Grade 12 learner and ensures that the learner engages with these drawings meaningfully.

(h) Teachers need to address bad drawing practices such as inaccuracy, untidy and incorrect line work and poor printing techniques before they become issues which cannot be fixed. This should start in Grade 10 and continue through to Grade 12.

QUESTION 4: CIVIL AND ELECTRICAL ASSEMBLY

Question 4 was attempted by the majority of candidates and in many instances, the question was answered well.

The civil assembly question involves working with graphic, numeric and verbal information that requires understanding 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 south 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 is designed in such a way that every candidate who applied themselves and practised by using previous NSC examination papers should have been able to answer at least part of each subsection.

Many of the weaker candidates appeared to become overwhelmed with processing the information and possibly found it challenging.

Common errors and misconceptions

(a) FLOOR PLAN

Common errors drawing windows and doors:

- Windows were not drawn using the dimensions shown in the window schedule but simply drawn to fill the gap in the wall on *Answer Sheet page 6*.
- The doors proved to be challenging this year, especially the double swing door in the living room. In some instances, they were not drawn to the correct size and the arc of the door swing was not scribed using a compass.

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 candidates still draw 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 errors adding the hatching:

There was a general improvement in the quality and correct application of hatching from previous years. There are still candidates who applied mechanical hatching to the walls and did not clearly show the double parallel lines at 45°.

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. They appeared to have not been adequately prepared for the examination. Labels must always be printed neatly to the correct size and using the correct font.

(b) SOUTH ELEVATION

Common projecting errors:

The projection of the walls and the roofline from the floor plan was well executed. Some candidates, however, did not project the double-swing door off the floor plan very well.

Common errors drawing the roof:

- As accuracy is a fundamental and an essential component of drawing, only a deviation of 1 mm or 1° is permissible on any measurement in the examination. There was a general problem with accuracy in determining the 20° roof angle on the south elevation. The ridge cover (parallel line) proved to be an even greater challenge even though the measurements were given.
- The majority of candidates incorrectly drew the fascia board and gutter using the break lines as shown in the incomplete south elevation on page 5. This showed a lack of knowledge in the application of break lines. It also demonstrates that candidates are either not reading the question carefully or the teacher is not adequately preparing the learners for the examination. It is vital that learners have access to past NSC papers with marking guidelines so that this type of elementary mistake is not repeated. Instructions in Q4.1.2 were also very clear.
- The height of the roof was often incorrectly calculated because candidates cannot determine an angle using a protractor.
- The rainwater down pipe *(RWDP)* was correctly and accurately projected by those candidates who drew it in. Some of those candidates then either omitted the gulley or used incorrect measurements to draw it.

Common errors drawing the window, door and chimney:

- The window was correctly projected off the floor plan but then its height was incorrectly measured. 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 windowsill were mostly omitted or poorly attempted.
- The height of the finished floor level *(FFL)* was not always determined correctly. The *FFL* must be indicated by a chain line as clearly shown in the incomplete south elevation on page 5 of the question paper.
- The weaker candidates found drawing the double-swing doors at an angle, challenging even though it was simply an exercise in projection.
- The addition of the chimney was a new concept this year and many candidates managed to project and draw it correctly in the south elevation.

Common errors with the labels:

Labelling of the *FFL* and *south elevation* were often left off and when included, most of the candidates printing was of a shockingly poor quality.

(c) DETAILED SECTION

The detailed section was designed to cover the easy to difficult higher cognitive level part of the question. 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. Many candidates appeared not to understand the purpose of a break line and did not extend the view to meet it.

Common errors with the walls:

The height of the wall, from the bottom of the foundation to the wall plate, was measured incorrectly. Many candidates then made mistakes with the measurements of the height and thickness of the finished floor level.

Common errors with the door and chimney:

- Very few candidates attempted to draw the angled door and chimney.
- The door was designed as a difficult higher cognitive level component aimed at the top candidates. It was not unexpected that only a few candidates attempted it.
- However, the chimney, although a new component, was not intended to be that difficult. It appears that but by the time the candidate probably managed to get to it, the transfer and recalculating of measurements became too much.

Common errors drawing the roof:

- Not many candidates displayed much knowledge of the roof detail or showed very little knowledge of the roof detail. Of those candidates who attempted to assemble the 8 components and assessed on the detailed section, many then did not draw them 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 they either did not know how to draw the roof detail or were not taught how to draw the roof detail.
- The pitch of the roof was poorly attempted with the tie beam and rafter not drawn in the correct position through the inside corner of the wall plate and at the correct angle. The knowledge of the beam fill was poor.

Common errors with hatching:

The application of the *SANS 10143* codes for hatching has shown an improvement over the years, especially the freehand substructure hatching. However, there is still a way to go before hatching is applied satisfactorily across all provinces.

Suggestions for improvement

The basic format of this question has remained constant and at the same standard for many years. One of the underlying problems is that it is covered very early in the year. This can be overcome by giving learners revision drawings, preferably past examination papers, throughout the year, to prepare them for the end of the year. However, on the positive side the *Practical Assessment Task (PAT),* contains all the elements of Q4 and should be a good method of not only reinforcing civil concepts but also as revision for the examination.

(a) FLOOR PLAN

- Weaker candidates should be advised to start the drawing by completing the floor plan and correctly including the following: neatly printing room designations and floor finishes; correctly drawing doors and windows to the correct size; adding the electrical layout and filling in the hatching detail. A window frame must be drawn as a set of parallel lines situated in the middle of the wall. The windowsill 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 give the sizes of these features. The relevant electrical symbol must be selected from the table and correctly copied across onto the drawing. The candidate 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) SOUTH ELEVATION

- In order to draw an elevation, there are three general areas on which the teacher needs to concentrate. These are: projection techniques, drawing the roof and accuracy.
- Projecting requires selecting the necessary information off the floor plan and projecting it to the elevation.
- The construction of a roof is a Grade 12 topic and can be challenging. Once the detail and the method have been taught to the learner, the learner should practise assembling and drawing all the components of the roof.
- As a deviation of only 1 millimetre or 1 degree is allowed in any measurement in the examination, it is imperative that accuracy is emphasised.

(c) DETAILED SECTION

- The detail of a roof is Grade 12 content. Learners must be taught and assessed on the order in which the components of the roof are assembled.
- The same applies to hatching patterns used to differentiate the various elements in the sectional elevation.

(d) Teachers should have an ample supply of resources to prepare for this topic. The minimum requirements must be a copy of the *SANS 10143 Code of Practice for Building Drawings*, DBE-approved textbooks and past NSC examination papers.

(e) Course drawings must be 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 to use 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 concept 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 on-going basis.

(i) It is important that every topic should be introduced by 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 CANDIDATES' PERFORMANCE IN EACH QUESTION IN PAPER 2

As always, the debate rages on over why so many candidates were unable to complete the paper in the given time. Was it because the paper was too long? Were the candidates not 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 remains undetermined. It is also not clear as to whether candidates planned properly or whether they managed their time optimally.

What we do know is that all the questions were answerable, not necessarily by the same candidates. We also know that there were candidates in every province that managed to complete the paper and achieved very good marks. We were also able to quantify that the paper was no longer or shorter than any previous year's paper.

QUESTION 1: MECHANICAL ANALYTICAL

The marks obtained by candidates across the country in this question varied from province to province. Some provinces showed a slight improvement in the marks while others experienced a slight decline from the 2022 results. It is a cause for concern as candidates generally perform very well when answering the analytical question.

The first few subquestions were set at an easy to moderate level of difficulty, at the lower cognitive level, proving not to have been a problem for the majority of candidates. The middle set of subquestions were less predictable and therefore, a little more challenging as they 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 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, in particular. Weaker candidates continued to be challenged by these topics. However, the more capable candidates were able to show insight and understanding and they achieved good marks.

Common errors and misconceptions

(a) A matter of concern is the large number of the candidates who displayed poor reading and comprehension skills when answering the subquestions. This was evident in many of the answers that the candidates submitted had no relevance or bearing on the question being asked.

(b) A large percentage of candidates showed a lack of understanding of the third-angle orthographic projection in Q1.7 (identifying the view). Their responses were poor to mediocre.

(c) Calculating dimensions is a standard question and has been asked for many years. Candidates struggled to properly calculate or determine the *complete dimensions* in Q1.10.

(d) Many learners failed to calculate the minimum diameter of the hole at E by correctly applying the given tolerance. Whether candidates in Q1.17 had a reading problem, a

terminology problem, a mathematical problem, or a knowledge problem, is difficult to determine.

(e) A number of the questions come directly out of *SANS 10111*. These are: Q1.5, Q1.6, Q1.7, Q1.8, Q1.9, Q1.14, Q1.16, Q1.18, Q1.19 and Q1.20, all of which are concepts generally used in most aspects of the mechanical drawing. These questions range 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.*

(f) The lack of technical terminology was evident in the inability of many candidates to answer some questions. The responses from candidates indicated that many of them possibly did not understand the terminology or language used in the paper. In Q1.14, the word *truncated* (page 24 of the *CAPS* mentions 'truncated pyramids and cones') should not have been an unfamiliar word to the candidates if the teacher had made them aware of it.

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 would benefit 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 projection is fundamental for the candidate 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 that the learner becomes familiar with the subtle differences between the two and can apply them in any context.

(c) Even though a learner is always calculating a dimension in one way or the other, while drawing, it is often done in the background and possibly without thinking about the finer nuances of the dimension. A complete dimension requires that when a dimension has a prefix (diameter, radius), or a suffix (degrees), that these are added to the dimension when it is recorded. These little subtleties or attention to details must be taught to learners.

(d) Calculating a tolerance is a basic mathematical process that has been asked before. Learners must be taught how to identify and apply a tolerance to a dimension and particularly the mathematical process of determining a tolerance. They then need to practice the concept by applying it to a number of dimensions.

(e) It is absolutely essential that every drawing teacher has a copy of the *SANS 10111 Code of Practice for Engineering Drawing* in their classroom as the content is fundamental to all teaching of technical drawing. It contains all the concepts that are used in most aspects of the mechanical drawing.

(f) 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.

(g) 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.

(h) 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

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.

Teachers still appear to be 'spotting' which topics are more likely to appear in the examination and concentrate their teaching on those topics, possibly ignoring the others. This unfair and unethical practice must be discouraged in the strongest possible terms and the teachers are encouraged to adhere to the *ATP*.

Common errors and misconceptions

2.1 THE MECHANISM

(a) A number of candidates did not copy the given schematic diagram accurately. This made the answer more difficult to determine than intended. This did not require reading or understanding but simply coping given information, to a required scale. This suggests that the topic either had not been adequately covered during the teaching process or the candidates were not adequately prepared. Copying the schematic constituted 24% of the total marks for this sub-question.

(b) Many of the candidates who managed to draw the schematic diagram correctly then appeared not to understand the movement of the mechanism. Whether this was a reading issue, a lack of understanding issue or the lack of teaching of the concept issue, we can only know once these variables are removed.

(c) It appears that some candidates may have had issues with the terminology that described the movement of a mechanism. This was displayed by their inability to determine the locus of point E. However, it must be understood that this part of the question comprised the difficult higher cognitive level part of the question which might not have been well answered by all candidates.

2.2 THE CAM

(a) Although capable candidates were able to score good marks in this subquestion, there were many candidates who did not read the question with understanding. This was made obvious when they did not follow simple instructions.

(b) Although this subquestion was attempted with more success than the mechanism, there were still many errors with some of the fundamentals of the question. Candidates appeared to have challenges dividing the base line into the required number of divisions.

(c) The majority of candidates had challenges with determining the uniform acceleration and retardation movement and could not divide the horizontal and vertical distances into the same number of divisions as is required to determine the movement.

(d) There appeared to be teachers who did not correctly explain all the terminology that is used to describe the movement of a cam, leaving many candidates at a disadvantage. This became evident in those centres where very few if any candidates answered the question.

(e) 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 contained in the *CAPS* must be taught by the teacher. If the *ATP* is adhered to then there should be enough time to complete every topic. Ongoing and regular practice of the basics 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 graphic problem solve 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 in the movement. These include, but are not limited to: sliding, reciprocate, pivot, pin-jointed, crank and swivel guide.

(d) Most candidates incorrectly erased the construction they used which showed the method that determined the answers to questions. In the process they ended up losing marks.

2.2 THE CAM

(a) When learners are taught to read with meaning, it helps to eliminate unnecessary mistakes as they are better able to understand the requirements of the question. This can easily be overcome by teachers using past NSC examination papers as a foundation for both their lesson plans and as revision.

(b) The fundamentals of every topic that has been taught must be reinforced with as many practice drawings as can be managed by learners. In this way, the learners should be able to prevent making unnecessary mistakes under stressful conditions.

(c) Learners acquire knowledge according to the way they were 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 continually. If learners are taught to read with meaning, it will help them understand the requirements of the 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

Most of the candidates attempted the isometric drawing with a large number of them obtaining 80% or more for this question.

Common errors and misconceptions

(a) Many candidates did not show the required auxiliary view for the regular hexagon on the drawing sheet but in many instances still ended up with a correctly drawn hexagon, suggesting that it must have been drawn somewhere. Some candidates who drew the auxiliary view then had challenges transferring the dimensions from the auxiliary view to the isometric drawing correctly.

(b) Many candidates did not show the required circle construction clearly.

(c) Some candidates drew the arcs of the isometric circle in freehand. Most candidates, even some of those who answered the question correctly, did not include the centre lines in the arc.

(d) Many candidates demonstrated poor drawing skills and drew inaccurately. In many instances, line work was untidy and of 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) Isometric drawings require practice. The practice is not only in preparing isometric drawings, applying the concept of the auxiliary view and constructing isometric circles but also about acquiring the skill of converting a drawing from third-angle orthographic into an isometric drawing. The latter takes many learners a long time to acquire.

(b) Constructing an isometric circle or semicircle is a Grade 11 concept. The method that must be used is the one that requires candidates to use a compass to draw the ellipse. Freehand curves are unacceptable and are not marked. Learners must remember to draw centre lines in circular objects.

(c) 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.

(d) It is imperative that the teacher provides learners with a suitable number of relevant course drawings from Grade 10 through to Grade 12 and at the expected level of complexity. Grade 12 learners must engage with the work meaningfully 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 especially from past NSC papers, with marking guidelines.

(e) Isometric drawing is a topic introduced in Grade 10 yet it is a concern that so many candidates are still not able to get the basics right. The ability to convert a Grade 12 third-angle orthographic drawing into an isometric drawing takes a considerable amount of practice. From the number of candidates who found this question challenging, it was evident that many centres in all provinces are not giving learners enough practice tasks and course drawings at an appropriate level. It must also be noted that there are different methods of preparing an isometric drawing, all of which are acceptable.

QUESTION 4: MECHANICAL ASSEMBLY

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 two views. It appears that the question was answered more satisfactorily in this examination than in the past few years. There were still an unacceptably large number of the weaker candidates who appear to become overwhelmed with processing all the graphic and numeric information and who find this question very challenging.

Common errors and misconceptions

(a) Many candidates did not attempt to draw the 'left half' of the 'front view'. 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 and not being drawing fit, a lack of understanding of third-angle orthographic projection resulting in running out of space, or not being able to apply the convention of symmetry as contained in the *SANS 10111 Code of Practice for Engineering Drawings* and a sectional left view.

(b) Candidates also showed little to no understanding of sectioning. This was demonstrated by the number of candidates who hatched the entire sectional left view, including parts of components that were not supposed to be hatched.

(c) The information given for the construction of the M16 hexagonal nut required a candidate to understand that the *AF* (across the flats) distance is determined by applying the formula *1,5 x M.* The construction of the nut in the assembly was poorly executed.

(d) There were some unnecessary but general mistakes made by many candidates. These included omitting centre lines which should have been copied across from the parts sheet. Candidates were unable to assemble the parts.

(e) 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 resources 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 and 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 that learners be given regular revision drawings throughout the year to prepare them for the end-of-year examinations.

(b) 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.

(c) The construction of a hexagonal nut and bolt is a Grade 11 topic as mentioned on page 21 of the *CAPS*. It is unacceptable that there are so many candidates at the end of their Grade 12 year who are still unable to construct them, considering that they appear in every mechanical assembly drawing, in every DBE approved textbook and past NSC examination papers.

(d) Teachers must select level appropriate tasks that contain relevant parts so that their learners can develop their skills and can master the fundamental aspects of mechanical drawing.

(e) Accuracy has to be mentioned again as it is a fundamental aspect in 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.

(f) The exploded isometric drawing, showing the position of each part of the assembly, relative to all the others. It should be used as an aid to help the candidate visualise both the general shape of the parts, and the sequencing of the parts in the assembly.

(g) 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.

(h) Learners should not be expected to sit for an examination without being taught time management. This concept can only be realised by setting course drawings that must be completed within specified time constraints.

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